

## CHAPTER-VI

### INSTITUTE OF WOOD SCIENCE AND TECHNOLOGY BANGALORE

Institute of Wood Science and Technology (IWST) Bangalore, was set up in 1988 under Indian Council of Forestry Research and Education (ICFRE), Dehra Dun, by upgrading the erstwhile Forest Research Laboratory, merging Sandal Research Centre and Minor Forest Products Unit, functioning in the same campus with it. The primary objective of establishing the Institute is to carry out research on all aspects of utilization of forest products. Subsequently, activities pertaining to planting stock improvement programme were also initiated in the Institute. Four main Divisions, viz. Wood Properties and Uses, Wood Seasoning and Preservation, Chemistry of Forest Products, and Wood biodegradation are functioning at IWST. Two more divisions have been started viz. Tree Improvement and Propagation, and Wood Energy. The Institute maintains three field stations. A new multi-storeyed building to house various divisions of the Institute was inaugurated in April 1998 and occupied besides a Tissue Culture Laboratory and Extension Hall.

#### PROJECTS COMPLETED DURING 1998-99

Nil

#### OLD PROJECTS CONTINUED DURING 1998-99

**Project 1: Study of anatomical, physical and mechanical properties of plantation grown timber; *Acacia mangium*, *Acacia auriculaeformis* and *Tecomella undulata*.**

**Objectives:** (a) Study of anatomical structure of wood with special emphasis on identification of timber and assessment of wood quality. (b) Study of physical and mechanical properties of lesser known and plantation grown timber. (c) Classification of different end users.

#### Achievements

Five trees of 8-9 years old *A. mangium* were obtained for investigation. Data generated on strength properties of a single tree of *Grevillea robusta* were compiled in the form of a research article. The data indicate that the timber can be used for door shutter, joinery and frames, furniture, turnery and light construction, besides its use as packing material.

Analysis of data on variation of electrical properties with moisture content from pith to periphery in *Cupressus* and *Tecomella undulata* timber is under progress.

Studies of the electric effect on plantation grown timber species (Eucalyptus, rubber wood, teak and silver oak) are under progress.

**Project 2: Computer assisted wood identification.**

**Objectives:** To prepare Window-based user friendly software which can be used for species identification.

## Achievements

Card key features prepared for 20 species.

### **Project 3: Development of multipurpose software for calculating the properties (Strength) of timber spp. CALPRO.**

**Objectives:** In India nearly 1200 timber species of commercial importance are available but strength properties are known only for 400 species. The data are available in the form of research articles which are not easily available to the user. Thus, computer software CALPRO is in the process of development. It aims at displaying strength properties data. The in-built data base will contain strength properties data reported so far in various journals/research articles on timber grown in India. In the absence of data on a particular timber, software uses strength-specific gravity relationship.

## Achievements

Literature survey carried out to collect information for adding on to the database. Computer program developed earlier was further improved by adding new features and sub-routines.

### **Project 4: Non Destructive Testing (NDT) of timber.**

**Objectives:** Many times enough samples are not available for determining strength properties of timbers. The above project is aimed at developing a suitable co-relation and standard methods for determining the strength properties by NDT.

## Achievements

Data have been generated to determine the strength properties for *E. tereticornis* clone for within tree variation.

### **Project 5: Effect of growth stresses on processing of timber from plantation.**

**Objectives:** Assessment of growth stress in timber from plantation; alleviation of stress and developing appropriate conversion techniques for their rational utilisation.

## Achievements

Longitudinal growth strains were measured in logs of *Acacia auriculiformis* drawn from different age group of plantations of Honnavar range in Karnataka State. Results of the study indicate that the growth strain are higher (1700 micro strain) in younger trees compared to older ones (250 micro strain).

Similar work was carried out on stems of trees of *Eucalyptus* species of 30 years old trees. Growth strain in the trees varied from 30 micron strain to 1400 micron strain. Larger diameter trees were found to possess less stresses compared to younger ones.

## **Project 6: Modifications in design of FRI type solar drying kiln for improved energy efficiency.**

**Objectives:** To modify the existing kiln design in order to reduce the drying times in seasoning of wood.

### **Achievements**

Experiments on heat storing systems in kiln for extended period of operation after sunset were carried out using pie of black stones, blackened concrete bricks and water in a container in prototype models. Results indicated best performance under black stone presence, especially for energy storing as well as radiating heat energy. However, this has to be further tested under standard conditions before any recommendations are made for its adoption.

## **Project 7: Weathering of Wood Surfaces and its Protection.**

**Objectives:** (a) To study interaction of wood and its constituents with various environmental /weathering factors. (b) Evaluation of the efficacy of chemical pre-treatments for surface protection against outdoor exposure. (c) Development and assessment of chemical pretreatments to enhance life of paint coatings on wood surface.

### **Achievements**

Pre-treatment of wood surfaces with chromium trioxide (chromium VI compound) and ferric chloride was found to restrict surface degradation and provide significant resistance to fungal staining in outdoor exposure.

Rubber wood samples acetylated with acetic anhydride (10 % WPG) along with untreated control were exposed to natural weathering. Partial protection against weathering was achieved with acetylation.

Samples of *Hevea brasiliensis* and *Pterocarpus marsupium* were pre-treated with different inorganic salt solutions and subsequently coated with three types of commercial paints, viz., synthetic enamel paint, acrylic paint and polyurethane paint. These were examined for their performance against outdoor exposure. The extent of loss of lignin from the surface of coated specimen was significantly less than those of uncoated specimen. Pre-treatment reduces delignification and also prevents peeling of coating over wood surfaces.

Wood of *Pterocarpus marsupium* contains high content of water soluble extractives. Samples treated with dilute aqueous solutions of certain inorganic salts were found to arrest the leaching of extractives effectively.

## **Project 8: Chemical modification of wood.**

**Objectives:** (a) To improve dimensional stability, water repellency and biological resistance of wood. (b) To impart novel properties like thermoplasticity and solubility. (c) Value addition to variety of lignocellulosic materials, secondary timbers and sawdust through chemical modification.

### **Achievements**

The reaction kinetics of phenolic anhydride with wood was carried out to optimise the reaction conditions to achieve the desired extent of modification in wood. Modification of wood by maleic anhydride and phenolic anhydride imparted thermoplasticity to wood. Yellowish brown colour plastic like sheets were

developed by hot pressing the modified wood powder at a temperature of 120°C and pressure 120 kg/cm<sup>2</sup> for 3 hours.

### **Project 9: Efficacy of preservatives for enhancing durability of timber.**

**Objectives:** (a) To generate data base on durability of plantation timbers (*Eucalyptus teriticornis*, *Eucalyptus camaldulensis*, *Hevea brasiliensis* and *Ficus bengalensis*). (b) To study the efficacy of preservatives.

#### **Achievements**

Durability studies on timbers from plantation were continued. It was observed that treated stakes of *Hevea brasiliensis* (rubber wood) with a minimum absorption level i.e 0.5lb cft by both CCA and CCB preservatives were sound for over 54 months, whereas untreated rubber wood stakes were destroyed within 3-4 months of installation. Also, all the treated (with CCA & CCB) stakes of *Eucalyptus teriticornis*, *Eucalyptus camaldulensis* and *Ficus bengalensis* also remained sound though some of the untreated *Ficus bengalensis* and *Eucalyptus* showed mild termite attack on it.

### **Project 10: Environmental effects of wood preservative.**

**Objectives:** To understand the mechanism of fixation of preserving chemicals in plantation timbers.

#### **Achievements**

Comparative chemical analysis made on leach of extracts in specimens of *Albizia chenensis* treated with CCA (loading of 16 kg/Cum) after 25 hours of agitation in sea water and tap water indicated traces of copper, chromium and arsenic in leached solution. Further investigations are in progress.

### **Project 11: Wood fibres in thermoplastic composites.**

**Objectives:** To enhance compatibility between wood fibre and synthetic polymers by different coupling agents and grafting.

#### **Achievements**

Wood fibers of Eucalyptus were grafted with styrene using aqueous solution of Mn<sup>3+</sup> ions at pH 6.0. Polymer loading as high as 200% and a maximum grafting efficiency of 90% was achieved. Composites from grafted wood fibers were prepared with polystyrene at 5,10,15 and 20% fiber loading using a laboratory extruder. Wood fiber filled composites exhibited superior tensile strength and impact strength.

### **Project 12: Effect of repeated cycles of wetting and drying on physical and strength properties of wood.**

**Objectives:** (a) Study of adsorption behaviour of treated wood. (b) Effects of repeated cycles of wetting and drying on treated timbers.

#### **Achievements**

Preliminary studies for standardisation of experiment on the behaviour of untreated timber under repeated wetting and drying for different cycles are in progress. The initial results indicate marginal increase in weight of treated timbers compared to the controls.

### **Project 13: Studies on qualitative improvement of *E.* hybrid oil for value addition.**

**Objectives:** To modify the aroma of *E.* hybrid oil by simple chemical reactions for better utilization in perfumery and industry.

#### **Achievements**

Successful reactions were standardised. Sensory evaluation indicated that three modified varieties of oil are of perfumery interest due to disappearance of cineole.

### **Project 14: Scientific debarking experiments on *Machilus macrantha*.**

**Objectives:** To evolve scientific debarking techniques to minimise damage to the tree and have sustained yield of bark.

#### **Achievements**

Regeneration of bark was found to be very good in 90% of trees resulting in their survival. This method will help in sustained yield of bark with least damage to this valuable tree. Solvent extraction of the bark was taken up to isolate extractives/chemical constituents.

### **Project 15: Studies on Red sanders wood.**

**Objectives:** Study of physical and chemical properties of Red sanders wood.

#### **Achievements**

The yield of santalins, the red pigments, was more by methanol extraction of wood. The isolated extracts were subjected to further analysis. The colour of wood darkens irreversibly on exposure to both visible/UV light.

### **Project 16: Preparation and screening of compounds of biocidal and pharmacological activity.**

**Objectives:** To assess the biocidal or weedicidal efficacy of natural products and isolates.

#### **Achievements**

*Eucalyptus* hybrid bark extract as a weedicide for parthenium grass and steam volatile portion of creosote as an antifungal agent for rubber wood showed encouraging results.

### **Project 17: Research on Sandal.**

**Objectives:** Utilization of spent sandalwood powder.

#### **Achievements**

Spent (exhausted) sandalwood powder on simple chemical treatment yielded two new oils of different aroma. Perfumery evaluation of the new oils is in progress. Isoenzyme studies on trees from different provenances and analysis of soil samples collected from these areas are also in progress.

### **Project 18: Chemical and utilization studies on *Pterocarpus marsupium* wood.**

**Objectives:** (a) *In situ* conversion of water soluble colouring matter into insoluble complex to prevent leaching.

#### **Achievements**

Treatment with three different mixtures of inorganic chemicals has successfully prevented leaching of colouring matter from the wood.

### **Project 19: Studies on durability of different timbers and timber products against biodeterioration under terrestrial and marine conditions.**

#### **Sub-Project 19(1): Control of biodeterioration with the help of water-borne preservative and bioactive substances under terrestrial conditions.**

**Objectives:** (a) Collection of plant extractives and other bioactive substances. (b) Treatment of bioactive substances with perishable wood and testing the efficacy of treated wood against stain and wood rot fungi. (c) Recommendation for end users depending of the effectiveness of treatment.

#### **Achievements**

Clean and odourless preservative formulations have been obtained by steam distillation of creosote. Potential use of this Steam Volatile Creosote (SVC) as an effective preservative has been tried and results are encouraging. Behaviour of wood rotters on water repellent property of treated rubber wood under laboratory conditions with differential decay pattern has been recorded.

#### **Sub-Project 19(2): Natural resistance of timber and timber products against decay fungi under terrestrial conditions.**

**Objectives:** (a) Testing the wood to find out the natural resistance against wood rotting and staining fungi under laboratory conditions. (b) Finding out the durability class and making recommendations for the user.

#### **Achievements**

Large collection of authentically identified staining and wood rotting fungi required for bioassay studies is being maintained in the laboratory. Natural resistance of *Tecomella undulata* wood against stain and wood rotting fungi is being tested under laboratory conditions. Marine wood fungi have been isolated from affected catamarans and are being sub cultured to get pure strain. Effects of these isolated fungi on wood blocks are being tested under laboratory conditions.

#### **Sub-project 19(3): Studies on insect pest problems of timber in storage, building materials and other structures and ascertainment of control.**

**Objectives:** (a) Identification of timber pests. (b) Studies on the bio-ecology, seasonal occurrence, and extent of damage and natural enemies. (c) Study and evolution of appropriate prophylactic and other control methods.

## Achievements

Surveys were conducted at different timber depots and wood industries of Karnataka to study the insect pest problems. Beetles belonging to different families like Platypodidae, Bostrychidae, Lyctidae, Scolytidae, Curculionidae and Cerambycidae were collected from timber under different moisture content. *Platypus* spp., *Lyctus africanus*, *Minthea* sp., *Sinoxylon anale*, *S. atratum*, *Heterobostrychus aequalis* and many species of Cerambycids including *Stromatium barbatum*, *Xystocera globasa*, *Batocera rufomaculata* were collected and identified. The infestation of *Lyctus* sp. on blockboards used for furniture work was found very serious.

A new commercial preservative formulated from Cashew nut shell oil was tested in the field against termites using rubberwood as test material. The standard test pieces were subjected to vacuum followed by pressure impregnation of the chemical. The preservative treated test materials were exposed to field tests. Upto six months observations reveal that the treated stakes resist the termite attack. Wood specimens subjected to pressure impregnation and dipping treatments with chlorpyrifos formulations continued to be resistant against termites even after three years of exposure to termites in the field.

## Sub-project 19(4): Studies on durability of different timber and timber products against bio-deterioration under marine conditions.

**Objectives:** (a) To make observations on the fluctuations in occurrence, distribution and ecology and biology of marine wood-boring and fouling organisms. (b) To assess the natural durability of different species of Indian timbers and various panel products. (c) To identify suitable timber species for further work. (d) To determine the factors, like presence of naturally occurring biocides responsible for natural durability of timbers. (e) To assess the efficacy of wood preservatives. (f) To study the marine fungi and interrelationship between microorganisms (preconditioning effect of primary film) and wood-infesting organisms.

## Achievements

Natural resistance of 82 timber species was studied in Krishnapatnam seawaters. Most of the species were destroyed within a short period of 6 months. However, three species of timber, namely *Xylia xylocarpa*, *Adina cordifolia* and *Garcinia indica* performed better. The species performance will be studied again to recheck the results.

Five species of timber, i.e., *Lanea coromandelica*, *Symplocos spicata*, *Euoida* sp., *Chloroxylon switenia* and *Ficus asperima* were exposed at Visakhapatnam during March, 1998 for evaluation of their natural durability. *L. coromandelica*, *S. spicata*, *Euoida* sp. and *F. asperima* were destroyed within 5 months and *C. switenia* was rejected at the end of 12 months.

Exposure trials on treated panels: (1) Observations were made on CCA and CCB treated test panels. The panels suffered attacks ranging from 10-30%. (2) Pine panels treated with 2%, 4%, 6%, 8% and 10% solutions of ammonium and chromium acetates and exposed at Visakhapatnam harbour were found to have lasted just for 3 months because of severe attack by teredinids, especially, *Bankia campanellata*. The important foulers observed during the period were: *Serpula vermicularis*, *Balanus amphitrite*, sponges, ascidians, sabellids and bryozoans.

At Kochi, the tests on durability of preservative treated timbers were concluded in January, 1999. Among the 10 species of timbers treated with CCA and CCB preservatives, some of the panels were found to be in very sound condition while other were heavily destroyed. Detailed inspections are under way.

## **Project 20: Diseases and pests of seedlings in nurseries, plantations and natural forests.**

### **Sub-Project 20(1): Studies on diseases of seedlings (in nurseries), plantations and natural forests.**

**Objectives:** (a) Survey for incidence of disease and pests in nursery and plantation. (b) Developing different methods to control the pest and diseases. (c) Maintenance of healthy seedlings in nursery and plants in plantations.

#### **Achievements**

Various nurseries and plantations maintained by IWST, SFD, UNDP, World Bank Projects and NGOs were regularly surveyed for incidence of pest and diseases and suitable control measures were suggested.

### **Sub-project 20(2): Study of insect pests of nurseries, plantations and of natural forests and their control.**

**Objectives:** (a) To identify the pest problems and study the seasonal occurrence and population intensities. (b) To study the biology, host spectrum, natural enemies etc. of the pests. (c) To evolve suitable prophylactic and other control measures.

#### **Achievements**

Seasonal surveys were conducted in the forest nurseries, plantations and natural forests of Karnataka, Goa and Andhra Pradesh. The major pests were collected, identified and bio-ecological aspects were studied in the laboratory.

Eggs, nymphs and adults of the spiralling whitefly *Aleurodicus dispersus* Russell were observed infesting the leaves of variety of important avenue and forest tree species. Maximum infestation was noticed on *Tectona grandis* (484.5 nymphs/leaf) followed by *Michelia champaca* (379.8 nymphs/leaf). *Psidium guajava* (365.8 nymphs/leaf), *Euphorbia pulcherimma* (337.5 nymphs/leaf) and *Eucalyptus camaldulensis* (154.8 nymphs/leaf). Although the infestation was noticed on other tree species also like *Eugenia jambolana*, *Artocarpus heterophyllus*, *Bauhinia variegata*, *Tespesia populnea*, *Pongamia glabra* and *Polyalthia longifolia*, the intensity of attack was low.

Survey of the sandal plantations at Yelwala revealed occurrence of three borers viz., *Aristobia octofasciculata*, *Zeuzera coffea* and *Indarbela quadrinotata* attacking sandal. Occurrence of a Trypetrid fly feeding on the fruits of sandal was also observed. Enumeration work on the borer-attacked trees was carried out. RBD experiments were conducted to study the effect of ovicidal/larvicidal action of insecticides Monocrotophos, Chlorpyrifos, Quinalphos, Neem oil and Endosulphan for the management of the three borers. Further observations and studies on the insect borer incidence are being taken up.

As regards teak, all the clones were found susceptible to the attack of teak defoliators. Other than the defoliators, the major pests observed on teak seedlings, saplings and trees were the whiteflies, spittle bugs, and *Ptylus* sp.

*Switenia macrophylla* was found to be severely infested by a coccid *Hemilecanium imbricans*. The host spectrum of this pest includes 6 important tree species. *S. macrophylla* is a new host record of this pest.

Silk cotton trees (*Ceiba* sp.) in Bangalore showed symptoms of gummosis, bark peeling and drying of branches, which led to the mortality of some of the trees. Studies revealed that the Cerambycid borer, *Batocera rufomaculata* inhabiting the sapwood area below the bark damages the tree to a great extent. Studies are in progress.

### **Project 21: Studies on biofertilizers.**

**Objectives:** (a) Literature collection regarding VAM fungi and its application to different forestry species. (b) Collection of pure strain and composite spores of different species of VAM and multiplying them. (c) Studying efficacy of VAM application on different forestry species. (d) Extension of the techniques for the end users.

#### **Achievements**

Pure strain of VAM fungi and composite spores are being multiplied in nursery by pot culture technique using maize as nurse seedlings. Efficacy of VAM fungi is being tried on different forestry seedlings to assess growth and survival percentage. Experiments are being conducted to observe the effect of biofertilizer on Sandal seedlings in root trainer and polybags. The results are encouraging.

### **Project 22: Studies on mangroves and coastal vegetation.**

**Objectives:** (a) To study the occurrence, distribution, systematics, ecology and biology of marine borers, foulers and fungi and associated organisms in mangroves of Goa, Karnataka and Andhra Pradesh. (b) To study the insect borers and defoliators of coastal zone vegetation. (c) To assess the extent of damage caused by marine wood-infesting organisms to living mangrove vegetation and also host specificity. (d) To suggest ways and means to minimise damage to mangrove vegetation, including seedlings, for effective afforestation and management of this endangered ecosystems. (e) To gather information on the biodeterioration aspects (insect defoliators and borers) of mangrove associates and other tree species suitable for coastal plantations.

#### **Achievements**

Survey of Coringa mangroves (Kakinada) and Visakhapatnam mangroves of east coast and Coondapur, Karwar and Goa in the west coast revealed the occurrence of trees like *Rhizophora mucronata*, *R. conjugata*, *Excoecaria agallocha*, *Avicennia officinalis*, *A. marina*, *A. alba*, *Sonneratia apetalea* etc. Many species of defoliators, leaf and stem galls, leaf miners, stem borers and fruit and seed borers were found infesting many of these spp. The major defoliator on *Rhizophora mucronata* was *Pteroma plagiophleps*, the bionomics of which was studied in detail. *Hyblaea puera*, *Dasychira mendosa* and *Homona coffearia* are reported from *Avicennia* sp.

### **Project 23: Biological investigations on marine fouling and wood boring organisms.**

**Objectives:** (a) To monitor the faunistic composition and variability in attack of wood borers and marine foulers.

#### **Achievements**

Faunistic composition of biofoulants comprises balanids, hydroids, serpulids, ascidians, sponges, sabellids and bryozoans etc. Among borers, *Lyrodus pedicellatus*, *L. biparitata*, *Bankia campanellata* and *Martesia striata* were found to be dominant.

## **Project 24: Efficacy of preservatives against bio-deterioration.**

**Objectives:** (a) To evaluate the efficacy of CCA and CCB preservatives in preventing marine biodeterioration and increasing life of timbers.

### **Achievements**

Seven species of timber, namely, *Toona ciliata*, *Trema orientalis*, *Erythrina indica*, *Ficus mysorensis*, *Samanea saman*, *Melia dubia*, *Bombax ceiba* and *Ailanthus excelsa* treated with CCA and *T. ciliata* and *F. mysorensis* treated with CCB are undergoing trials at Visakhapatnam harbour.

## **Project 25: Assessment of service life of treated timber structure under aquatic conditions.**

**Objectives:** (a) To enhance the life of structures under actual service conditions to help the poor traditional fishermen.

### **Achievements**

Untreated catamarans made of *Bombax ceiba* suffered severe fungal attack and became unserviceable after 9 months. Prophylactically treated catamarans made of *B. ceiba* suffered fungal attack and became unserviceable in 13 months. CCA treated catamaran of *Albizia falcataria* put to service in 1995 continued to be in very sound condition. However, *B. ceiba* catamarans treated with CCA and put to service in 1986 continue to offer good service even after 13 years though few cracks and splits developed in a few of them.

## **Project 26: Research on Sandal.**

**Sub-Project 26(1): To identify provenance areas and collect test seeds from these to develop a gene base for genetic improvement.**

**Objectives:** (a) To identify provenances and conduct isoenzyme assessment of plant material to study genetic distance between different provenances. (b) Analysis of core samples of heartwood to study variation in heartwood and oil content.

### **Achievements**

Iso-enzyme studies on trees from different provenances were continued. Composite soil samples from each provenance area were collected and analysed. Evaluation of the new oils prepared from exhausted (spent) sandal powder which is different from sandalwood oil is in progress.

**Sub-Project 26(2): To develop nursery practices including *in vivo* and *in vitro* propagation technologies for mass production of high quality planting stock.**

**Objectives:** (a) Development of protocol for operational scale production of quality seedlings of Sandal. (b) Generation of technology for vegetative propagation of quality planting stock. (c) Development of protocol for production of high quality (high oil yielding clone) planting stock through *in vitro* cloning.

### **Achievements**

Seeds were collected from clonal orchard of Sandal. Germination studies were carried out in mother beds as well as in various potting media in trays (eight germination media composed of sand, soilrite, vermicu-

lite, perlite, cocopeat in different combinations). Germination in gunny bags was also carried out. Pre treatment of seeds with GA<sub>3</sub>, vermiculite at elevated temperature (+300) favoured early germination (45 days to 30 days). Two leaf seedling stage was found to be better than 4-6 leaf stage for the establishment of seedlings in containers (polybags and root trainer). Result of potting media experiment revealed that compost and sand combination favoured better growth of seedlings than traditional potting media (soil, sand and FYM). Grading of seeds and germinated seedlings helped in production of uniform seedlings in root trainers and polybags. Early results of experiment on containers size and type indicated that 270cc root trainers block type could be used for raising seedlings of Sandal.

Micrografting experiments are being carried out to standardise age of the stock material, incubation conditions and best period of grafting. Mother stock of 30, 60 and 90 days old seedlings are being used.

Studies on *in-vitro* cloning of high oil yielding clones initiated since September 98 after establishment of new tissue culture laboratory. Physicochemical (explant type, size, media, growth hormones incubation conditions) conditioned were optimised for high frequency multiple shoot induction from mature and selected genotypes (clones). Experiments on clone specific response on multiple shoot induction, multiplication of differentiated shoots are being carried out particularly on media, growth hormones, additives, sub-culturing period, explant size and incubation condition to achieve high frequency multiplication rate and rejuvenation of culture.

### **Sub-Project 26(3): Study of various pathogens and pests and development of suitable protective measures.**

**Objectives:** (a) Survey for incidence of diseases and pests in nursery and plantations. (b) Developing different methods to control the pest and diseases. (c) Maintenance of healthy seedlings in nursery and plants in plantations.

#### **Achievements**

Survey completed to study the incidence of pests and diseases in all Sandal bearing areas. Nursery and experimental plots at IWST institute, Gottipura, Nallal and Yelwala are being regularly visited to study the incidence of diseases and to evaluate the control measures. Physiopathological studies in healthy and spiked plants have been done.

### **Project 27: Tree Improvement.**

**Sub-Project 27(1): To establish and evaluate provenance and progeny trials, including assessment of trials already laid out by SFDs.**

**Objectives:** (a) Evaluation of provenances and progenies of Teak, *E. tereticornis* and *C. equisetifolia*.

#### **Achievements**

Seedling Seed Orchards cum progeny trial of *Casuarina equisetifolia* has been established in 4 ha at Nellore, Andhra Pradesh comprising genetic base of 400 families. Six monthly evaluation is being carried out. Variation in growth (height and collar diameter) between families and in some cases within family were recorded. SSO cum progeny trial of teak was established at Bhakarapet range, Andhra Pradesh, which comprise 49 families (seed source CSO Tithimathi and Chandrapur).

**Sub-Project 27(2): Study of variability of growth rate, yield, quality of timber, resistance to disease and pests, and identification of superior phenotypes and provenances.**

**Objectives:** (a) Selection of provenances and superior phenotypes based on above parameters.

#### **Achievements**

Collected data on sp. gravity for 20 trees (600 specimen) representing 5 clones for between tree variation (repetition). Collected data on fibre diameter, lumen diameter, wall thickness for 12 trees representing 3 clones. Collected data on vessel characters for 20 trees representing 5 clones. Collected data on tissue proportion for 12 trees representing 3 clones. Data analysis is under process. Preparation of pulping for 12 trees of 3 clones and 2 trees of others completed. Proximate analysis: Alcohol-benzene extractive and holocellulose content estimated for all the twenty trees of five clones. Collected data on sp. gravity, fibre characters, vessel characters for CPT of *E. tereticornis* from Tamil Nadu. 21 CPTs of *E. tereticornis* for wood quality analysis were collected from Andhra Pradesh Forest Dept. Preliminary survey of Eucalyptus plantation from SPA for wood quality assessment of standing trees was done. Sp. gravity and rate of growth were determined for 20 clones of Teak obtained from CSO of Thithimathi. Survey of *Casuarina equisetifolia* plantation for SPA was carried out. Assessment of wood quality of standing trees was made with the help of Pilodyn and specific gravity was determined for 15 trees.

**Sub-Project 27(3): Studies on vegetative propagation of selected clones and evolving mass propagation technique.**

**Objectives:** (a) Development of protocol for vegetative propagation of CPTs/Plus trees/Superior genotypes for mass production of clonal planting material.

#### **Achievements**

Studies were conducted with various potting media, growth hormones (auxin, IBA/ NAA, NOA), and different types and size of stem cuttings of teak. Woody stem cuttings (3-5 months) treated with IBA (2000 - 5000 ppm for 1-2 hrs) induced root induction (50%) within 45 days under green house condition. Out of the various potting media, used soilrite was found to be the best for lateral root formation. Intermediate green stem cuttings responded with IBA 1000 - 2000 ppm treatment (1-2 hr) and induced 20-30% root induction, which need further experimentation for high frequency root induction.

**Sub-Project 27(4): Development of tissue culture protocols for the selected genotypes (*Tectona grandis* and *Eucalyptus tereticornis*).**

**Objectives:** (a) To develop tissue culture protocols for the selected genotypes (*Tectona grandis* and *Eucalyptus tereticornis*) for production of superior clonal planting material.

#### **Achievements**

Literature survey was carried out on *in vitro* cloning and embryogenesis.

Experiments were conducted on pre-treatment of explants, media, growth hormones, additives and incubation conditions to achieve high frequency multiple shoot induction.

Nodal shoot segment as an explant was found to be better than apical shoot segment for establishment of multiple shoot cultures. Embryogenic cultures were established from the zygotic embryo and leaf as an explant in teak.

In case of Eucalyptus, vegetative multiplication garden of 25 clones was established in 1998 and source material for cloning is being used from selected 5 clones, which are fast growing.

### **Project 28: Utilization of alternative timbers for Catamarans.**

**Objectives:** (a) To reduce investments by increasing the service life of catamarans made of alternative timbers through treatment.

#### **Achievements**

Panels of *Bombax ceiba* and *Albizia falcataria* treated with high concentration of CCA and ACQ and rest of the panels treated with low concentrations of ACZA and ACC were removed to lab in January 99 for analysis as they were found destroyed. Panels of *Ailanthus malabaricum*, *Albizia chinensis*, *Albizia falcataria*, *Bombax ceiba*, *Eilocarpus* sp. *Erythrina variegata*, *Ficus mysorensis*, *Kydia calycina*, *Populus nigra* and *Toona ciliata* treated with high concentrations of CCA and CCB were exposed at Krishnapatnam and analysed for performance. All panels are found in good conditions. Observations were continued.

Untreated panels of 10 species of potential catamaran timbers were exposed at Krishnapatnam in October '98 and studied for their natural durability. Panels were destroyed within 3 to 6 months.

Wood borers and foulers, regularly collected from untreated and treated panels exposed at Krishnapatnam, Vizag and Cochin, were identified.

Five more treated catamarans made of *Bombax ceiba* launched in Feb. 99 along Chennai coast. Small blocks of *Bombax ceiba* and *Toona ciliata* were pressure treated with CCA and experiments on leaching under laboratory conditions are in progress.

Group meetings of fishermen were organised wherein fishermen from 5 adjacent villages of A.P. and Tamil Nadu participated. Catamaran protection technology was explained with the help of brochures and pamphlets.

### **Project 29: Planting stock improvement under World Bank.**

#### **Sub-Project 29(1): Seed Production Areas (SPA).**

**Objectives:** Identifying source of quality seed for improved planting material.

#### **Achievements**

Based on the survey of 740 ha teak plantations in Karnataka and comparison between stands/plantations, 74 ha, the best plantations were selected in Haliyal and Yallapur Forest Division. After completion of enumeration of the selected plantations for SPA, marking was done to cull inferior trees. Culling operations in 29 ha has been completed. In case of Eucalyptus, after survey of 30 ha plantations, 3 ha area was selected and enumerated. Marking works have been carried out. Surveyed 50 ha casuarina plantation in and around Nellore (coastal area - Andhra Pradesh) and selected 5 ha plantation. Enumeration was carried out to identify inferior trees for culling.

### **Sub-Project 29(2): Clonal Seed Orchard (CSO).**

**Objectives:** (a) Early and regular supply of quality seeds from superior tested clones for improved planting stock. (b) Enhance synchronised flowering and seed setting.

#### **Achievements**

Clonal Seed Orchard of teak in 2 ha was established in 1997 at Mulgu consisting of 25 clones, which is maintained by Forest Research Centre (FRC), Hyderabad. During 1998-99, IWST has established 2 ha Clonal Seed Orchard of 25 clones of *Eucalyptus tereticornis* and 4 ha Clonal Seed orchard of *Casuarina equisetifolia* comprising 25 clones at Nellore. Four ha CSO of Sandal was established in S.V. University Campus, Tirupathi in August 98, which has a genetic base of 25 clones.

### **Sub-Project 29(3): Seedling Seed Orchard (SSO).**

**Objectives:** (a) To maintain an *ex-situ* gene conservation bank as a source of quality seeds. (b) To have a broader genetic base for tree improvement programme. (c) Genetic testing and seed production.

#### **Achievements**

In order to establish SSO of Teak, seeds from CSO of Teak at Tithimathi and Chandrapur were collected and seedlings raised. Twenty five hectare SSO of Teak comprising 49 families was established at Bhakarpet Forest Range near Tirupathi, Andhra Pradesh. SSO of Sandal of 25 families was established at Sidalgundi, and 1 ha at Kuchubarapally, Bhakarpet Forest Range, Andhra Pradesh. Casuarina SSO (4 ha) was established at Nellore.

### **Sub-Project 29(4): Vegetative Multiplication Garden (VMG).**

**Objectives:** Establishment of vegetative multiplication garden of Teak, Eucalyptus and Bamboo as a source of clonal planting material and germplasm.

#### **Achievements**

VMG of teak with 41 clones established in 1996 at Gottipura and VMG of Teak having 25 clones at IWST Campus were maintained and used for vegetative propagation. VMG of *Eucalyptus tereticornis* with 25 clones was established in 2.9 ha at Nagroor, Guddadahalli and Bangalore.

### **Sub-Project 29(5): Model Nursery.**

**Objectives:** (a) To establish a compact service centre providing nursery and vegetative propagation facilities to a range of research programmes at the Institute. (b) Standardisation of protocol for raising quality seedlings of different species. (c) Production of quality planting stock and demonstration of technology.

#### **Achievements**

##### **Model Nursery:**

Vegetative propagation work has been taken at IWST Campus in the existing facilities till the green house-cum-mist chamber is constructed at new site of Model nursery (Nagroor, Bangalore). Preliminary work has been done to raise a model nursery in 1 (one) ha area.

## NEW PROJECTS TAKEN UP IN HAND DURING 1998-99

### **Project 30: Evaluating efficacy of preservatives against marine bio-deterioration.**

**Objectives:** (a) To evaluate the efficacy of some inorganic acetates in warding off marine borer attack.

#### **Progress made**

Pine panels treated with different concentrations of the solutions of ammonium, calcium and chromium acetate exposed at Visakhapatnam were found to be destroyed in just 3 months by the activities of the teredinid borers, especially *Bankia companellata*.

## EXTENSION

### **(a) Consultancy to various agencies rendered:**

Consultancy services like testing of samples, advice in right choice of timber, identification of wood samples, testing of new pesticides and preservation etc. were rendered to various agencies (CBI, Indian railways, NGOs, Universities, Forest Departments, Fisheries Research Organisations, etc.) during the year.

### **(b) Facilities generated and services rendered:**

Forty two sandal oil samples were tested for the State Forest/Police Departments and advice rendered.

### **(c) Transfer of technology:**

Field demonstration of essential oil distillation using portable distillation unit was conducted at Bangalore and Narasipatnam near Visakhapatnam, A.P for the benefit of farmers, NGOs, forest dwellers, tribals and Vanasamrakshana Samithi members. They evinced keen interest in this simple technique and noted the details to make their own unit locally.

The following Technologies/Expertise have also been demonstrated to end users:

1. Treated Catamaran for the benefit of the poor traditional fishermen at Chennai and Vizag. End users: Fishermen of Andhra Pradesh and Tamil Nadu.
2. Sap-displacement technique for treating small girth timber and bamboo (An on-site treatment procedure especially useful in rural areas) to university officials, foresters.
3. Proper Utilisation of plantation grown timber to small entrepreneur, toy makers and other end user at Narasipatnam, AP.
4. Regular meetings with farmers organised under UNDP project. Training on nursery techniques, quality seedling and seeds was organised and seeds and seedlings were distributed among farmers.

### **(d) Teaching Support:**

Teaching support extended to various university/college students and probationers of Indian Railway. Special lectures on biological control were delivered. Refresher courses for academic staff /college of university of Calicut were conducted.

(e) **Publication and extension literature brought out by the Institute:**

Pamphlets and technical bulletins containing details of the portable distillation unit are being prepared in English and Kannada.

(f) **Library:**

Library is equipped with one connection of V-SAT and a computer. 29 National journals are being currently subscribed by the library. Various documents like Research highlights, summarisation of research results, publicity material were also compiled. There are 50 computers in the Institutes.

(g) **Video Films Production:**

A film on "Treated catamaran : A boon to traditional fishermen" has been produced in (B- CAM format to be telecast on DD.

Following Video Films have been prepared to popularise various techniques amongst end users.

1. Video on National Demonstration workshop on Uses of advanced technology in forestry.
2. Workshop on 'Forestry, forest products and coastal population'.
3. Culling operation in Seed Production Area.

(h) **Exhibition and Kisan mela:**

1. Exhibition of IWST activities during various state level and Institute level meetings was carried out.
2. A kisan mela on Demonstration plantation under UNDP project was organised on 8-7-98 at the village Harohalli, Devenahally Taluk of Bangalore.
3. A contact programme with farmers of Tirupati region under UNDP project was carried out.

(i) **Seminar/ Workshops etc.**

Following workshops/seminars were organised.

1. National demonstration Workshop on 'Uses of Advanced Technologies in Forestry' 17-18 April, 1998. Hyderabad.
2. Workshop on 'Setting Research Priorities for IWST' at Bangalore on 28-29 Jan., 1999.
3. Institute level Sandal workshop at IWST Bangalore on 18-1-99.
4. Workshop on 'Forestry, Forest Products and Coastal Population' at Chennai on 10-11 Feb, 1999.

In addition, the institute has also supported the following workshops:

- (i) An Interactive meeting on Biodiversity and Conservation in Biligiri Hills during 17-18 Sept 1998 at Bangalore organised by ATREE, Bangalore.
- (ii) State level workshop on 'Setting Research Priority' for Karnataka Forest Department at Bangalore during 24-25 Sept 1998 organised by Karnataka State Forest Department.

### **Linkages with other organisation/Institutes/States etc. -:**

The Institute has strong linkages with the State Forest Departments of Andhra Pradesh, Karnataka and Goa; Goa university, Bharathidasan Manonmaniam Sunderanar university; a number of Central and State Government Departments/Organisations (Indian Navy, Port Trusts, Fisheries Research Organisations and Departments, Defence Establishments, CBI, Police, Anti-corruption Bureau, Indian Railways, PWD, Telephone Industries, Atomic Research Establishments etc.); and Private Sector Organisations (Timber Industries, Pesticide Industries, Boat-builders, NGOs) and Farmers.

### **Publications and Extension literature:**

#### **Name of Publication**

**Sandal and its products:** Proceedings of an Int. Seminar held on 18-19 Dec.1997 organised by the IWST (ICFRE) and Karnataka State Forest Department, Bangalore, India. Editors: A.M. Radomitjac, H.S. Ananthapadmanabha, R.M. Welbaum and K.Satyanarayana Rao. Published by Australian Centre for International Agricultural Research, Canberra, 1998.

#### **Brochure (Translation & Printing and New Brochure)**

#### **Language**

- |    |                        |         |
|----|------------------------|---------|
| 1. | Brochure on Catamarans | Tamil   |
| 2. | Brochure on Casuarina  | Kannada |
| 3. | Brochure on Jatropha   | Kannada |

#### **Pamphlets**

- |    |                            |                             |
|----|----------------------------|-----------------------------|
| 1. | Sap Displacement Technique | Telugu                      |
| 2. | Portable Distillation Unit | English, Kannada and Telugu |
| 3. | Catamaran                  | Tamil                       |

## FINANCIAL STATEMENT

<b>I. PLAN</b>		
Sl.No.	SUB-HEAD	Expenditure (Rs. in lakh)
1.	<b>A. REVENUE EXPENDITURE</b> (a) Research (b) Administrative Support	76.66 53.57
	<b>Total for Revenue Expenditure 'A'</b>	<b>130.23</b>
	<b>B. LOAN AND ADVANCES</b> (a) Loan Advances (Conveyance) (b) House Building Advance	1.25 -
	<b>Total for 'B'</b>	<b>1.25</b>
	<b>C. CAPITAL EXPENDITURE</b> (a) Building & Roads (b) Equipments, Library Books/Furniture (c) Vehicles (d) Maintenance works (e) Civil works	- 25.16 - 18.48 3.78
	<b>Total for 'C'</b>	<b>47.42</b>
	<b>GRAND TOTAL FOR A+B+C(PLAN)</b>	<b>178.90</b>
<b>II. NON-PLAN</b>		
1.	<b>A. REVENUE EXPENDITURE</b> (a) Research (b) Administrative Support (Salary)	53.32 23.16
	<b>Total Non-Plan</b>	<b>76.48</b>
	<b>TOTAL FOR PLAN + NON-PLAN</b>	<b>255.38</b>
<b>III. FUNDED PROJECT</b>		
	A. World Bank Project B. UNDP Project C. NABARD Project D. FORTIP	101.40 4.76 - -
	<b>GRAND TOTAL for (A+B+C+D) FUNDED PROJECT</b>	<b>106.16</b>