



CHAPTER III

INSTITUTE OF WOOD SCIENCE AND TECHNOLOGY BANGALORE

The Institute of Wood Science and Technology (IWST), Bangalore formed in 1988, is mandated to conduct research on wood science and technology as its national objective with a focus on important forestry research needs of the states of Karnataka, Andhra Pradesh and Goa at regional level. Taking into consideration the expertise available and contributions made, the Indian Council of Forestry Research and Education (ICFRE), Dehradun has assigned the Institute the status of Centre for Advanced Studies in the areas of Improved Utilisation of Wood; Mangroves and Coastal Ecology and Research on Sandal. The direction of research being carried out at IWST is in consonance with and in response to the aims of National Forest Policy in the areas of utilisation of timber and non-timber products and for increasing productivity. The Institute mainly aims to develop sustainable strategies for use and production of wood and other forest products.

PROJECTS COMPLETED DURING THE YEAR 2003-2004

Project 1: Wood quality parameters for improving planting stock of *Bambusa arundinacea*, *Pseudooxytenanthera stocksii* and *Dendrocalamus strictus* [IWST/0009/WPU/009/1999-2004]

Principal Investigator - Dr R.V. Rao

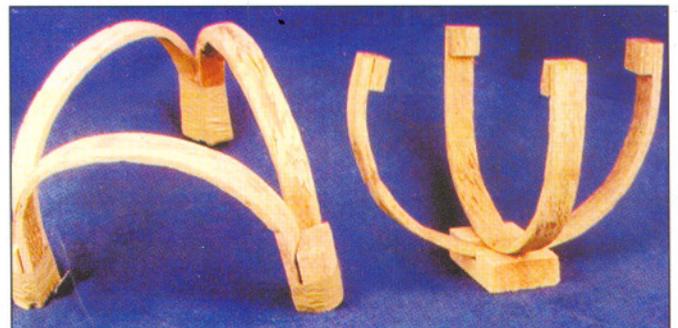
Findings: Based on strength properties, *Pseudooxytenanthera stocksii* is comparable with *Bambusa arundinacea* and *Dendrocalamus strictus* in some properties. This species can be put to possible uses like walking sticks,

umbrella handles, roofing for huts, tent poles, baskets and javelin.

Project 2: Plasticisation of palms and bamboo [IWST/0005/WPU/005/2001-2004]

Principal Investigator - Dr S.K. Sharma

Findings: *Cocus nucifera*, *Bambusa arundinacea* and *Dendrocalamus strictus* were subjected to ammonia vapour treatment at 5 kg/cm² pressure for different durations (2-6 hrs) to study their plasticisation. Solid and hollow bamboos resulted into frequent failures at nodes. The split bamboo gave satisfactory results and bent to a minimum radius of 75 mm. Coconut wood samples were successfully bent to different shapes with a minimum radius of 40 mm. Prototype products were also made using bent coconut wood.



Coconut wood bent using vapour phase ammonia treatment method

Treated and untreated coconut wood also did not show any significant difference in strength properties after treatment except for a slight change in color. Treatment with ammonia did not show any improvement in strength properties.



Project 3: Analysis of wood and its constituents by fluorescence and FTIR spectroscopic technique - a non-destructive tool for rapid characterisation of wood [IWST-34/WSP-11/2000-2003]

Principal Investigator - Dr K.K. Pandey

Findings: Pre-treatment of wood surfaces with chromium trioxide (chromium VI compound) significantly restricted weathering deterioration and microbial colonisation, whereas ferric chloride was most effective in preventing microbial colonisation. Acetylation also prevented delignification and fungal staining partially.

Project 4: Studies on lignin filled thermoplastic composites [IWST/WSP/2000-2004]

Principal Investigator - Shri Ajay Karmarkar

Findings: A novel compatibiliser, m-isopropenyl-a-dimethylbenzyl-isocyanate grafted PP (m-TMI-g-PP) was prepared by melt phase grafting of polypropylene. The hydroxyl groups of lignin forms carbamate ester bond with copolymers and the surface of lignin changed from hydrophilic to hydrophobic. Treatment with compatibiliser decreases surface energy of lignin to a level much closer to that of plastics and a better wetting by molten plastics is achieved.

To overcome the problem of melt phase blending, a new technique called Polymerisation Filling Technique was also studied. Using this new 'Polymerisation Filling Technique'. One-step formation of homogeneously filled composites with high degree of filler content was achieved. Surface properties of the unmodified and modified lignin were determined by using column wicking method. The modified Washburn equation was

used to determine the contact angle by wicking method. Results proved that the chemical modification of lignin with m-TMI-grafted polypropylene brings down surface free energy of lignin close to that of polypropylene.

Project 5: Thermodynamics of moisture adsorption and desorption in wood [IWST/WSP/012/2000-2005]

Principal Investigator - Dr S.P.S. Rawat

Findings: From adsorption isotherms, changes in free energy, enthalpy and entropy were determined. These quantities were shown to be representative of adsorption behaviour of wood. The changes have strong dependence on moisture content and weak dependence on temperature. Studies in enthalpy-entropy for adsorption effect were made and a linear relationship was found to exist between enthalpy and entropy for adsorption of water in wood. This was found linked to LeChatelier's principle and offered insight into the understanding of the adsorption behaviour of water in wood. Water molecular organisation was responsible for the origin of this phenomenon. A thermodynamic parameter for wood water system was found to be related to work required for swelling. Enthalpy-entropy compensation effect was shown to be related to swelling behaviour of wood.

Project 6: Phytochemical and pharmacological investigations on *Persea macrantha* [IWST/CFP-002/1999-2004]

Principal Investigator - Shri K.H. Shankaranarayana

Findings: From benzene and methanol extract of *Persea macrantha* bark powder, a solid coloured active principle has been obtained and purified evaluation of pharmacological features is in progress.



Project 7: Investigations on the potential of medicinal and aromatic plants as source of botanical insecticides [IWST-20/WBD-5/2000-01]

Principal Investigator - Dr R. Sundararaj

Findings: It was observed that effectiveness of neem oil was comparable to that of commercial neem formulations and chlorpyrifos in containing the nymphal populations of *Aleurodicus dispersus*. It is observed that *A. dispersus* under natural condition can be effectively managed by using neem oil or neem based commercial formulations.

Experiments conducted by basal application of neem cake, pongam cake and VAM alone and in combinations in nurseries of *Michaelia champaka* and *Bauhinia variegata* revealed that neem cake, pongam cake and VAM were compatible and effective in containing the incidence of the spiraling whitefly, *A. disperses*, on these plant species.

Project 8 : Phenological studies of clonal seed orchard of *Tectona grandis* in Karnataka [IWST/TIP-3/2000-2004]

Principal Investigator - Shri Ashutosh Srivastava

Findings: Clonal Seed Orchard (CSO) of *Tectona grandis* selected for this study consisted of 49 clones in 12 ha area established in 1981-82 at Tittimatti, Karnataka. Various clones in the CSO were categorised into non-flowering, low flowering, moderate flowering and heavy flowering. Low flowering and moderate flowering clones were used to test various chemicals in different concentrations during 2001-02 and 2002-03. It was found that paclobutrazol @ 4 g per tree was most effective in inducing flowering in non-flowering and low flowering clones. Potassium nitrate, salicylic acid and etheral were also found to be effective

in inducing flowering in low and non-flowering clones. Future studies can be focused on identifying most appropriate time of application and combinations with other chemicals for better flowering and higher seed set.

Project 9: Evaluation and characterisation of sandal (*Santalum album* L.) accessions of diverse origin with special reference to heartwood content, oil content and other morphological characters [TIP-4/2000-2004]

Principal Investigator - Shri Arun Kumar A. N

Findings: Various sandal accessions representing four different southern states have been established during 1982 in the clonal germplasm bank at Gottipura Research Station in Karnataka. The data obtained is first of its kind in understanding the interaction between G and E with reference to heartwood content and sandal oil content for a known aged sandal crop. Variation was seen across 30 accessions, with reference to heartwood (range from 0.67 to 5.04 cms), while in case of oil content, it varied from 0.38 percent to 3.61 percent. Similarly, variation has been seen with reference to morphological traits and seed parameters. The isoenzyme studies undertaken showed that diversity existed between various accessions. Effort is on to establish relationship, if any, with reference to heartwood content, oil content and other parameters among various accessions.

Project 10: Conservation and management of Coondapur mangroves, Karnataka [IWST-41/WBD-15/2000-2004]

Principal Investigator - Dr K. S. Rao

Findings: Observations on various phenological aspects like flowering, fruiting of the mangrove plants at the selected site in Coondapur were continued. Data were collected on growth

parameters such as number of leaves, height of the seedlings, collar diameter of the planted mangrove seedlings at Hemati area at Coondapur. Studies on biodeterioration of mangrove seedlings were also continued.

Branch wood samples from four mangrove species of Kadi mangrove area were extracted and brought to the laboratory for anatomical studies. A pneumatophore sample of *Rhizophora* was also collected, for anatomical investigations. Cross structure of the wood from all the genera collected has been described. Anatomical details of the pneumatophore have also been worked out. Micro slides for *Avicennia*, *Kandelia*, *Candel*, *Rhizophora* and *Sonneratia alba* have been prepared. Vulnerability and mesomorphic value have been developed.

PROJECTS CONTINUED DURING THE YEAR 2003-2004

Project 1: Assessment of wood quality (anatomical) of 8-10 years old *Acacia auriculiformis* and *Acacia mangium* hybrids [IWST/WPU/X01/2002-2004]

Principal Investigator – Ms T.R. Hemavathi

Status : Studies on pith to periphery variation in shrinkage properties (radial, tangential, longitudinal and volumetric) at different moisture contents of *Acacia auriculiformis* hybrids are in progress. Data on fibre morphology, vessel morphology and tissue proportions have been collected for one tree.

Project 2: Evaluation of wood quality parameters of plantation grown *Eucalyptus citriodora* for different end uses [IWST/WPU/X02/2002-2005]

Principal Investigator - Dr R.V. Rao

Status : Specific gravity of bark at four different heights and specific gravity of wood at five

different heights and eight radial positions was determined. Studies on radial, tangential and volumetric shrinkage completed. The shape retention value for this species was found to be 50 as compared to the value for teak (100) as standard indicating the possible development of warping and cracks during air-drying. Physical and mechanical properties were studied for two trees in green condition.

Project 3: Analytic studies on viscoelastic behaviour of wood and tree biomechanics [IWST/WSP/X03/2002-2005]

Principal Investigator - Dr S.P.S. Rawat

Status: An approach based on chemical kinetics was used to study stress relaxation behaviour. Studies on time dependent deformation in wood with respect to cyclic humidity were made.

Project 4: Studies on fiber formation in wood [IWST/WSP/X04/2002-2005]

Principal Investigator - Dr S.P.S. Rawat

Status: Processes of crystallisation with simultaneous polymerisation were analysed as a possible mechanism of fiber formation in wood. Studies on defects in crystalline lattice of cellulose as a mechanism for the paracrystalline nature of cellulose were made.

Project 5: Evaluation of ammonia based preservatives against Indian termites [IWST/WSP/2002-2005]

Principal Investigator – Shri P. Narayanappa

Status: Wood samples treated with ACZA, ACQ and CC in comparison with CCA were periodically observed to assess the damage caused by termites. It was further observed that all the control samples were destroyed completely whereas samples treated with CCA were affected moderately.



Project 6: Evaluation of treatability of selected refractory species [IWST/WSP/2002-2005]

Principal Investigator – Shri P. Narayanappa

Status: After procurement of *Eucalyptus* hybrid, experimental samples were prepared and ponded at different periods before subjecting to different diffusion periods.

Project 7: Studies on forced air-drying of plantation grown timbers [IWST/WSP/X05/2002-June 2004]

Principal Investigator – Shri N.K. Upreti

Status: Planks of *Acacia auriculiformis* and 25 mm thick planks of *Eucalyptus tereticornis*, *Grevillea robusta* and *Albizia lebbek* were forced-air-dried by keeping air speed of 2.8 m/sec using pedestal fans. After continuous forced-air-drying of nine weeks *A. lebbek*, silver oak and *E. tereticornis* reached to 6.79 percent, 9.26 percent and 14.12 percent moisture content (mc), whereas control samples reached to 16.61 percent, 15.60 percent and 23.35 percent mc respectively.

Planks of *Eucalyptus tereticornis*, *Grevillea robusta* and *Albizia lebbek* (25 mm thick) were simultaneously kept for drying inside the experimental solar timber drying kiln at required humidity and maximum 52°C temperature. It took eight weeks to dry planks of *Albizia lebbek* up to 7.52 percent mc, *Grevillea robusta* up to 14.71 percent mc and *Eucalyptus tereticornis* up to 12.51 percent mc inside the kiln whereas their naturally dried controls were at 15-20 percent higher moisture content during similar period. The dried wood quality was excellent due to the complete absence of drying degradates. This was due to release of drying stresses during night time.

Project 8: Efficacy of preservative in enhancing durability of timber (Development of alternative preservatives of more economic value and schedule for their incorporation in wood) [IWST/WSP/2000-2005]

Principal Investigator - Shri D. Venmālar

Status: Cashew-nut shell liquid (CNSL) a plant extractive was incorporated with less toxic inorganic copper ions, to develop an eco-friendly preservative, *Hevea brasiliensis* and *Acacia auriculiformis* specimens were treated with this preservative by brushing, dipping and pressure process.

Observations on the field test stakes of *Hevea brasiliensis* treated (brush coated) with CNSL and untreated control show that copperised CNSL increased the service life of the timber three times compared to control and two times compared to specimens treated with CNSL alone as compared to untreated control.

Eucalyptus tereticornis and *Hevea brasiliensis*, test stakes were treated by brushing and dipping method with the formulated preservative (copperised neem oil), with neem oil and also with copper naphthenate.

Project 9: Chemical induction of heartwood in Sandal [IWST/CFP-001/ 2000-2006]

Principal Investigator – Shri K.H. Shankaranarayana

Status: Sandal plants were injected with fifth dose of heartwood stimulant chemicals viz. Paraquat and etherel. Different parameters like girth, height, etc. were recorded.

Calcium carbide and water (for acetylene), ethereal and sodium hydroxide (for ethylene) have been identified as possible stimulants.



Project 10: Natural products evaluation of extractives of plant origin for biological and pharmacological activity-*Nothapodytes nimmoniana* and *Garcinia indica* [IWST/CFP – 003/2000-2005]

Principal Investigator – Shri V.G. Angadi

Status: Purified methanol extracts containing active principle in case of *Nothapodytes nimmoniana* wood and *Garcinia indica* fruits have been prepared. Pharmacological properties are being evaluated.

Project 11: Development of colouring reagents based on enzyme - substrate reaction for differentiating oil yielders of sandal in field [IWST/ CFP / X01/2002-2007]

Principal Investigator – Shri V.G. Angadi

Status: Twelve substrates/chemicals have been identified for studies in case of development of colouring reagents for differentiating oil yielders of sandal in field. Estimation of oil content in the selected trees and tests for solubility of substrates to carry out reaction has been completed. Composition of reaction mixtures in case of two substrates under study has been worked out.

Project 12: Eco-restoration of degraded mangrove habitat along Goa coast [IWST-2/WBD-1/2000-2005]

Principal Investigator – Shri Surekha Sawant

Status: Studies on phenology of the natural mangrove habitat at Charao Island and afforested mangrove area at Ribander was continued. Water samples were analysed periodically for salinity and pH. Soil samples analysed for pH, EC and OC, major nutrients like N, P, K and micronutrients like Zn, Fe, Cu, Mn, Ca and Mg were analysed from the soil.

Project 13: Role of biofertilizers in ecorestoration of problematic site like mine reject soil in Goa [IWST-28/WBD-3/1997-2005]

Principal Investigator – Ms H.C. Nagaveni

Status: *Cassia fistula*, *Acacia auriculiformis*, *Casuarina equisetifolia*, *Lagerstroemia frasnigenica* and *Dalbergia latifolia* were planted in randomised block design in three replicates. Techniques of multiplication, application to the nursery plants and use of biofertilizer have been demonstrated to officials of Goa Forest Department.

Project 14: Impact of disturbances on canopy insect biodiversity: An assessment of forest health [IWST-22/WBD-6/2000-2005]

Principal Investigator – Shri Y.B. Srinivasa

Status: The project is the first attempt made in the country to quantify the diversity of organisms ('insects' in this case) among the rooftops of the forests. Monsoon and post-monsoon samples were drawn from the emergent undisturbed canopies (>25m from the ground) of *Vateria indica* and *Dipterocarpus indicus* using an insecticide fog. Samples were also drawn from the adjacent plantations and are presently being compared with the samples from the undisturbed forest. A total of approximately 35,000 arthropods have been collected so far. The monsoon collections have been sorted to recognisable taxonomic units and data on the diversity of different taxa analysed.

Project 15: Studies on entomofauna of mangroves of Karnataka, Goa and Andhra Pradesh [IWST-24/WBD-7/2000-2005]

Principal Investigator - Dr O.K. Rema devi

Status: Studies on diversity of mangrove insects along west coast of India (Karnataka and Goa) were continued in different seasons. A total



number of 340 species of insects belonging to 122 families of 11 orders, were encountered. Three species of bagworms *Brachycyttarus* sp., *Pteroma plagiophleps* and *Metisa* sp. were recorded; *Brachycyttarus* sp. being more prevalent. More than 60 percent of the saplings were infested by these psychids. Regular and severe defoliation and leaf damage by lepidopteran caterpillars was noted in three true mangrove species, *Avicennia officinalis*, *Sonneratia caseolaris* and *Rhizophora mucronata*. Studies on the biology, seasonality and nature of damage of important pest species were attempted.

Project 16: Control of biodeterioration of wood with the help of eco-friendly preservative and bioactive substances on staining and decay fungi under terrestrial conditions [IWST-13/WBD-8 /1997-2005]

Principal Investigator - Ms H. C. Nagaveni

Status: Pure culture of wood rotters, stain and plant pathogenic fungi are repeatedly subcultured and maintained in virulent conditions. Rubber wood blocks were chemically modified by a two-step reaction to get esterified wood with different anhydrides and subsequently with epichlorohydrin to obtain oligoesterfied rubber wood. Complete protection against wood rotters was obtained with these oligoesterfied rubber wood blocks. Work on natural durability against wood rotters of both heartwood and sap wood samples of *Cleistanthus collinus* were completed. Fungitoxic studies were carried out with *Garcinia indica*, *Nothapodytes nimmoniana* and *Clerodendron inerme* plant extract against plant pathogens like *Fusarium oxysporum*, *Rhizoctonia solani* and *Macrophomina phaseolina* and with wood rotters.

Project 17: Application of pheromone technology for the management of teak heartwood borer, *Alcterogystia cadambae* Moore [IWST-29/WBD-9/2000-06]

Principal Investigator - Dr O. K. Remadevi

Status: Studies on the larval life history of teak heartwood borer have been successfully taken up using artificial diet. Studies on biological aspects of the pest were conducted in the field site at Gunjavati area (Yellapur division). Robinson light traps were installed in selected sites and collections were done at every alternate day. 30-50 adult moths were collected from May to August.

Completed the survey of timber depots of North Canara Circle, namely, Kirwathi, Mundagod, Bhagavathi, Dandeli, Jagalbet, Kulgi, Idugunji, Kabbinmahokkalu and Kadre, etc. Infestation level and the volume loss were determined in these depots of North Canara Circle. As a preliminary trial for the management of the pest, entomopathogenic nematodes (EPN), *Heterorhaptis indica* and *Steinernema carpocapse* were tested in the laboratory and field level. The nematodes were effective in killing the larval stages. Five percent of *Bacillus thuringiensis* var. *kurstaki* and also Solunem bio-pesticides were applied in borer holes in teak plantations.

Project 18: Studies on durability of selected Indian secondary timbers against marine wood biodeterioration agents in the marine environment along Karwar coast (Karnataka) [IWST-30/WBD-10/2000-2005]

Principal Investigator - Dr K. S. Rao

Status: Chemical treatment of *Paraserianthus fulcataria* and *Bombax ceiba* with copolymer resin was completed. The treated panels were



categorised into five groups based on the absorption pattern. The absorption category of *P. fulcataria* was 5-12 kg/cu.m, 12-16, 16-18, 18-21 and ≥ 21 kg/cu.m. The *B. ceiba* panels were grouped in ≥ 10 -32 kg/cu.m, 32-35 kg/cu.m, 35-38 kg/cu.m, 38-43 kg/cu.m and ≥ 43 kg/cu.m categories.

Project 19: Biosystematic studies on parasitoid complex of sandal coccids and their utilisation in biological control [IWST/WBD/2002-2005]

Principal Investigator – Shri Y.B. Srinivasa

Status: Documentation of parasitoids and their coccid hosts occurring on sandal is in progress. Samples are periodically drawn to study the population dynamics of the host and its parasitoids. A serious decline in the coccid population was noticed during the summer of 2003. Parasitoids specific to the developmental stage of the coccid species have been identified.

Project 20: Species, provenance and clonal test trials on *Casuarina* sp. in North Andhra [IWST/WBD(M)/004/2003-2008]

Principal Investigator - Dr V. Kuppusamy

Status: A coastal village, Chippada, 60 km south of Visakhapatnam, was selected for the trial of salt tolerant clones of *Casuarina equisetifolia*. The site preparation was done and 0.4 ha was demarcated for plantation. Ten salt tolerant clones of *C. equisetifolia*, each having 100 individuals were procured. Plantation was raised as per randomised row planting design. Casualty replacement was carried out. Plantation is being maintained regularly.

Project 21: Development of modern nursery techniques for propagation of important species of Goa - *Terminalia tomentosa*, *Xylia xylocarpa*,

***Myristica fragrans*, *Bambusa bambos* and *Dendrocalamus strictus* [TIP-1/2002-July 2004]**

Principal Investigator - Dr T. S. Rathore

Status: Three experiments were completed in case of *Myristica fragrans* viz., standardization of potting medium in root trainers, standardisation of potting medium in polybags and standardisation of container size and type. Results indicate that in case of root trainers, compost: sand: soil in the ratio of 50:40:10 resulted in best seedlings growth with the average height of 24.7 cm and collar diameter of 4 mm in eight months. In case of polybags, compost: sand: soil in the ratio of 50:25:25; proved to be the best mixture which produced seedlings with an average height of 24.66 cm and a collar diameter of 4 mm in eight months. 5" X 6" polybag (900 ml) resulted in tallest seedlings with average height of 31.63 cm and a collar diameter of 4.51 mm, while 270 ml root trainers produced seedlings with average height of 29.18 cm, which were statistically at par with polybags.

Project 22: Studies on micropropagation field evaluation and conservation of *Pseudoxytenanthera stocksii* (*Oxytenanthera stocksii*) [TIP-2/2000-2005]

Principal Investigator - Dr T.S. Rathore

Status: Conducted *ex vitro* rooting studies from *in vitro* shoots of candidate plus clumps of *Pseudoxytenanthera stocksii* on various rooting media; vermiculite, soilrite, sand, soil and sand + soil and auxins: IAA, IBA, NAA and NOA and found that sand was the best medium and IBA as the best auxin for high frequency rooting (above 95 percent). From *ex vitro* rooting stage onwards plantable cloned plants with four to five tillers with rhizome formation can be achieved in four months period.



In case of standardised explant type and growth hormones on callus induction and somatic embryogenesis in *P. stocksii* it was observed that leaf sheath and juvenile stem segment are suitable (explants) on MS medium with 2, 4-D, 1.0-2.5 mg/l for callus induction and MS medium with 2, 4-D, 1.0-2.0 mg/l + BAP 0.1 – 0.25 mg/l + additives for somatic embryogenesis.

Project 23: Ethnobotanical studies of Godavari valley in Andhra Pradesh [TIP-5/2002-2007]

Principal Investigator - Dr N. Rama Rao

Status: Ethnobotanical data on 114 plant species were collected from West Godavari district. Ethnobotanical information on medicinal uses such as cuts, pains, fever, head ache, wounds, sprains, abortion, snake bite, diabetes, epilepsy, jaundice, boils and blisters, bone fracture, cough and cold, eye diseases, etc., insecticidal and piscidal applications, agricultural implements, house construction, hair wash, detergents, fiber, food habits, religious rites, cultural aspects, taboos, etc., was gathered from local herbal doctors and priests of Godavari valley. Ethnobotanically useful plants were collected and preserved as herbarium. So far 92 plant specimens have been identified. Three live plant materials were introduced in the campus for *ex situ* conservation.

NEW PROJECTS INITIATED DURING THE YEAR 2003-2004

Project 1: Assessment of wood quality of *Simarouba glauca* for its timber value [IWST/WPU/X05/2003-2005]

Principal Investigator - Dr S.K. Sharma

Status: Procured six trees (eight years old) of *Simarouba glauca* from plantation in Bangalore. Completed the studies on percentage of bark and

wood, bark thickness and specific gravity of wood and bark in stems and branches of all the six trees. Data on fibre morphology of six branches of one tree was collected.

Project 2: Evaluation of culm quality before, during and after flowering in bamboo (*Bambusa bamboo*, *Dendrocalamus strictus*, *Melocana* and *Ochlandra* species [IWST/WPU/X04 2003-2006]

Principal Investigator - Dr R. V. Rao

Status: Method for detection of starch and lipids using histo-anatomical methods in flowered *Bambusa arundinacea* culms have been standardised.

Project 3: Assessment of wood quality of *Tectona grandis* (teak) clones from Thithimathi (Karnataka) and Andhra Pradesh [IWST/WPU/X06/2003-2006]

Principal Investigator - Dr S.R. Shukla

Status : Collection of data initiated on specific gravity and shrinkage properties (radial, tangential) of 10 clones (from bottom, middle and top portions). Studies on volumetric shrinkage of all the clones from bottom, middle and top portions of the logs have been completed.

Project 4: Studies on fracture mechanics in solid wood and wood composites using acoustic emissions [IWST/WPU/X07 2003-2007]

Principal Investigator - Dr S.R. Shukla

Status: Acoustic emission testing equipment is being set right for taking measurements. Basic density and gross anatomical features of teak wood were recorded. Samples are subjected to compression failure at different load crushed speed (0.01-100 mm/min) in all the three directions (radial, tangential and longitudinal). The observations on microstructure of damaged



wood provide the information on the nature of compression failure in different planes and the wood elements fractured in the process.

Project 5: Use of sonic and ultrasonic testing techniques to evaluate wood strength of plantation species - A non-destructive test method [IWST/WPU/X08 2003-2005]

Principal Investigator - Dr Y.M. Dubey

Status: Wood materials of *Eucalyptus citriodora*, *Simarouba glauca* and *Acacia auriculiformis* have been procured. Testing of *E. citriodora* samples was carried out to study the effect of density, principal grain directions, moisture content and sample sizes on ultrasonic velocity. The preliminary tests show that ultrasonic velocity along the longitudinal direction is greater than transverse ones (radial/tangential directions) and also decreases with increasing moisture content (Ψ 25 percent), while least effect of density of test samples on ultrasonic velocity was noticed. Testing of *Simarouba glauca* samples is in progress. An experimental setup was fabricated for measuring strength properties (MOE) using sonic waves.



Method to measure the strength properties (MOE) of wood using sonic waves.

Project 6: Development and popularisation of packing boxes of plantation growth timbers

from South India for horticulture produces [IWST/WPU/X09 2003-2005]

Principal Investigator - Shri Dhyan Singh

Status: *Eucalyptus tereticornis* was procured and converted into planks, strips and battens of required dimension and fabricated packing boxes of 20 kg load for horticultural produce.

Project 7: Studies on the gas permeability of secondary species of timbers [IWST/WSP/2003-2008]

Principal Investigator - Shri P. Narayanappa

Status: Samples of *Acacia auriculiformis* are being kept for conditioning over saturated salt solutions. After bringing samples to a required moisture content, permeability will be recorded and data will be calculated using the Darcy's law.

Project 8: Studies on the drying behaviour of timbers used for handicrafts [IWST/WSP/X20/2003-2005]

Principal Investigator - Shri N.K. Upreti

Status: *Acacia mangium*, *Wrightia tinctoria* and *Albizia lebbek* are some of the species being used by handicraft artisans in Karnataka. Handicraft units are facing the problem of surface cracks in their finished items. In view of this problem these three species were chemically seasoned by bulking the wood with urea and common salt. Linseed oil was also used for minimising the surface cracks. It was found that the urea and the common salt were working as an excellent bulking agent and were having equally good performance in minimizing surface cracks. The linseed oil was also effective but not as good as urea and common salt.

Project 9: Effect of temperature, humidity and pH on CCB fixation in wood [IWST/WSP/2003-2005]

Principal Investigator - Shri Pankaj Aggarwal



Status: Samples of *Bombax ceiba* and *Paraserianthes falcataria* (size: 25 mm³) prepared to evaluate the effect of temperature, humidity and pH on CCB fixation.

Project 10: Polymerisation filled composites [IWST/WSP/2003-2006]

Principal Investigator – Shri Ajay Karmarkar

Status: Design and fabrication of polymerisation reactor system for initial studies has been completed.

Polymerisation of ethylene using filler supported catalyst at normal pressure was achieved. It is possible to create active polymerisation sites by immobilising a cocatalyst (aluminoxanes) and then contacting the cocatalyst carrying filler with a cyclopentadienal containing transition metal catalyst (metallocenes). Using this new 'Polymerisation Filling Technique', we have achieved one-step formation of homogeneously filled composites with high degree of filler content.

Project 11: Community involvement in coastal forestry through periodical returns by value added produce [IWST/WBD (M)/X24/ 2003-2008]

Principal Investigator - Dr K. Satyanarayana Rao

Status: Chippada, a coastal village 60 km south of Visakhapatnam was selected for trials. Three ha land was cleared and prepared for plantation. Seeds of *Eucalyptus citriodora* were procured from Bangalore, Karnataka and IFGTB, Coimbatore and nursery was raised. Plantation of *Eucalyptus citriodora* and *Casuarina equisetifolia* in Quinquinox design was taken up in 2 ha area with a spacing of 3 m x 3 m and 2.5 m x 2.5 m.

Project 12: Environmental impact of leachates from copper-chrome-arsenic (CCA) wood preservative under marine condition [IWST/WBD(M)/X23/2003-2006]

Principal Investigator - Dr V. Kuppusamy

Status: Timber test material procured and test coupons of the size 5 cm x 2.5 cm x 40 cm were prepared and kept for air drying. Design for the conduct of the experiments finalised. Treatment of the test coupons with CCA wood preservative is being initiated.

Project 13: Studies on recruitment and metamorphosis of marine wood borer larvae [IWST/WBD(M)/X22/2003-2008]

Principal Investigator - Dr M. Balaji

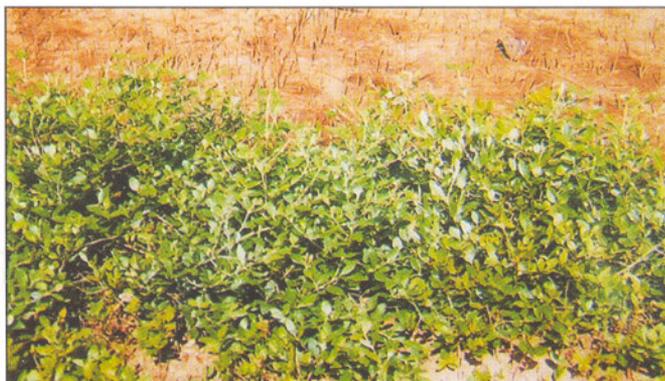
Status: Generations of live wood borers were reared and maintained in the laboratory for use as stock for larval production for different experiments. Creation of artificial illumination for the culture of single celled algae for larval feed has been completed. Algal species were identified and inocula were procured. These are being maintained in the laboratory.

Project 14: Inventory of coastal plant communities of north Andhra region [IWST/WBD (M)/X25/2003-2006]

Principal Investigator – Shri M.V. Rao

Status: Intensive field surveys were undertaken on mangroves, halophytes, hydrophytes and psammophytes from the coastal areas of Srikakulam and Visakhapatnam districts. A total of 295 plant specimens were collected, made into herbarium and about 50 percent of them were identified. The collection includes excellent sand binders such as *Hydrophylax maritima*, *Launaea sarmentosa*, *Acanthus ilicifolius* L., *Avicennia marina* (Forssk.) Vierh., *Hydrophylax maritima* L.f. and *Sesuvium*

portulacastrum (L.) L. These are the new distributional records collected for the first time from Srikakulam district, Andhra Pradesh.



Avicennia marina (Forssk.) Vierh - a new distribution record to Srikakulam district, Andhra Pradesh

Project 15: Genetic screening of *Jatropha curcas* – an important biofuel species of dry areas [IWST/TIP/2003-2006]

Principal Investigator - Dr Geeta Pandey

Status: Seeds of five different provenances, viz., Hangal, Sammasagi, Dasankoppa, Isloor and Akkialur of *Jatropha curcas* from Haveri, Dharwad and Sirsi districts of Karnataka during November, 2003 were collected. The oil estimation from the seeds of various provenances is being done.

Project 16: Seed studies of some of the economically important recalcitrant species of Western Ghats [IWST/TIP/2003-2006]

Principal Investigator - Dr Geeta Pandey

Status: The project aims at investigation of the desiccation sensitivity of economically important recalcitrant seeds and studying the various factors influencing seed viability. Seeds of *Myristica fragrans* were collected and processed. Initial moisture content, germination percentage and seed conductivity have been

recorded. Experiments were conducted to study the effect of desiccation on seed viability, leading to the determination of critical moisture content at which seed viability can be maintained for a longer period.

Project 17: Standardization of protocol for viability testing and prolonging the viability and vigour of *Santalum album* seeds in storage [IWST/TIP/2003-2005]

Principal Investigator - Dr Geeta Pandey

Status: Seeds of sandal have been collected during October – December, 2003 and processed and exposed to different saturated salt solutions in order to study the effect of different levels of Relative Humidity (RH) on the equilibrium moisture content of sandal.

Project 18: Variation in photosynthesis in clones of sandal and Eucalyptus [IWST/TIP/2003-2006]

Principal Investigator – Shri Arun Kumar A. N.

Status: The study material comprised of the clonal material of various accessions of sandal. This was collected from the clonal germplasm bank of sandal at Gottipura, out of which 35 clones were selected for the study. Presently, studies on gas exchange measurements, like, net photosynthesis rate, transpiration rate, stomatal conductance and intercellular CO₂ concentration have been completed.

Project 19: Carbonisation of selected fuelwood species [IWST-34/WE-1/2004-2005]

Principal Investigator – Dr K.K. Pandey

Status: Project initiated in January 2004. Studies on fuel characteristics (calorific value, ash content, volatile content, and fixed carbon content) of few selected wood species have been initiated.



Project 20: Development of seasoning schedules for plantation timbers using dehumidification based drying [IWST/WSP/2003-2006]

Principal Investigator – Shri N.K. Upreti

Status: Work has been initiated.

Project 21: Development of durable and dimensionally stable block board using plantation timber – An IPIRTI-IWST collaborative project [IWST/ID/Nov 2002–Nov. 2004]

Principal Investigator - Shri N.K. Upreti

Status: The project is cancelled by IWST due to some unavoidable circumstances.

Project 22: The application of shock waves to wood science and forestry [IWST/ID/2003-2006]

Principal Investigator - Dr K.S. Rao

Status: Possibilities are being explored for external funding for the project and, therefore, not initiated.

PROJECTS COMPLETED DURING THE YEAR 2003-2004

(Externally Aided)

Project 1: Transfer of forestry technologies for the benefit of rural and sectoral communities of Karnataka (Eastern Plains)

Principal Investigator – Dr K.S. Rao

Findings: A total of seven technologies on "Forestry and Wood Science" aspects identified for demonstration in four districts of Eastern plains of Karnataka. These are: ammonia plasticisation -1 no., ammonia fumigation-2 nos., portable distillation unit (1 no.) and boucheri method demonstration unit (2 nos.).

PROJECTS CONTINUED DURING THE YEAR 2003-2004

(Externally Aided)

Project 1: Establishment of Advanced Wood Working Training Centre at IWST.

Principal Investigator - Dr K.S. Rao

Status: The Advanced Wood Working Training Centre has been established at IWST jointly by IWST and Italian Trade Commission in March, 2003. Training courses under three modules are being conducted. 406 trainees have been trained in 15 modules.

Project 2: Characterisation and quantitative analysis of decayed wood by fluorescence and Fourier transform infrared (FTIR) spectroscopy, [2003-2006]

Principal Investigator - Dr K.K. Pandey

Status: Samples of softwood (*Pinus roxburghii*) and hard wood (*Hevea brasiliensis* and *Bombax ceiba*) were exposed to brown-rot (*Polyporus melia* and *Trametes palustris*) and white-rot (*Coriolus hirsustus* and *Coriolus versicolor*) fungi. Batches of these samples are being removed at an interval of two weeks for physico-chemical analysis. Lignin modification in *Pinus sylvestris* L. and *Fagus sylvatica* L. wood decayed to different weight losses by the brown-rot fungus *Coniophora puteana* was investigated by FTIR. Polysaccharide components of wood were selectively degraded as decay progressed. Polysaccharide to lignin ratios estimated using FTIR correlated well with lignin contents determined by acetyl bromide method.

Project 3: Weathering of wood surfaces [2002-2005]

Principal Investigator – Dr K.K. Pandey



Status: Photodegradation of *Pinus roxburghii* (chir pine) and *Hevea brasiliensis* (rubber wood) was studied under artificial accelerated weathering conditions in a xenon test chamber. UV-Vis irradiation modified physical and chemical characteristics of wood surface resulted in rapid colour change, reduction in lignin content and increased chromophoric groups. Results demonstrated, lignin to be most sensitive to photodegradation and photodegradation increases with increasing the intensity of radiation. Effect of direction of cut on rate of photo discoloration of rubber wood indicated that radial surfaces deteriorate slightly faster than tangential faces. Analysis of colour changes and FTIR spectra measured from irradiated wood surfaces of *Acacia auriculiformis* indicate that presence of extractives increases rate of discoloration and leads to an apparent increase in rate of photodegradation of wood surfaces in the initial period of exposure.

Kinetics of chemical modification of wood specimens of *H. brasiliensis* and *P. roxburghii* esterifies with benzoyl chloride was studied. FTIR and fluorescence spectroscopy and photostability of modified wood was effective in inhibiting photo-discoloration and in photostabilising wood polymers.

Project 4: Refinement of protocols for rapid clonal propagation of sandal and red sanders; demonstration of field performance and evaluation of genetic fidelity [2003-2006]

Principal Investigator – Dr T.S. Rathore

Status: Facilities for isozymes and molecular (DNA) markers to carry out studies on genetic variability and fidelity of micropropagated plants were developed. Plus trees of red sanders in Andhra Pradesh with state forest department

of Andhra Pradesh were located. Explant type, medium, growth hormones for shoot initiation in sandal and red sanders from explants of selected plus trees/ clones and shoot multiplication in sandal were standardised. Explant type, size, medium and growth hormones for callus and cell suspension cultures for somatic embryogenesis from two clones of *Santalum album* were optimised. Severe leaching and browning problems were encountered in red sanders, which were overcome by management of source material, pre-treatments with anti-oxidant solutions and incorporation of additives in the medium.

NEW PROJECTS INITIATED DURING THE YEAR 2003-2004

(Externally Aided)

Project 1: Biocomposites from engineered natural fibres [2004-2006]

Principal Investigator – Shri Ajay Karmarkar

Status: Project approved in January, 2004. Work just initiated.

Project 2: Assessment of fruit characters in *Garcinia cambogia* and gender identification of economically important forestry species using isozyme studies - *Garcinia cambogia* and *Myristica fragrans*

Principal Investigator – Shri Sanjai Mohan

Status: Field survey was undertaken in Coorg and Uttar Kannada districts for the initiation of identification of male and female *Garcinia cambogia* and *Myristica fragrans* plants and study of different parts of tissue and their collection for laboratory work. Different tissues (leaf, leaf mid rib, living bark tissue, tender bark tissue) for knowing enzyme activity were tested. Activity of peroxidase, malate dehydrogenase,



esterase and glucose dehydrogenase enzymes were checked in different tissues. Suitable substrates for peroxidase enzyme were selected. A simple questionnaire has been prepared and information is being collected in case of *Garcinia cambogia* plants to study market dynamics of fruits.

Project 3: Investigations on the mechanisms of success of *Mytilopsis sallei* (Recluz) in managing toxic load arising out of biodeterioration control measures

Principal Investigator – Dr M. Balaji

Status: Project will be initiated as soon as funds from donor agency are received.

Project 4: Bio-invasion, SPS measures and import of wood and wood products into India [2003-2004]

Principal Investigator - Dr K.S. Rao/Dr O.K. Remadevi

Status: Insects and fungi's from different parts of India were collected and identification work is in progress.

Project 5: Introspection into the phytosanitary procedures for storage of forestry seeds in Karnataka [Sep 2003-May 2004]

Principal Investigator - Dr O.K. Remadevi

Status: Work has been initiated.

Project 6: Studies on field incidence of tea mosquito bug *Helopeltis antonii* sign. on neem trees in Karnataka and its management [Nov., 2003 – July, 2004]

Principal Investigator - Dr O.K. Remadevi

Status: Roving survey work showed that so far no damaging symptoms and insects were found in pongam and neem nurseries. The work on management of leaf gall of pongam caused by *Acacia pongamiae* has been initiated in the field.

Project 7: Estimation of demand and supply of fuel of wood and other available biomass in

three districts of eastern plains of Karnataka [Aug., 2003- Aug., 2004]

Principal Investigator – Shri Sanjai Mohan

Status: Questionnaires for collecting data from rural areas and urban areas were prepared. General survey of two districts in Karnataka (Kolar and Tumkur) was carried out. Data collected from Kolar and Tumkur districts were compiled and are being analysed.

Project 8: A study on avian diversity, threats faced and measures to protect and conserve in the area comprising the adjoining campuses of Institute of Wood Science and Technology, Indian Institute of Science, Central Power Research Institute, Karnataka State Forest Department, Air Force Area and Central School, Hebbal along with Hebbal Lake [Feb. 2004 - July 2004]

Principal Investigator – Shri Sanjai Mohan

Status: Points have been laid in the study area for point sampling. Point sampling for the birds is being carried out for estimating bird population. Water fowl monitoring (migratory and resident birds) is in progress in Hebbal Lake.

RESEARCH ACHIEVEMENTS

Name of State	No. of projects completed in 2003-04	No. of ongoing projects in 2003-04	No. of projects initiated in 2003-04
Karnataka and Andhra Pradesh	-	2	3
Karnataka, Andhra Pradesh and Goa	-	4	1
Karnataka	4	2	1
General	6	15	14

EDUCATION AND TRAINING

Organised

1. Conducted a Demonstration Programme on Forestry and Wood Science Technologies at Dharwad on 21st July, 2003



Demonstration Programme on "Forestry and Wood Science Technologies"



National Workshop on Wood Preservation in India: Challenges, Opportunities and Strategies

2. Training Course on Field Identification of Timber was organised for four in-service officials of Naval Dockyard, Visakhapatnam from 1st to 5th September, 2003.
3. Training Course on Joinery was organised for five in-service officials of Naval Dockyard, Visakhapatnam from 8th to 12th September, 2003.
4. One Week Compulsory Training Course for IFS Officers on IPR in Forestry Issues was organised from 15th to 19th September, 2003.
5. One Week Compulsory Training Course for IFS Officers on Mangrove Conservation and Management was organised from 6th to 10th October, 2003.
6. National Workshop on Wood Preservation in India: Challenges, Opportunities and Strategies was held from 20th to 21st October, 2003.

7. One Week Training Programme was organised at Advanced Wood Working Training Centre for the scientists/staff of the institute in December and January, 2004.
8. One Week Compulsory Course for IFS Officers on Advances in Wood Science and Technology was held from 19th to 23rd January, 2004.
9. National Workshop on Conservation, Restoration and Sustainable Management of Mangrove Forests in India was organised at Visakhapatnam from 18th to 22nd February, 2004.



His Excellency Shri Surjit Singh Barnala, Governor, Andhra Pradesh inaugurating the National Workshop on Conservation, Restoration and Sustainable Management of Mangrove Forests in India



Attended

1. Dr Syam Viswanath participated in the Training Course on Participatory Planning and Management of Agroforestry under Integrated Watershed Programme for Sustainable Development at the National Institute of Rural Development, Hyderabad from 10th to 15th November, 2003.
2. Shri S.C. Gairola attended Advanced Forestry Management Course at Indira Gandhi National Forest Academy, Dehradun from 12th to 23rd January, 2004.
3. Dr Avinash M. Kanfode attended One Week Compulsory Training on Biodiversity at National Environmental Engineering Research Institute, Nagpur from 19th to 23rd January, 2004.
4. Shri Y.B. Srinivasa attended Training in Tree Climbing as a Part of Canopy Access in Order to Sample Canopy Insects.
2. Aggarwal, Pankaj K.; Chauhan, S.S. and Karmarkar, Ajay (2002). Reduction of growth stresses in logs of *Acacia auriculiformis* by heat treatment. *Wood News*, 12(2): 36-39.
3. Aggarwal, Pankaj K.; Chauhan, S.S. and Karmarkar, Ajay (2002). Variation in growth strains, volumetric shrinkage and modulus of elasticity and their inter relationship in *Acacia auriculiformis*, *JTFP*, 8 (2): 135-142.
4. Aggarwal, Pankaj K.; Chauhan, S.S.; Prasad, N.R.R. and Rao, K.S. (2003). Water repellent treatments for catamaran grade *Bombax ceiba* wood. *Indian Journal of Marine Sciences*, 32 (4): 340-343.
5. Angadi, V.G; Jain, S.H. and Shankaranarayana, K.H. (2003). Genetic diversity between sandal population of different provenances in India. *Sandalwood Research Newsletter*, February, 4.
6. Anoop, E.V. and Vijendra Rao, R. (2003). Wood property variation in fast growing provenances of Acacias suitable for growing in agroforestry systems of Kerala. In: National Symposium on Agroforestry and Sustainable Development, Jhansi, 7th to 9th November, 2003. Proceedings.
7. Arun Kumar, A.N. and Srinivasa, Y.B. (2003). Stand level radial growth convergence on *Tectona grandis*. In: International Conference on Quality Timber Products of Teak from Sustainable Forest Management, Peechi, 2nd to 5th December, 2003. Proceedings.

LINKAGES AND COLLABORATION

Advanced Wood Working Training Center (a joint venture of Institute of Wood Science and Technology, Italian Trade Commission and Italian Wood Working Machinery Manufacturers Association) started First Training Course on Manual Wood Working on 29th April, 2003.

PUBLICATIONS

Research Papers Published / Presented

1. Aggarwal, Pankaj K. (2004). Effect of growth stresses and their reduction in plantation grown species – *E. tereticornis* for its better utilization: An approach towards forest conservation. In: 91st Indian Science Congress, Chandigarh, 3rd to 7th January, 2004, pp. 22.
8. Chauhan, Luxmi and Vijendra Rao, R. (2003). Wood anatomy of legumes of India: Their identification, properties and uses. Dehradun, Bishen Singh Mahendrapal Singh. 155 p.
9. Chauhan, S.S. and Aggarwal, Pankaj K. (2004). Effect of moisture sorption state on



- transverse dimensional changes in wood. *Holz-als-roh-und-werkstoff*, 62 (1): 50-55.
10. Dubey, Y.M. and Jain, V.K. (2003). Dielectric constant of some Indian timbers at different moisture contents. *Journal of Timber Development Association*, 49 (3-4): 34-41.
 11. Hayat, Mohammad; Narendra, T.C.; Remadevi, O.K. and Manikandan (2003). Parasitoids (hymenoptera: chalcidoidea; ceraphronoidea) attacking sandalwood, *Santalum album* L. *Oriental Insects*, 37: 309-334.
 12. Jain, S.H.; Angadi, V.G.; Shankaranarayana, K.H. and Ravikumar, G. (2003). Relation between girth and percentage of oil in trees of sandal (*Santalum album* L.) provenances. *Sandalwood Research Newsletter*, December, 4.
 13. Karmarkar, Ajay; Aggarwal, Pankaj K.; Modak, Jayant and Chanda, Manas (2003) Grafting of m-Isopropenyl- α , α -dimethylbenzyl-isocyanate (m-TMI) onto isotactic polypropylene: Synthesis and characterization, *Journal of Polymer Material*, 20(1): 101-107.
 14. Khali, D.P. and Rawat, S.P.S. Modelling the kinetics of moisture adsorption by wood. *Journal of Timber Development Association of India*, 49(3-4).
 15. Koppad, A.G. and Vijendra Rao, R. (2003). Effect of moisture conservation methods and fertilizers on nutrient uptake in two year old teak (*Tectona grandis*) plantation (poster presentation) In: International Conference on Quality Timber Products of Teak from Sustainable Forest Management, Peechi, 2nd to 5th December, 2003.
 16. Nagaveni, H.C. and Vijayalakshmi, G. Effect of VAM and *Azotobactor* inoculation on growth and biomass production in forestry species. *Indian Journal of Forestry*, 25 (1): 286-290.
 17. Nagaveni, H.C. and Vijayalakshmi, G. (2003). Growth performance on sandal (*Santalum album* L.) with different host species. *Sandalwood Research Newsletter*, 18th December, 1-4.
 18. Nataraja, K.N.; Arun Kumar, A. N. and Srivastava, Ashutosh (2003). A non-destructive rapid method for estimation of leaf area in nursery growing teak (*Tectona grandis* Linn.) seedlings. *Annals of Forestry*, 11(1): 94-97.
 19. Pandey, K.K. (2004). Effect of extractives on the photo-discoloration and degradation of wood In: 91st Indian Science Congress, Chandigarh, 3rd to 7th January, 2004. Proceedings.
 20. Pandey, K.K. and Pitman, A.J. (2003). FTIR studies of the changes in wood chemistry following decay by brown-rot and white-rot fungi. *International Biodeterioration and Biodegradation*, 52: 151-160.
 21. Pandey, K.K. and Pitman, A.J. (2004). Examination of lignin content in a softwood and hardwood decayed by a brown-rot fungus using the acetyl bromide method and FTIR. *Spectroscopy*, 42: 2340-2346.
 22. Raji, B., Remadevi, O.K. and Rao, K.S. (2003). First report on incidence of white flies from eumangroves. *My Forest*, 39 (4): 371-374.
 23. Rao, Rama N. and Satyanarayan Rao, K. (2004). Wild genetic resources/cultivars in Godavari valley of Eastern Ghats in Andhra Pradesh. In:



- Regional Strategy for plant conservation, Jabalpur, 26th to 27th February, 2004.
24. Rao, Vijendra R. and Shashikala, S. (2003). Assessment of growth rate, basic density, heartwood content in selected teak clones of CSO, Thithimathi, Karnataka. In: International Conference on Quality Timber Products of Teak from Sustainable Forest Management, Peechi, 2nd to 5th December, 2003. Proceedings, pp. 440-447.
25. Remadevi, O.K; Nagaveni, H.C. and Muthukrishnan, Raja (2003). Pest and Diseases of Sandalwood Plants in Nurseries and their management Paper presented in the 5th meeting of IUFRO working party held at Kerala Forest Research Institute, Peechi from 6th to 8th May, 2003.
26. Samani, A.; Pandey, K.K. and Reddy, K.S. (2003). Economics of biomass energy conversion systems. *Wood News*, 13: 22-23.
27. Sharma, S.K.; Shukla, S.R.; Kumar, P.; Sudheendra. R.; Dubey, Y.M. and Vijendra Rao, R. (2003). Utilisation potential of coppiced *Eucalyptus tereticornis* – wood. In: First Seminar on Panel Industry-Wood and Beyond, New Delhi, 5th September, 2003. Proceedings, pp. 49-53.
28. Shukla, S.R. (2003). Utilisation potential of coppiced *Eucalyptus tereticornis* wood. In: Panel Expo 2003, New Delhi, 5th September, 2003.
29. Singh, Dhyan; Singh, Rajeshwar and Bhandari, Rajesh (2003). Packing boxes from bamboos for horticulture produce. *Journal of Timber Development Association*, 49 (1-2): 39-42.
30. Srivastava, A.; Rathore, T.S. and Somashekar, P.V. (2003). Genetic screening of selected clones of *Eucalyptus tereticornis* at three years stage. In: International Conference on World Perspective on Short Rotation Forestry for Industrial and Rural Development, Solan, 7th to 13th September, 2003.
31. Sundararaj, R. and Dubey, A.K. (2003). Potential of plant products for the management of whiteflies in nurseries. In: 5th Meeting of IUFRO Working Party, Peechi, 6th to 8th May, 2003.
32. Sundararaj, R. and Dubey, A.K. (2003). Whiteflies (hemiptera: aleyrodidae) associated with sandal (*Santalum album* L.) in southern India with description of a new species. *Entomon*, 28 (4): 1-6.
33. Sundararaj, R. and Vasantharaj David, B. (2003). *Massilieurodes homonoiae* (Jesudasan and David) Comb. Nov. (aleyrodidae: homoptera), *Entomon*, 28(4): 7-8.
34. Sundararaj, R.; Muthukrishnan, Raja and Remadevi, O.K. (2003). Insect pests of pongam (*Pongamia pinnata*) in India (poster presentation). In: Consultative Workshop on Scientific Strategies for Production of Non-edible Oil for Use as Biofuels, Bangalore, 7th and 8th September, 2003.
34. Sundararaj, R.; Muthukrishnan, Raja and Remadevi, O.K. (2003). Field evaluation of some insecticides against termite infestation of sandal (*Santalum album* L.) trees. *My Forest*, 39 (4): 375-378.
36. Sundararaj, R.; Remadevi, O.K. and Muthukrishnan, Raja (2003). Comparative efficacy of some insecticides in ground contact against subterranean termites. *Pestology*, 27 (2): 16-18.
37. Swaminathan, L.P., Purushothaman, S. and Viswanath, S. (2003). Grazing issues in



- degraded semi arid areas. In: National Workshop on National Grazing strategy, Common Property Resource Management and Conservation of Indigenous Animal Breeds, Coimbatore, 5th and 6th August, 2003.
38. Uniyal, K.K.; Dubey, Y.M. and Jain, V.K. (2003). A note on thermal conductivity of wood and different moisture content. *Journal of the Timber Development Association of India*, 49(1-2): 12-16.
39. Vijendra Rao, R. (2004). Better utilisation of lesser known and plantation timber from South India. In: Workshop on Conservation and Sustainable Utilisation of Lesser Known Tree Species, Dehradun, 8th to 10th March, 2004.
40. Viswanath, S.; Peddappaiah, R.S.; Subramanian, V.; Manivachakam, P. and George, M. (2003). Canopy and root management in *Casuarina equisetifolia* for optimizing performance in wide row inter cropping systems in Tamil Nadu. In: National Symposium on Agroforestry and Sustainable Production, Jhansi, 7th to 9th October, 2003.
2. Portable distillation unit (Kannada)
3. Sap displacement technique (Kannada)
4. Sandal (English).

CONFERENCES/MEETINGS/WORKSHOPS/SEMINARS / SYMPOSIA / EXHIBITIONS

Participated

1. In Bio-2003: An International Exhibition on Biotechnology, Bangalore, 15th to 17th April, 2003 by putting a stall.
2. In India Wood 2004: The International Exhibition of Woodworking Machinery, Tools, Fittings, Accessories, Materials and Products, Bangalore, 6th to 10th February, 2004 by putting a stall.
3. Shri Asutosh Srivasatava attended International IUFRO Conference on World Perspective on Short Rotation Forestry for Industrial and Rural Development at Solan, H.P. and presented a paper.
4. Dr S.R. Shukla participated in the Workshop cum Exhibition on Technology Development for Bamboo Composite Materials and Products for Socio-Economic Applications, Bangalore, 16th January, 2004.
5. Dr Syam Viswanath participated in the National Symposium on Agroforestry and Sustainable Production, Jhansi, 7th to 9th November, 2003.
6. Dr Syam Viswanath participated in the Training Course on Participatory Planning and Management of Agroforestry under Integrated Watershed Programme for Sustainable Development, Hyderabad, 10th to 15th November, 2003.
7. Dr T.S. Rathore participated in Second Hi-Technology Cooperation Group Meeting Bangalore, 19th November, 2003.

Brochures and Pamphlets

1. Ammonia Plasticisation unit – Kannada.
2. Ammonia Fumigation – Kannada.
3. Sap displacement method-English.
4. Portable distillation unit-English and Kannada.
5. Nursery practices of important tree species - English and Kannada.
6. Sandal – English.

Handouts

The institute published the following handouts:

1. Modern nursery practices (English and Kannada)



CONSULTANCIES

The institute provided following consultancies during the year:

1. Bio-efficacy evaluation testing of wood preservatives to M/s Pidilite Industries Limited, Mumbai.
2. Preparation of mine closure plan for Kudremukh Iron Ore Company under Consultancy awarded to ICFRE.
3. Kiln seasoning of pencil slats and related aspects to M/s Umesh Pencils Processors Pvt Ltd., Pollachi, Coimbatore.
4. Wood seasoning and related aspects to the Karnataka State Handicrafts Development Corporation Limited (KSHDC).
5. Testing of commercial wood preservatives against fungi, termite and borer attacks to M/S Pidilite Industries, Mumbai.
6. Identification and determination of moisture content of the doors and window frames, installed at the newly constructed Vidhana Soudha South Block (Assembly Hall), Bangalore.
7. Testing services were rendered to Indian Institute of Science, Bangalore at its new Hostel complex for authentication of wood and its quality.
8. Timber identification and testing services were rendered to different users, like industry, government departments, construction industry, NGOs and private sectors. The institute also provided technical information to the different users on use of wood and wood products.
9. Analytical services were rendered to Police Department, Forest Department and public in analysis of essential oils from sandalwood samples.

AWARDS

- ♦ Dr K. Satyanarayana Rao, Director has been conferred "The Great Son of Karnataka" honour by the All India Conference of Intellectuals (AICOI) at the Karnataka State Intellectuals Conference held at Bangalore on 6th July, 2003 in recognition of his distinguished services rendered to the society in the field of Wood Science. The Award was presented by His Excellency Shri T.N. Chaturvedi, the Governor of Karnataka.
- ♦ Dr V. Kuppusamy was awarded S.K. Seth Prize (along with co-authors) for the year 2002 by *Indian Forester* for the research paper entitled "Variations in foliage and soil nutrient composition in *Acacia tortilis* plantation of different age in north-western Rajasthan" by Singh, G.; Singh, Bilas; Kuppusamy, V. and Bala, N. published in the *Indian Forester*, 128 (5): 514-522.

DISTINGUISHED VISITORS

- ♦ Shri Angus Wallace, OSMOSE, visited the Institute on 1st April, 2003.
- ♦ Dr Roman Kalser, Director, Natural Aromatic Plants and Sandalwood Centre, Giraudan, Dubendorf, Switzerland and Dr Prakash Narayan, Operations Director, Giraudan visited the Institute on 9th April, 2003 for discussions on various aromatic plants and sandalwood.
- ♦ Shri Vittorio Mecozzi, Italian Trade Commissioner visited the institute on 14th May, 2003.
- ♦ Shri Claudie Braind of Adrian Industrial France visited the Institute on 11th June, 2003.
- ♦ Shri Mark, from INBAR (Ghana) visited the Institute on 18th June, 2003.



- ◆ Shri Yamuna Singh, Hon"ble Minister of Forests and Environment, Govt. of Jharkhand visited the Institute in the month of July, 2003.
- ◆ Shri Subhash Thakare, Minister of Forests and Environment, Govt. of Maharashtra visited the Institute on 17th September, 2003.
- ◆ Dr E. M. Wild, Executive Director, Global foundation cultural corporate visited the institute on 30th March, 2004 and gave a talk on "Science and Philosophy Towards a Culture of Synthesis".
- ◆ Shri Jaime F.Sales Luis, Professor of Eng. Silvicultor, UTAD, Florestal, Portugal visited Xylarium.
- ◆ Shri Xavier Martin, Director, Graduate School of Timber Engineering, Nantes Cedex 3 – France visited Xylarium and showed interest in collaboration.
- ◆ Shri K. Jude Sekar, Director, Environment-Cum-Special Secretary to Govt. of Orissa, Bhubaneswar visited and showed interest in collaboration.

- ◆ Students from Graduate School of Timber Engineering, France visited the institute on 4th March, 2004.



Faculty and students from Graduate School of Timber Engineering, France

MISCELLANEOUS

- ◆ Anti- terrorism day was observed on 21st May, 2003.
- ◆ Vigilance Awareness Week was observed by the Institute from 3rd to 8th November, 2003.
- ◆ Hindi Week was celebrated by the Institute from 15th to 28th September, 2003.