

Institute of Wood Science and Technology Bangalore

The Institute of Wood Science and Technology (IWST), Bangalore established in 1988, is mandated to conduct research on Wood Science and Technology as its national objective and focuses its research 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 Utilization of Wood; Mangroves and Coastal Ecology and Research on Sandal. The focus 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 utilization of timber and non-timber products and increasing productivity. The Institute mainly aims to develop strategies for use and production of wood and other forest products in a way that sustain their supply.

The vision of the Institute is to attain excellence in forestry and wood science research for generation of desired resource values, uses, products, services in a way that sustains diversity and productivity in an eco-friendly regime.

A Shore Laboratory at Visakhapatnam and a Forest Research Centre at Hyderabad have been established under IWST. It has field stations at Gottipura and Nallal near Bangalore, Yelawala near Mysore and Mulugu near Hyderabad.

PROJECTS COMPLETED DURING THE YEAR 2006-2007

Project 1: Wood-fibre plastic composite foams with improved cell morphology by continuous process [IWST/WSP/X-37/2004 2006]

Findings: Flexural modulus of the fibre filled PS showed an increase in the value upto 30% loading followed by a sharp decrease at 40%. In powder filled composites an increase in the flexural modulus was observed. Foaming experiments indicated 35% increase in stiffness as compared to normal WPC. There was no significant change in density with decreasing the die temperature from 180°C down to 135°C and the density 1050 kg/m³. When the die temperature was suddenly reduced to less than 135°C, there was a decrease in density (910-950 kg/m³).

Project 2: Polymerization filled composites [IWST/WSP/2003-2006]

Findings: An efficient way to overcome problems of poor dispersion and interfacial adhesion is one-step synthesis of composites by using Polymerization-Filling Technique (PFT). Using this technique, ethylene was polymerized directly from the wood fiber surface, and this proved to be an efficient method to promote good filler dispersion and improvement in mechanical properties of the resulting composites. Studies on polymerization kinetics have contributed in optimizing the reactor. A novel technique of *in situ* generation of co-catalyst from co-catalyst precursor has resulted in higher rates of polymerization and very high catalyst activity. The study has successfully demonstrated that highly filled composites can be prepared by filler supported catalyst system using cellulosic materials as fillers in a slurry reactor.

Project 3: Evaluation of culm quality before, during and after flowering in bamboo (*Bambusa bambos* and *Dendrocalamus strictus*) species [IWST/WPU/X-14/2003-2007]



Findings: Starch content estimated by bio-chemical method in non-flowered, flowered, and after flowered culms of *Bambusa bambos* showed variation. Histo-anatomical studies on starch, lipids and proteins also showed variations. Histo-anatomical studies on starch, lipids and proteins were also made in non-flowered culms of *Dendrocalamus strictus*. Round bamboo showed higher values in compression parallel to grain in non-flowered culms while static bending values are higher in culms during flowering. Strength properties (MCS and static bending) were more in split bamboo culms after flowering (air-dry) than non-flowered and flowered culms (green). The percentage of damage (natural durability) in culms in flowering stage showed variation with reference to height.

Project 4: Assessment of wood quality of *Tectona grandis* (teak) clones from Thithimathi (Karnataka) and Andhra Pradesh [IWST/WPU/X-15/2003-2007]

Findings: Among the clones studied it was observed that Thithimathi clones have better strength values compared to Haliyal clones but their strength values were less than standard teak. The correlation between dynamic and static modulus of elasticity (MOE) is very useful in determining the stiffness of the material without destroying it. The growth rate rather remained more or less same for both sources. The data generated from 11 clones from Andhra Pradesh indicated that some of the wood quality parameters do not support the rating followed by the department for best, average and poor.

Project 5: Studies on fracture mechanics in solid wood and wood composites using acoustic emissions [IWST/WPU/X-16/2003-2007]

Findings: Timber exhibited more fracture toughness in longitudinal-tangential plane than in longitudinal-radial plane, which was based on Linear Elastic Fracture Mechanics (LEFM) model. Microscopic observations of the longitudinally compressed specimens revealed a characteristic fracture band of buckled fibres making S-like shape. Branching macroscopic failure lines were also observed. Acoustic activity (cumulative signal intensity) was found to be increasing with the application of increasing loads and also with time till the sample failure.

Project 6: Characterization and identification of imported timbers available in the timber markets and sea ports [IWST/WPU/X-43/2004-2007]

Findings: A booklet entitled “A guide to some imported timbers in south Indian market” was published. The information consists of 25 species of imported timbers collected from Bangalore timber market in which information on the trade name (original country's), family to which it belongs, other common names, distribution, general appearance, weight and specific gravity with some information on mechanical properties, seasoning, durability, preservation and uses were given to help the public. Collection of quantitative data after the preparation of permanent slides followed by the characterization and development of card key features was carried out.

Project 7: Influence of pretreatment techniques on the treatability of hardwood species grown in Karnataka [IWST/WSP/X-33/2004-2007]

Findings: Study indicates that there is a considerable improvement in the absorption of chemicals in the ponded specimens than that of control specimens. Data also indicate upward trend of increase in absorption with increased diffusion period.

Project 8: Studies on drying characteristics of plantation timbers in dehumidifier drying kiln (Old title: Development of seasoning schedules for plantation timbers using dehumidification based drying) [IWST/WSP/X32/2004-2007]

Findings: Drying behaviour of plantation grown timbers namely silver oak, teak, shivane, *Acacia auriculiformis* and rubber wood was studied in the desiccant based dehumidifying wood drying system.

Drying rate in all the species was found to vary with the reduction in moisture content. Drying of teak, silver oak, rubber wood and *Acacia* at varying temperature as recommended for the dry bulbs in the conventional drying schedules has given satisfactory results. Species like silver oak exhibited some tendency to warp but it was more due to inherent wood quality variation. This system has an advantage in terms of operational ease and low maintenance over conventional kilns.

Total electrical energy consumed during drying of different species was evaluated. For teak the energy consumption required to remove one kg of water was estimated to be 0.86 kWh/kg, which is in close agreement with the reported values for dehumidification drying elsewhere.

Project 9: Development of colouring reagents based on enzyme - substrate reaction for differentiating oil yielders of sandal in field [IWST/CFP/ X-12/2002-2007]

Findings: A simple, less expensive, user friendly and field oriented colour reaction has been developed for identification of high oil yielders. Of the 12 substrates identified for colour reaction, only 2 substrates Benzidine and Guaiacol were found to be effective for distinguishing sandal plants into low and high oil yielders. The developed colour reaction using Benzidine and Guaiacol substrates was modified so as to distinguish sandal plants of varying oil content in the field. Results of the colour reaction have been verified in the field. Cost effectiveness of the study indicates that Benzidine is cheaper as compared to Guaiacol.



Verification of research findings
Kushalnagar forest range



Distinguishing sandal plants of varying oil content using field method



Project 10: Standardization of anti-leaching treatment for *Pterocarpus marsupium*, *Pterocarpus soyauxii* and *Intsia* species [IWST/CFP/X-51/2005-2007]

Findings: Appearance of discoloured patches on the wood surface due to leaching of water soluble extractives is quite common in the timbers of *Pterocarpus marsupium*, *P. soyauxii* and *Intsia* species. Samples of these species were treated with chromium trioxide, copper sulphate, potassium dichromate and stannous chloride to arrest extractive leaching. Chromium trioxide and stannous chloride were found to be effective and the treatment has been standardized. It has practical application and will be very useful for better acceptability of these timbers.

Project 11: Studies on the sucking pest complexes of Sandal and their management [IWST/WBD/X-13/2004-2007]

Findings: In this study 73 species of sucking pests breeding on sandal were authentically identified and documented. Out of these 14 species were reported for the first time out of which *Megapulvinaria maxima* (Coccidae), and *Nipaecoccus viridis* (Psuedococcidae) were found as potential pests of sandal. The study exposed the presence of an array of natural enemies of sucking pest on sandal. Many new insecticides including neem formulations were first time evaluated against *N. viridis* on sandal and Imidacloprid, Metasystox and Deltamethrin were found superior in containing this pest. Hence, these insecticides can be effectively used to manage the scales and mealy bugs infesting sandal on need basis.

Project 12: Role of Fungi biodeterioration of timber under marine conditions [IWST/WBD/X-35/2004-07]

Findings: From the marine infected wood samples 15 species of fungi were isolated. Microscopic and macroscopic characterizations were studied. Initially the fungal isolates were screened for the production of amylase and cellulase enzymes. Based on these activities, the isolates were classified as cellulolytic and non-cellulolytic fungi. Each isolate was subjected to weight loss study by exposing the rubber wood separately to each fungus by adopting accelerated laboratory evaluation as per IS 4873. Their decay pattern was recorded individually. Percentage of infection, type of fungus, seasonal occurrence of fungus were calculated.

Project 13: Impact of disturbance on canopy insect biodiversity: an assessment of forest health [IWST/WBD/2003-2007]

Findings: This is the first study in the country to quantify diversity in the forest canopies. The rich diversity of insects in the canopies paves way for a new dimension of research work on rainforest canopies. The work also represents the arthropod sample drawn in India using insecticide fogging method and also the first access of the forest canopy using single rope technique

Project 14: Ethnobotanical studies of Godavari valley in Andhra Pradesh [IWST/WBD-Marine/X-04/2002-2007]

Findings: Intensive field studies were conducted for collecting ethnobotanical data in the Rampachodavaram and Polavaram agency areas of East and West Godavari Districts, respectively of Godavari valley in Andhra Pradesh. Data on 426 plant species were collected from Konda Reddis, Konda Kammaras, Koyas and Valmiki and herbarium was made for all the species of ethnobotanical interest. Twenty-six lesser known potential plant species were collected for the first time from the tribes of Godavari valley and recommended for further studies. Collected for the first time a rare cane genetic

resource, *Calamus latifolius* Roxb. - from the study area, which forms a distributional record to southern India. Twenty-three rare, endangered and economic / wild plant genetic resources of ethnobotanical importance were collected from the tribal areas and introduced for *ex-situ* conservation in the office of the State Silviculturist, Regional Forest Research Centre, Rajahmundry. Recorded environmental



Globba marantina L.-tuberous rhizome used for eye diseases by
Konda reddis of Godavari valley, Andhra Pradesh

relationship and utilization practices of plant resources. Documented traditional system of agricultural practices and their knowledge on preservation of primitive cultivars and wild genetic resources.

Project 15: Inventory of coastal plant communities of north Andhra region [IWST/WBD-Marine/X-25/2003-2007]

Findings: Intensive field surveys were undertaken along the coastal areas of Srikakulam, Vizianagaram, Visakhapatnam, East Godavari, West Godavari and Krishna Districts. In all, 2148 plant specimens were collected, made into herbarium and 1080 of them identified. Several mangroves, halophytes, hydrophytes, xerophytes, psammophytes and seaweeds were collected. *Acanthus ilicifolius* L., *Avicennia marina* (Forssk.) Vierh., *Hydrophylax maritima* L.f., *Sesuvium portulacastrum* (L.) L. and *Solanum trilobatum* L. were found as new distributional records to Srikakulam district. An excellent sand binder, *Pupalia lappacea* (L.) Juss. var. *orbiculata* (Heyne ex Wall.) Townsend was collected for the first time from the north coastal region of Andhra Pradesh. Recorded a rare and endemic plant namely, *Dimorphocalyx glabellus* Thw. from the coastal hilly area near Bangarampalem, Visakhapatnam District. Recorded sixteen hitherto lesser-known mangrove wetlands from Srikakulam, Visakhapatnam, East Godavari, West Godavari and Krishna Districts.

Project 16: Studies on productivity and management of teak (*Tectona grandis*) in agroforestry practices in Karnataka and Andhra Pradesh [IWST/TIP/X-38/2004-2007]



Findings: Growth stresses were low and within utilizable range for farm teak in line and in less intensively managed block plantations. Intensively managed block plantations had significantly higher growth stresses indicating possible loss in utilizable timber if harvested at 12 years. Mechanical and physical properties of farm teak in line and in less intensively managed block plantations were almost at par. Among the various teak based agroforestry models compared, teak on farm boundaries (line plantations) with annual arable crops and horticultural crops like mango appear to be financially viable.



Twelve years old farm teak in line plantations in Devanahally, Bangalore rural district.

Project 17: Seed studies of some of the economically important species of Western Ghats [IWS/TIP/2003-2007]

Findings: The study was conducted to understand the critical moisture content of seeds at different temperatures and its effect on viability. The species studied were *Garcinia gummigutta*, *Dysoxylum malabaricum*, *Myristica fragrans* and *Dipterocarpus indicus*. It was found that seeds of *G. gummigutta* are sensitive to temperature below 15°C and can be stored for 18 months at 15°C with seed moisture content between 34 to 43%. Viability of *Dysoxylum malabaricum* can be prolonged for six months when stored at 15°C with 48.5% moisture content. Seeds of *Myristica fragrans* are recalcitrant in nature and loose viability under all conditions of storage.

Project 18: Screening clonal propagation, ex-situ conservation and genetic improvement of *Pongamia pinnata* [IWS/TIP/X-36/2004-2007]

Findings: Collected seeds of plus trees from 4 silvicultural zones namely, Central, Southern, Eastern and Northern zones of Karnataka. Conducted variability studies on fruits, seeds and germination. Estimated oil content in seeds to screen the plus trees with higher oil content. Seeds of northern silvicultural zone recorded highest (29.7%) oil content followed by the central silvicultural zone and minimum (24.0%) in southern silvicultural zone. Completed studies on the effect of various auxins and their concentration, and the size of cutting for the refinement of vegetative propagation of *P. pinnata*. Raised seedlings from the seeds of 25 plus tree sources and established progeny trial at Nallal field research station in 0.6 ha of land with 375 seedlings.

PROJECTS CONTINUED DURING THE YEAR 2006-2007

Project 1: Studies on the gas permeability of secondary species of timbers [IWS/WSP/2003-2008]

Status: Flow rates have been measured for *Acacia mangium* specimens (150 samples) in axial, radial tangential directions. *Eucalyptus tereticornis*, *Eucalyptus camaldulensis* and *Eucalyptus grandis* are being subjected to conditioning.

Project 2: Studies on the durability of treated and untreated timbers of selected species [IWS/WSP/X-34/2004-2009]

Status: Test yard specimens of *Lophopetalum wightianum*, *Lagerstroemia lanceolata*, *Artocarpus heterophyllus*, *Spondias pinnata*, *Melia azadirachta* and *Sterospermum personatum* were subjected to pressure treatment adopting the Full Cell process using 3 different preservatives viz. Copper Chrome Arsenic composition (CCA), Copper Chrome Boric composition (CCB) and Creosote and furnace oil 1:1 preservatives for 4 different levels of absorption. The specimens were exposed to the field tests in the Test yard at Nallal along with untreated control.

All the untreated specimens of the above mentioned species were attacked by termites except *Lagerstroemia lanceolata* after 21 months of exposure.

All the untreated specimens of *Lophopetalum wightianum* were destroyed by termites within a year of exposure while 30% of the treated specimens with CCB, (4 kg/m³) were showing termite attack after 20 months of exposure. Loss of weight was more than 40%. This shows that 4 kg/m³ retention of CCB in this species will not increase the durability for a longer period.

Treated specimens of remaining 5 species are in sound condition showing that preservative treatment even with very low retention of CCA and CCB (4 kg/m³) improves the durability of non durable timbers.

Project 3: Analysis of active principles in *Gymnema sylvestre* and *Phyllanthus amarus* from the forest of southern India [IWST/CFP/X-46/ 2005-2008]

Status: Collection of plant material (*Gymnema* and *Phyllanthus*) from Tamil Nadu, selected place of Andhra Pradesh and selected part of Kerala is over. Collected plant material was processed and extracted with petroleum ether and 95 % ethanol to get gymnemic acid. Quantification of gymnemic acid has been initiated.

Project 4: Screening and evaluation of wild varieties of *Emblica officinalis* fruit in various Agro-climatic zones of Western Ghats [IWST/CFP/X-48/ 2005-2008]

Status: Fruits of *Emblica officinalis* were collected from Mudumalai and BRT Hills (Karnataka); Agastiar Malai, Peechi, Athirapallys, Parambikulam (Kerala) and Thenmalai, Kurtalam and Kanyakumari (Tamil Nadu). Collected fruits were processed for extraction of ascorbic acid. Estimation of Vitamin-C has been initiated.

Project 5: Extraction and separation of Chemical constituents of *Dysoxylum malabaricum* Bedd. wood [IWST/CFP/X-52/2005-2008]

Status: White cedar wood was distilled by hydro distillation method and the oil was analysed by GC-MS. The result showed that 28 important chemical compounds are present out of which 5 major compounds i.e., more than 3% in quantity. Extractives (<2%) were column chromatographed with different solvent mixtures and partial separation and purification was done.

Project 6: Investigations on the resistance of commercially available bamboo species in Karnataka against insect borer and termite [IWST/WBD/X-45/2004-2008]

Status: Length-wise durability of 2 commercially available bamboo species, *Bambusa bambos* and *Dendrocalamus strictus* was tested against termites and borers. These bamboos were treated with 8 chemicals and are being tested against termites in the field conditions at Nallal. Shock wave (new technique) treated bamboos, Hot and cold process and CCA 4% pressure treated bamboos were tested for their durability against termites. Controls were completely destroyed.



Project 7: Studies on age related durability of plantation grown timbers [IWST/WBD/X-50/2005- 2009]

Status: Maintenance of wood rotters in virulent condition by repeated sub - culture technique is being done. Wood samples were prepared for both fungal and termite studies from all species and age groups. One set of samples was treated with ACA and exposed for termites in test yard. Monthly observation is being done for termite activity on the treated samples. *Acacia auriculiformis* and *A. mangium* of all age group were exposed to both wood rotters under accelerated laboratory studies. Treatment of CCA and CCB for fungal and termite exposure are being done.

Project 8: Clonal test trials on *Casuarina equisetifolia* L. in North coastal Andhra region [IWST/WBD-Marine/X-004/2003-2008]

Status: Observations on survival of different clones of *Casuarina equisetifolia* L. recorded. Growth in terms of height of five dominant clones was found to be 10.2 m in APVSYM-5M; 7.50 m in APVSYM-4F; 8.40 m in APVZVZ-1F; 9.70 m in CP4202-M and 7.8 m in CP0305-M. Basal stem diameter of the five clones was noted to be 40.5 cm in APVSYM-5M; 38.4 cm in CP0305-M; 41.0 cm in CP4202-M; 35.6 cm in APVZVZ-1F and 34.8 cm in APVSYM-4F.

Project 9: Periodical income generation for communities involved in coastal plantation (Old title: Community involvement in coastal forestry through periodical returns by value added produce) [IWST/WBD-Marine/X-24/2003-2008]

Status: Growth parameters of *Casuarina equisetifolia* L. were recorded. Herbage was collected from 3m x 3m plantations of *Eucalyptus citriodora*. Essential oil yield was at the rate of 620 ml/quintal and 581 ml/quintal, respectively from 500 kg and 430 kg of herbage. Assessment of quality of essential oil is under progress at IWST. Observations on the survival of NTFP species showed that the soil and weather conditions are not congenial for the species.

Project 10: Environmental impact of leachates from Copper Chrome Arsenic (CCA) wood preservative under marine condition [IWST/WBD-Marine/X-23/2003-2008]

Status: Prepared out of untreated and CCA treated mango test panels, 200 test ladders were secured sequentially to thick nylon ropes and exposed in the fishing harbour at Visakhapatnam. Test panel sets were retrieved periodically and observations on biodeteriogens recorded. Important environmental parameters were monitored. Boring samples were obtained from all the 375 panels retrieved and being processed for further analysis.

Project 11: Studies on recruitment and metamorphosis of marine woodborer larvae [IWST/WBD-Marine/X-22/2003-2008]

Status: Pure cultures of microorganisms separated from the primary film were maintained. Biochemical tests were conducted to identify the bacteria so cultured. The microbes so far identified are *Halomonas* species, *Actinobacillus* species, *Serratia ficaria*, *Haemophilus* species, *Vibrio* species and *Staphylococcus* species. Wooden wafers were coated with pure bacterial cultures and experiments conducted on their influence on the recruitment of teredinid wood borer larvae.

Project 12: Productivity and interaction studies in *Acacia hybrid* based agroforestry practices in Karnataka [IWST/TIP/X40/2004-2009]

Status: *Acacia* hybrid ramets were outsourced from MPM, Bhadravathi. Agroforestry trial plots were set up in farmers' fields in Kolar (in 2004) and in Doddaballapur (2005). Data on growth performance of *Acacia* hybrid was recorded at both sites. Analysis of soil samples for soil physico-chemical parameters were completed. Maintenance of trials is carried out on regular basis. Data on intercropped agricultural crop like ragi, maize and tomato was also recorded.

Project 13: Comprehensive tree improvement program for *Gmelina arborea* in Karnataka Phase I Progeny trial [IWST/TIP/X-41/2004-2009]

Status: Seeds were collected from 27 plus trees from Karnataka (17 plus trees) and Andhra Pradesh (10 plus trees) and were sown for germination at IWST, Rajamundry and Tittimathi. Although germination was not satisfactory at the IWST nursery but the seedlings were produced at the Rajamundry and Tittimathi nurseries.

Project 14: Assessment of seed quality in unimproved populations, seed production areas and seed orchards of *Tectona grandis* [IWST/TIP/X-48/2005-2007]

Status: Preliminary results indicate that seeds collected during February-March 2006 from SPA were of better quality in terms of seed morphological characters and germination compared to unimproved populations. Seeds were collected again during February-March 2007 from CSO, SSO, SPA and unimproved population for studies on seed variability, germination and growth performance.

Project 15: Studies on seed source variation, determination of age of the trees and establishment of germplasm bank of Sandal [IWST/TIP/X-47/2005-2008]

Status: Seed collection from Karnataka, Tamil Nadu and Kerala has been completed and the seedlings are being raised to establish germplasm bank. Seed variability study has been initiated.

Project 16: Carbonisation of selected fuelwood species [IWST-34/WE-1/2004-2007]

Status: Variation in calorific value of *Casuarina equisetifolia* with age (1, 2, 3, 4, 5 and 7 years) was studied. No significant change in calorific value of different age groups of *C. equisetifolia* was found. Proximate analysis and Elemental analysis of *C. equisetifolia* with age and height was carried out. No significant changes in these parameters were observed. The carbonization of three wood species *Acacia auriculaeformis*, *Eucalyptus* hybrid and *C. equisetifolia* has been carried out at 300°, 400°, 500°, 600°, and 800° at 1 hour soaking time and three different heating rates of 4° C/min, 8° C/min, 12° C/min. The study shows that the yield of charcoal decreases with rise in temperature. Variation in the calorific values of the charcoals prepared under different experimental conditions was also evaluated. The study shows that with increase in temperature the fixed carbon increases and volatile content decreases. The ash content is more in case of *C. equisetifolia*.

NEW PROJECTS INITIATED DURING THE YEAR 2006-2007

Project 1: Processing and evaluation of plantation grown *Simarouba glauca* DC. from Orissa [IWST/WPU/X-59/2006-2009]

Status: Heartwood is yellowish grey in colour and is indistinguishable from sap wood. Average bark thickness was 8 mm and specific gravity was 0.647. Studies conducted on shrinkage behaviour showed average 3% radial shrinkage and 5% tangential shrinkage from green to oven dry.



Project 2: Detection of natural and biological defects in timbers by non-destructive testing techniques [IWS/WPU/X-63/2006-2010]

Status: Ultra Sonic Flaw Detector was installed along with transducers of various diameters and frequencies. Experiments were repeated using the equipment to standardize the testing procedure using samples of *Acacia mangium*.

Project 3: Study on utilization aspects of plantation grown *Acacia mangium* Willd. from Orissa [IWS/WPU/X-57/2006-2010]

Status: Heartwood and sapwood are distinct. Heartwood is dark brown and sapwood is whitish to yellow in colour. Heartwood and sapwood percentage varied from 92-94% and 6-8% respectively. Studies conducted on shrinkage behaviour showed average 2% radial shrinkage and 6% tangential shrinkage from green to oven dry.

Project 4: Study the variability in growth stresses in clones of *Eucalyptus* [IWS/WSP/X-56/2006-2008]

Status: Studies were carried out on 25 Clones of *Eucalyptus* raised by the institute at Nagaroor. Basic data such as DBH, pilodyn penetration, taper and height has been recorded for 8 clones. Out of 25 clones 15 have been selected for the final study. Based on initial studies, modification in the design of instrument was made.

Project 5: Effect of particle size on properties of wood filled polypropylene composites [IWS/WSP/X-53/2006-2009]

Status: Injection moulding machine for moulding standard wood polymer composite specimens was procured and installed. Moulding parameters like injection pressure, temperature profile, hold up pressure and time, cooling rate and time for moulding WPC material were standardized.

Wood of *Hevea brasiliensis* (rubber wood) was chipped and pulverized. Wood flour was segregated into five different sieve sizes (-30/+40; -40/+52; -52/+60; -60/+80; and 80) using sieve shaker fitted with BSS standard meshes. Using optical microscopy, 50 measurements on each size class were made.

Composite specimens with polypropylene as matrix material were prepared using each of the above size class at 40% filler loading using twin screw extruder. The compounded material was palletized and moulded into ASTM type test specimens using injection moulding machine. Moulding parameters were standardized. The test specimens were evaluated for tensile strength, flexural strength and modulus of elasticity (MoE). A mathematical model based on shear lag theory was also developed for predicting elastic properties of wood filled composites.

Project 6: Analytic Studies on Woody Cell Wall Architecture [IWS/WSP/ 62/2006-2009]

Status: It has been found that rosettes are created in a hexagonal arrangement through which glucose from cell is drawn and is polymerized into cellulosic chains that are in turn packed into a microfibril that is extruded on the outer side of plasma membrane. Forces exerted by the growing microfibril are responsible for the motion of rosettes in the plasma membrane. Role of microtubules as the system guiding the movement of rosettes in a fluid plasma membrane has been explored.

Project 7: Studies on chemical modification of wood by vapour phase treatments [IWS/WSP/X-61/2006-2008]

Status: Glass reaction vessel for carrying out experiments on chemical modification of wood in vapour phase was designed and fabricated. Wood of *Hevea brasiliensis*, *Mangifera indica*, *Pinus radiata* and *Pinus roxburghii* was procured. Defect free samples of size 2.0X2.0X2.0 cm and 2.0X2.0X0.5 cm from each species were prepared from sapwood after air seasoning to 8-10% moisture content. Studies on per cent extractives present in sapwood portion of each species using toluene, ethanol, acetone and mixture of toluene: ethanol: acetone::2:1:1 have been completed.

Project 8: Investigations on chemical composition and utility of AESP oil from exhausted sandalwood powder [IWST/CFP/X-60/2006-2009]

Status: Study between the ratio of exhausted sandalwood powder and water is being standardized. Exhausted sandalwood powder (two sets) is treated with different concentrations of acids (2.5 % to 10 %) for confirmation of results. The products obtained in above treatments were steam distilled. The steam distilled product was distilled again and AESP oil was estimated.

Project 9: Isolation and anti-fungal activities of the chemical compounds of *Baccaurea courtallensis* Muell.-Arg. - a wild edible plant of Western Ghats [IWST/CFP/X-64/2006-2009]

Status: Surveyed two locations in Karnataka and Tamil Nadu and located *Baccaurea courtallensis* in the natural forest of Western Ghats region. Collected plant materials. Powdered different plant parts. Extracted plant parts (wood and fruit rind) with different polarity solvents, quantified the extracts and separated and purified extracts by column chromatography.



Profuse fruiting of *Baccaurea courtallensis* at Makut, Karnataka



Fruits of *Baccaurea courtallensis* under process for phytochemical studies

Project 10: Laboratory testing for the assessment of the durability of timbers against powder post beetles standardization and evaluation [IWST/WBD/X-55/20062010]

Status: Culture of 2 species, *Lyctus africanus* and *Sinoxylon anale* has been established using Tapioca chips as feed material. Specimens from different age groups of plantation timbers (*Acacia auriculiformis*, *A. mangium*, *Eucalyptus tereticornis*, *Grevillea robusta* and *Melia dubia*) were procured from Hoskote and treated with ACA for laboratory testing. The contact toxicity and residual toxicity of bifenthrin was tested by adult release method.

Project 11: Database Development of IWST Xylarium [IWST/IT/X-58/ 2006-2009]



Status: Classification and arrangement, number and identification of specimens of IWST Xylarium is in progress. Visited Gass Forest Museum, IFGTB, Coimbatore to collect information and some specimen pictures.

PROJECTS COMPLETED DURING THE YEAR 2006-2007 **(Externally Aided)**

Project 1: Refinement of protocols for rapid clonal propagation of Sandal and Red sanders; Demonstration of field performance and evaluation of genetic fidelity (Funding Agency: Department of Biotechnology, Govt. of India) [2003-2006]

Findings: Developed refined protocols for *in vitro* cloning of *Santalum album* through axillary shoot proliferation and somatic embryogenesis of mature trees and clones. Genotype/clones have shown significant effect on shoot initiation, multiplication and rooting. Five genotypes/clones tested viz; AP4, KL3, CPT6, T1 and T13 and shoot multiplication rate varied from 2.66-4.43 fold and rooting from 40.77-70.39%. Genotypes/clones have also shown variable response on embryogenic callus induction, multiplication, somatic embryo induction, maturation and germination. Five clones viz; KL3, AP4, T11, K31 and K36 tested for somatic embryogenesis. Somatic embryo induction varied from 60.31-89.65%. Germination percentage varied from 40.42-50.73% with genotypes. Developed process for direct adventitious shoot induction and plantlet development from leaf and internode tissues of mature and selected genotypes for rapid and mass production of planting material of sandal. Basic protocol also developed for *in vitro* cloning of red sanders.

Project 2: Biocomposites from engineered natural fibres (Funding Agency: Ministry of Environment and Forest (MoEF)) [2004-2006]

Finding: Natural fibres are increasingly being used as reinforcement in commercial thermoplastics due to their low cost, high specific properties and renewable nature. The effect of filler concentration on the mechanical properties of wood fibre filled composites, prepared by using *m*-TMI-g-PP as the compatibilizer, was investigated. Tensile strength of composites so prepared increased by almost 45%, whereas an 85% increase in flexural properties was observed. The addition of wood fibers resulted in a decrease in elongation at break and impact strength of the composites. Dynamic modulus of elasticity (MoE) and shear modulus of wood filled polypropylene composite at various filler contents ranging from 10% to 50% were determined from the vibration frequencies of disc shaped specimens. Between the two fillers, wood fibre filled composites exhibited slightly better properties. Halpin-Tsai model equation was used to describe the changes in the composite modulus with the increasing filler content. The continuous improvement in elastic properties of the composites with the increasing wood filler is attributed to the effective reinforcement of low modulus polypropylene matrix with the high modulus wood filler

Project 3: Revision of subfamily Ponerinae (Hymenoptera:Formicidae) in India with special emphasis to western ghats (Funding Agency: DST-Fast Track Scheme) [2004-2007]

Finding: Out of 64 species of Ponerinae ants known from India, 51 species occur in Western Ghats. One new genus and six new species of Ponerinae ants have been described from Western Ghats.

PROJECTS CONTINUED DURING THE YEAR 2006-2007 (Externally Aided)

Project 1: Studies on the properties of coffee wood as indicators of white stem borer resistance (Funding Agency: Central Coffee Research Institute) [2005-2008]

Status: Specialized training in histo-anatomical features was imparted to the in-service officials of CCRI. Selections of coffee stems of healthy, susceptible and induced to borer attack nature were collected coinciding the phenology. Data on specific gravity and bark thickness was collected. Histo-anatomical studies for starch, proteins and lipids were made



In vitro cloning of *Santalum album*: Shoot multiplication cultures of clone KIL3

Project 2: Investigations on lesser known aspects of mangrove biodiversity and ecology in the states of Goa, Karnataka and Andhra Pradesh (Funding Agency: Ministry of Environment and Forest (MoEF)) [2004-2008]

Status: Surveyed 75 mangrove areas in the states of Karnataka, Goa and Andhra Pradesh. A total of 375 plant specimens were collected and documented. Samples of *Aegiceras corniculatum*, *Ceriops decandra*, *Sonneratia alba*, *Sonneratia apetala*, *Avicennia alba*, *Avicennia officinalis*, *Avicennia marina*, *Lumnitzera racemosa*, *Excoecaria agallocha*,



Xylocarpus granatum Koen. a rare true mangrove found along the coast of Andhra Pradesh

Bruguiera cylindrica, *Bruguiera gymnorrhiza*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Kandelia candel*, *Excoecaria agallocha*, *Avicennia marina* and *Avicennia officinalis* were collected. Bark and wood samples of *Rhizophora mucronata* and *Excoecaria agallocha* were processed separately for extraction of chemical constituents. Water and soil samples were also collected and analyzed.

Project 3: Establishment of Advanced Wood Working Training Centre at IWST (Funding Agency: Italian Trade Commission/ACIMALL) [2003-2008]

Status: Training was imparted to 31 batches consisting of 1788 students upto March 2007 as per module. Over 95 percent unemployed persons were benefited after the course. The salary earned by the trainees after their employment in various wood working companies in India ranging from Rs. 3000 to Rs. 15000 per month depending on their qualification, experience, etc.



Project 4: Community ecology of a detritus system. Insects and fungi associated with fallen trees in the Nilgiri Biosphere Reserve (Funding Agency: MoEF, Govt. of India) [2004-2007]

Status: Various sampling methods, including black light traps were used to collect insects from fallen logs. About 300 xylophagous insects were also recorded from fallen logs at Nagarhole National Park. From fungi inhabiting fallen logs, 20 species of fungi and 42 species of mycophagous insects were recorded. Chemical characterization of different stages of fallen logs of 10 species has been completed and is being correlated with the community structure of insects and fungi.

Project 5: Studies on the entomofaunal diversity and their interactions in selected provenances of sandal (Funding Agency: Ministry of Environment and Forest (MoEF)) [2004-2007]

Status: From the six selected sandal provenances 344 insect species belonging to 12 orders have been identified. Specimens are preserved as reference collection for future use. In terms of number of hopper *Nephotettix nigropictus* was found to be dominant and *Nephotettix nigropictus* and *Empoasca* sp. were found to be active throughout the year.

Project 6: Insect-plant relationships with special reference to herbivory in the mangroves of South India [2005-2008]

Status: Surveyed West coast (Mangalore, Honnawar, Kundapur and Karwar) mangroves monthly and collected insects by light traps and other methods. Solar light traps were installed in the selected study sites inside the mangrove forests for collection and monitoring of the nocturnal insects. Frugivores and their parasites were collected and identified. Pollinators of 6 species of mangroves have been identified and studies on pollination biology and role of insects were conducted. Herbivory in 4 insect species of mangroves with reference to different areas and seasons was assessed.

Project 7: Investigations on the mechanisms of success of *Mytilopsis sallei* (Recluz) in managing toxic load arising out of biodeterioration control measures (Funding Agency: Department of Science and Technology) [2005-2008]

Status: Recruitment of *Mytilopsis sallei* was monitored at monthly intervals at Visakhapatnam and Kakinada ports. Water samples were collected and salinity, temperature and pH recorded and additional samples processed for heavy metal analyses. Animal tissue samples were also collected, processed and preserved for analyses. Gut micro flora from *M. sallei* was cultured, isolated and pure cultures maintained. Characterization of bacteria isolated from the gut of *M. sallei* completed. In all, eleven species of bacteria, viz., *Serratia* sp., *Bacillus subtilis*, *B. cereus*, *Staphylococcus aureus*, *Escherichia coli*, *Vibrio cholerae*, *V. parahaemolyticus*, *Aeromonas* sp., *Pseudomonas* sp., *Micrococcus* sp., and *Staphylococcus epidermi* were identified. Tests on copper tolerance by the bacteria were conducted and growth pattern of different bacteria under copper stress recorded. *Bacillus* sp. and *Staphylococcus aureus* were found to tolerate higher copper concentrations.

Project 8: Development of protocols for rapid and mass clonal propagation of *Bambusa pallida* Munro and *Phyllostachys bambusoides* Sieb. et Jucc. (Funding Agency: Department of Biotechnology) [2004-2007]

Status: Studies were conducted on effect of additives, sucrose concentrations and pH on shoot multiplication, media and auxins for *in vitro* rooting in *B. pallida*. Maximum 4.0 fold shoot multiplication

could be achieved on shoot multiplication medium with additives (ascorbic acid 50 mg/l + citric acid 25 mg/l + cysteine 25 mg/l) + sucrose 4.5% + NAA 0.25 mg/l + BAP 1.0 2.5 mg/l or TDZ 0.25 mg/l. Liquid medium proved better than agar gelled medium for shoot multiplication. Sub culturing within 2 weeks proved essential to maintain growth and vigour. Auxins (IAA, IBA, NAA and NOA) and media (MS, MS/2, MS/4 and B5) have significant effect on rooting. Low nutrient medium with NAA/IBA proved suitable for *in vitro* rooting in *B. pallida*.

Medium with NAA + BAP proved suitable for somatic embryo induction and germination in *B. pallida*. In *P. bambusoides* multiplication rate was poor (2 fold) and rooting was sporadic. High rate of rooting (> 70%) from leaf stem branch cutting in *P. bambusoides* achieved in 5 weeks period with auxins (IBA/NAA) treatment.

Project 9: Field performance of micro and macro propagated planting stock of selected five commercially important bamboo species (Collaborative project with KFRI and IFGTB) (Funding Agency: Department of Biotechnology) [2004-2007]

Status: Field trials of micro and macropropagated planting material of commercially important five bamboo species viz; *Bambusa bambos*, *B. balcooa*, *Dendrocalamus asper*, *D. strictus* and *Pseudoxytenanthera stocksii* established during July September 2005 in 16.7 ha area (Karnataka 13.0 ha and Andhra Pradesh 3.7 ha) had survival rate varying from 85-95 per cent after six months of planting and 65-90% after one year. Maximum survival rate (90%) was in *D. strictus* and minimum in *D. asper* (65%). Maximum height was observed in *B. balcooa* and minimum in *D. asper*. Whereas, maximum number of tillers were seen in *D.*



Hardened micropropagated plants of *Dendrocalamus asper* for field trials

asper and minimum in *B. balcooa*. In general micropropagated plants had more number of tillers as compared to seed and cutting raised plants. There was no significant difference in survival rate of seed base, cutting base and micropropagated plants of these bamboos.

Project 10: Studies on assessing growth performance of *Guadua angustifolia* Kunth under different management schedules (Funding Agency: National Mission for Bamboo Application) [2005-2008]

Status: Raised the planting material of *G. angustifolia* for casualty replacement by macropropagation. Field trials established at two sites viz; Yelwala and Gottipura with each site trial having area of 1.3 ha. Assessed survival rate and growth performance of *G. angustifolia* at Gottipura and Yelwala. Soil analysis of study sites completed. Intercropping carried out with horse gram, red gram and cow pea in Yelwala. Litter studies were initiated.



Project 11: Bamboo Location Trials (Funding Agency: National Mission for Bamboo Application) [2005-2007]

Status: Eight bamboo species viz; *Bambusa bambos*, *B. tulda*, *B. nutans*, *B. balcooa*, *Dendrocalamus hamiltonii*, *D. asper*, *D. giganteus* and *Phyllostachys stocksii* trials at Nallal in Karnataka and FRC, Hyderabad (at FRC seven species are common and in place of *P. stocksii* and *Guadua angustifolia* was planted) revealed maximum height in *D. hamiltonii* and maximum number of tiller in *B. tulda*. Bushy growth was observed in *B. tulda* at Nallal (Karnataka). Survival rate in both these trials was > 80% after 18 months of planting.

NEW PROJECTS INITIATED DURING THE YEAR 2006-2007 (Externally Aided)

Project 1: Investigation on Tree ring analysis of certain species in Western Ghats to monitor climate changes and its relevance to wood quality (Funding Agency: MoEF) [2006-2009]

Status: Formalities regarding purchase of certain equipments and recruitment of JRFs have been initiated.

Project 2: Studies on acoustical behaviour of plantation timbers for musical instruments and wall paneling (Funding Agency: CSIR) [2006-2009]

Status: Purchased a system consisting of FFT analyzer, microphones, impedance tube and display and storage device. Procured logs of *Acacia auriculiformis*, *Artocarpus heterophyllus*, *Azadirachta indica*, *Eucalyptus* spp. and *Melia composita*. Surveyed the markets and obtained information on timber being used for making musical instruments.

Project 3: Development of bamboo fiber reinforced thermoplastic composites (Funding Agency: National Mission for Bamboo Application) [2006-2009]

Status: Universal testing machine, injection moulding die, palletizer, Hauloff system and Dryer, were procured and commissioned. Studies on standardization of extrusion parameters for preparation of bamboo fiber filled thermoplastic composites completed. Approximately 125 Kg of compounded material was supplied to industrial partner for industrial scale trials. The extrusion parameters and compounding formulations were modified according to feedback from industrial trials and requirements suggested by industries.

Project 4: Investigations on the fungi and insects associated with fruits and seeds of selected endemic trees of Western Ghats (Funding Agency: Ministry of Environment and Forests) [2006-2009]

Status: Different Western Ghat forest areas in Karnataka and Kerala were visited several times to collect fruits and seeds of selected endemic species. Infested and uninfested fruits and seeds were classified, percentage of infection was calculated and causal organisms were isolated and are being identified.

Project 5: Monitoring of biofouling at Visakhapatnam Port. (Funding Agency: Ministry of Shipping, Road Transport and Highways, Government of India through the National Institute of Oceanography, Goa) [2006-2009]

Status: Biofouling material collected through active sampling during Port Biological Baseline Survey carried out along with Scientists of National Institute of Oceanography, Goa was sorted out. Wooden test panels were prepared and immersed at three test stations, viz., Slipway Complex, Ore Berth and Marine Foreman Jetty in Visakhapatnam Port for trapping biofouling and wood boring organisms. The panels were retrieved at monthly intervals and observations made on different aspects of fouling and wood boring.

Project 6: Need for conserving forest canopies: assessing the diversity of canopy insects in the Western Ghats. (Funding Agency: Ministry of Environment and Forests (MoEF) [October 2006 to September 2009]

Status: The project aims at developing methodologies for regular sampling of insects from the emergent rainforest canopies and evaluating them, and to develop a baseline data on seasonal variation in the diversity of canopy insects. Four traps were fabricated canopy pitfall trap, yellow pan trap, light trap and butterfly trap, which have been established in the canopies.

Project 7: Development, Augmentation of efficacy and improvement of dissemination systems of *Metarhizium* based mycoinsecticide for the management of major pests in forest plantations and nurseries (Funding Agency: Department of Biotechnology) [2007 2010]

Status: Survey of nurseries in South Canara, Mangalore (Karnataka), Tirupathi (Andhra Pradesh) was conducted and collection of insects and pathogens was made. Culture of fungal strains has been established in the laboratory.

Project 8: Bioecology, damage potential and management of Gall formers of *Pongamia pinnata* (L.) Pierre (Funding Agency: Department of Science and Technology) [2006-2009]

Status: Sanctioned equipments were procured and recruitment of JRF completed. Study sites were identified for the detailed studies.

Project 9: Multilocal introduction cum demonstration trials and field evaluation of six important bamboo species viz., *Bambusa balcooa*, *B. nutans*, *Dendrocalamus asper*, *D. hamiltonii*, *Guadua angustifolia* and *Pseudoxytenanthera stocksii* in Andhra Pradesh, Karnataka and Goa (Funding Agency: Department of Biotechnology) [2006-2009]

Status: Tissue culture plants of *Guadua angustifolia*, *Bambusa nutans*, *Dendrocalamus asper*, *Pseudoxytenanthera stocksii* have been produced at IWSST lab. while tissue culture plants of *D. hamiltonii* and *B. balcooa* were obtained from IHBT, Palampur and Grow More Biotech, Hosur. Vegetative propagation plants of the above species are being produced for laying out the field trial.

Project 10: Conservation of Sandal (*Santalum album* L.) germplasm, production of quality planting stock and promotion of sandal cultivational practices (Funding Agency: National Medicinal Plant Board) [2006-2009]



Status: Collected about 100 kg seeds of sandal from Yelwala (Mysore), Nallal and Salem (Tamil Nadu) and processed for storage and germination. About 40 kg of seeds were sown in germination beds and around 65,000 seedlings have been raised so far of which around 38,000 are in root trainers and 27,000 in polybags. A stake holders training programme was conducted in Mehsana, Gujarat on “Sandal nursery technology and cultivation” in March 2007.

Project 11: Cultivation of *Guadua angustifolia* Kunth. and *Dendrocalamus asper* in Kerala and Karnataka (Funding Agency: National Mission for Bamboo Application) [2006-2009]

Status: Established the demonstration plantations (0.5 ha each) of *Guadua angustifolia* Kunth. and *Dendrocalamus asper* Backer in Thithimathi, Coorg, Karnataka and in two sites in Alwaye and Palakkad, Kerala.

Project 12: Commercial cultivation of bamboo in Kodagu District: Raising of Quality Planting Material (QPM), Establishment of demonstration plots and bamboo based value addition facilities (Funding Agency: National Mission for Bamboo Application) [2006-2008]

Status: Conducted entrepreneurs meet in July 2006. Around 10,000 TC plants of *Dendrocalamus asper* procured from Grow More Biotech planting in farmers' fields and coffee estates. For establishing demonstration plantation of *D. asper* in 25 ha 77 beneficiaries were identified and plants were supplied to them.

Project 13: Vegetative Propagation Centre (VPC) for the production of quality plants of *P. stocksii*, *D. brandsii* and *Guadua angustifolia* (Funding Agency: National Mission for Bamboo Application) [2006-2009]

Status: Agrosched net house was established (area 17 m x 17m) and misting system was installed. Production of plants by rooting of culm and branch cuttings of *Guadua angustifolia* and *Dendrocalamus stocksii* has been initiated.

Abstract: No. of Projects

| | No. of projects completed in 2006-2007 | No. of ongoing projects in 2006-2007 | No. of projects initiated in 2006-2007 |
|-------------------|--|--------------------------------------|--|
| Plan Projects | 18 | 16 | 11 |
| External Projects | 3 | 11 | 13 |
| Total | 21 | 27 | 24 |

TECHNOLOGY ASSESSED AND TRANSFERRED

1. A Demonstration programme on 'Sap displacement, Boucherie, Seasoning and Ammonia fumigation techniques' was organized by the Andhra Pradesh Forest Department on 13th December 2006.

2. Demonstrated Sap displacement, Boucherie process, and delivered lecture on Wood Preservation to the participants of the training course on, "Training to Trainers and Master craft Persons" organized by the Govt of India, Ministry of Textiles, Bangalore on 23rd February 2007.
3. Demonstrations of the Institute activities were organized at Hyderabad, Tirupathi, Warangal and Rajamundry on 29th November 2006, 13th to 20th and 23rd December 2006, respectively.

EDUCATION AND TRAINING

Education

1. 332 students from different Universities visited the Institute from April 2005 to March 2006.
2. Students of Wood Science and Technology, FRI University were given lectures on wood quality.
3. Students of B.Sc. Forestry of Allahabad Agricultural Institute (Deemed University) did their project on documentation of standard wood testing methods under supervision of the Institute.

Trainings

Organized

1. Short term training course on "Wood biodegradation and preservation" was conducted. A total of 16 participants participated in the training programme representing different organizations like Asian Paints, Johnson fumigation, Rubber board, individual etc. from 17th to 21st July 2006.
2. Training programme was organized by IT cell of the Institute for the PhD students of FRI Deemed University on Computer Applications in July 2006.
3. Short term training on "Modern nursery practices of Sandalwood" was conducted from 21st to 25th August 2006.
4. Short term training course on Wood Bio-degradation and Preservation" was conducted from 16th to 20th October 2006. A total of 20 participants from different organizations participated.
5. Training course on "Field identification of important timbers" to the in-service officials of Tamil Nadu Forest Department from 30th October to 3rd November 2006.
6. Training course on "Timber Joinery" to the in-service officials of Andaman and Nicobar Forest Department, Port Blair from 27th November to 1st December 2006.
7. Three days training programme on "Classification of grading of timbers" from 4th to 6th December 2006, was organized. A total of 6 participants participated.
8. Training course on "Classification and grading of timbers" for the in-service officials of Ordinance Factory, Tiruchirapalli and M/s Moser Baer India Pvt. Ltd., Greater Noida, from 4th to 6th December 2006 was organized.
9. Compulsory Training Course for IFS officers on "Biotechnology for Forest Conservation" was organized from 15th to 19th January 2007. A total of 29 officers participated.
10. Specialized training to in-service official of CCRI in wood anatomy.



11. Two training programmes in modern seed and nursery practices for the farmers of Gujarat during 21st to 25th August 2006 and farmers of Maharashtra during 20th to 24th February 2007.
12. Training Course on “Extraction/purification techniques and instrumentation analysis” conducted by the Chemistry of Forest Products Division from 14th to 16th March 2007.

Attended

1. Dr. R.V. Rao, Scientist F attended 2 weeks training programme on “General Management for Senior Scientists” at ASCI, Hyderabad from 5th to 16th February 2007 conducted by Administrative Staff college of India, Hyderabad.
2. Dr. S.S. Chauhan participated as faculty in a 3 day training-cum-workshop on forest based crafts development organized by A.P. Forest Academy, Dulapally, Hyderabad from 29th to 31st May 2006.
3. Mr. Anil K. Sethy, Scientist B underwent a training on preparation and handling of increment core samples and tree ring analysis at Indian Institute of Tropical Metrology, Pune from 5th to 9th February 2007.
4. Dr. N. Rama Rao, Scientist E attended training on *General Management for Senior Scientists*, at Administrative Staff College of India (ASCI), Hyderabad from 4th to 15th September 2006.
5. Shri V. Soundararajan, Scientist B attended one week training programme on “Data Warehousing and Data Mining” at ASCI, Hyderabad from 19th to 23rd February 2007.
6. Dr. S. Viswanath, Scientist E attended National Workshop cum training on Bamboo Locational trial, Bambusetum and propagation from 14th to 16th February 2006, conducted by NMBA at Bamboo co-ordinating center, GB Pant University of Agriculture and Tech, Pantnagar, Uttaranchal.
7. Dr. S. Viswanath, Scientist E attended training programme on “Intellectual Property Rights and WTO related issues” sponsored by Govt. of India at ASCI, Hyderabad from 31st July to 4th August 2006.
8. Dr. Geeta, Scientist D attended training programme on “Intellectual property rights and world trade organization related issues” from 30th October to 3rd November 2006 at Administrative Staff College of India, Hyderabad.
9. Dr. Geeta, Scientist D attended Third country training program, on “Improvement of tropical tree species”, at Yogyakarta, Indonesia from 4th to 17th March 2007.
10. Dr. M. Balaji and M. V. Rao, Scientists C attended the Training programme on disease free shrimp seed production, organized by the Ocean Atmospheric Science and Technology Cell, Ministry of Earth Sciences, Andhra University, Visakhapatnam on 11th March 2007.

Exhibition

1. Participated in Krishi Mela 2006 organised by University of Agricultural Sciences, Bangalore and exhibited Institute's technologies from 17th to 20th November 2006. Institute got best stall prize.

2. Participated in Krishimela at Suttur, Mysore organized by Jathra Mahotsava Committee, JSS Mahavidhyapeeta, Mysore from 16th to 20th January 2007.

Meeting

1. The scientists of the institute participated in the one day international seminar on “Diagnostic wood heritage: Fundamental tools for knowledge, restoration and conservation” (Indo-Italian seminar) at IWST, Bangalore on 1st December 2006.



Dr. K.S. Shashidhar, Director, IWST addressing the participants during the Joint Interactive Meeting of IWST and IPIRTI with stake holders on 28th March 2007



Joint Interactive Meeting of IWST and IPIRTI participants being explained about the tissue culture practices

2. The scientists of the institute participated in “Discussion meeting on Biotechnological interventions for the conservation and utilization of forestry resources organized and sponsored by DBT at IWST, Bangalore from 22nd to 23rd March 2007.
3. The scientists participated in the Joint interactive meeting of IWST-IPIRTI with stakeholders at IWST on 28th March 2007.
4. The scientists of the institute participated in the RAG meeting of the institute on 26th September 2006.
5. Dr. O.K. Remadevi attended the executive meeting of Indian Academy of Wood Science held at IPIRTI on 12th May 2006.
6. Dr. O.K. Remadevi participated in the interactive meeting on Improved forest technologies organized by APFD at Forest Academy, Tirupati on 29th November 2006.
7. Dr. R. Sundararaj participated in the interactive meeting on Tree forming for sustainable development organized by APFD at Warrangal on 20th December 2006.
8. Mrs. D. Venmalar, Scientist-B attended the Bureau of Indian standard meeting for Wood preservation on 27th September 2006 at BIS, Bangalore.
9. Dr. K.S. Shashidhar, Director; Shri Suresh Gairola, Group Co-ordinator (R); Dr. T.S. Rathore, Scientist-E; Dr. Shyam Vishwanath, Scientist-E and Shri Pankaj K. Aggarwal, Scientist-in-charge (Extension) participated in Entrepreneurs Meet on Bamboo on 24th July 2006 at



Ponnampet. Meeting was organized by Kodagu Model Forest Trust, College of Forestry, Ponnampet under NMBA Sponsored project. Technical support is being provided by IWST.

LINKAGES AND COLLABORATIONS

1. MoU signed between Central Coffee Research Institute (CCRI), Coffee Research Station, Chikkamagalur district and IWST, Bangalore. Wood Properties and Uses Division of IWST will collaborate with scientists of CCRI in carrying out Research studies on the properties of coffee wood as indicators of white borer for resistance.
2. Officials from Coconut Development Board visited the Institute, appreciated the work carried out on ammonia plasticization of coconut wood and reproduced published paper in their Journal Indian Coconut Journal for wider publicity.
3. Linkages were developed with State Forest Department, Karnataka, Andhra Pradesh Forest Department, Goa Forest Department, Bangalore University, Bangalore, University of Agricultural Sciences, Bangalore, University of Agricultural Sciences, Dharwad, Andhra Pradesh Fisheries Department; Andhra University, Visakhapatnam; Sri Venkateswara University, Tirupati; Central Institute of Fisheries Technology, Visakhapatnam; Central Marine Fisheries Research Institute, Visakhapatnam; National Institute of Oceanography, Goa and Visakhapatnam; Naval Materials Research Laboratory, Ambernath; State Institute of Fisheries Technology, Kakinada; Visakhapatnam Port Trust and Toy making industries and Indian Institute of Science, Bangalore.
4. One operational DBT project in collaboration with KFRI, Peechi and IFGTB, Coimbatore on "Field performance of micro and macro propagated planting stock of selected five commercially important bamboo species"

PUBLICATIONS

Project Completion Reports

1. Evaluation of wood quality parameters of plantation grown *Eucalyptus citriodora* for different end uses.
2. Assessment of wood quality of *Simarouba glauca* for its timber value.
3. Use of sonic and ultrasonic testing techniques to evaluate wood strength of plantation species - A non-destructive test method.
4. Evaluation of treatability of selected refractory species.
5. Analytic studies on visco-elastic behaviour of wood and tree biomechanics.
6. Studies on fiber formation in wood.
7. Performance and evaluation of selected bamboo species treated by modified Boucherie process.
8. Chemical induction of heartwood in Sandal.
9. Gender identification of *Garcinia indica* and *Simarouba glauca* using isoenzyme studies and assessment of fruit characters, yield and market potential of *Garcinia indica* in Karnataka state.

10. Studies on teak heartwood borer *Alceterogystia (cossus) cadambae* moore and its management.
11. Standardization of protocol for viability testing and prolonging the viability and vigour of *Santalum album* seeds in storage.
12. Genetic screening of *Jatropha curcas* an important biofuel species of dry areas.
13. Evaluation of genetic variability and mating system analysis of *Aegle marmelos* Corr. and *Feronia elephantum* Corr. using isoenzyme markers.

Books

1. III Consolidated Report on Marine Work was published in March 2007.
2. Publication of Institute's profile of IWST Marine Centre, Vishakapatnam in December 2006.
3. Publication of "A guide to some important timbers in South Indian markets" in January 2007.

CONSULTANCIES

1. Analytical service was rendered to Police Department, Forest Department and public in analysis of essential oils from sandalwood samples. A number of technical inquiries on utilization of various non-wood forest products from Government Departments and public were attended to and advice given.
2. Attended several enquiries from Forest department officials and NGOs with respect to entomological and pathological problems in nursery, plantations and timber-in-service and suitable remedial measures were suggested.
3. Testing services were rendered to different users from Industry, Government departments, Police, Vigilance, CBI, Defence, Railways, Construction industry, NGOs and Private sectors on timber identification, moisture content, strength property determination and bulk density and specific gravity.
4. The peeling off paint of french knitters made from *Wrightia tinctoria* wood was investigated for an export-oriented company from Nilgiris as they were getting rejected by importing country. Laboratory conditions were simulated with high humidity and saline conditions. It was found out that physical damage during processing and handling were possible causes but not due to high saline conditions. An amount of Rs. 10,000 was charged for this.
5. Twenty seven wood samples received from end users were analyzed for their preservative content. Problems related to wood preservation were discussed and suitable advices were given based on their enquiries.
6. A one-day consultancy was provided to Karnataka State Handicraft Development Corporation on drying of wood in a desiccant based dehumidification wood drying system on 21st September 2006.
7. The wood preservative which was supplied by Moldrup System is being tested for the efficacy of their product against decay fungi.
8. Dr. O.K. Remadevi and Shri Raja Muthukrishnan visited the Bamboo Stocks of Ranga Rao and Sons, Mysore on 4th August 2006 to investigate the pest problems on stored bamboos.
9. Dr. O.K. Remadevi visited ITC, Bhadrachalam to study pest problems on the test yard from 11th to 13th November 2006.



10. Dr. R. Sundararaj and Smt. H.C. Nagaveni visited the plantation area at Chelur beat in Bagepalli range of Kolar district on 12th November 2006 to inspect the Eucalyptus plants for finding out the problems and suggesting remedies.
11. Enquiry regarding pathogen problems from cooling towers attended.
12. Requisition for carrying out the efficacy of treated samples against wood decay fungi has been received.
13. Test report on laboratory evaluation of wood preservative for its efficacy against borers was sent to by FMC India Private Limited, Bangalore.
14. Dr. O.K. Remadevi and Raja Muthukrishnan visited Channapatna and Mysore in connection with studies on timber pests in depots and wood handicrafts units on 13th March 2007.
15. Efficacies of commercial preservatives against wood rotters and termites are being tested for various agencies. The test report on the bioefficacy of terminator 'A' and 'E' against termite and borer was prepared and submitted to M/s Pidilite Industries, Mumbai.
16. Study of existing flora and fauna and assessment of impact of flora and fauna due to diversion of forestland, Singareni Collieries Company Limited, Kothagudem, Andhra Pradesh.
17. Study on Catchment Area Treatment Plan for Diversion of Forest land for bauxite mining in Visakhapatnam, Andhra Pradesh. Andhra Pradesh Mineral Development Corporation Limited, Hyderabad was the user agency.
18. EIA studies and ecological studies for exploitation of bauxite deposits in Visakhapatnam District, Andhra Pradesh Mineral Development Corporation Limited, Hyderabad.
19. Three bamboo species, *Bambusa bamboos* (80 Nos.) and *Dendrocalamus strictus* and *O. stocksii*, culms each 2 metre length (total 330 Nos.) were treated by Sap-Displacement method with CCB (Copper Chrome Boric) wood preservative, to protect against insects and fungi and to increase the durability to Treelands Development Services (P) Ltd. on 26th March 2007.

CONFERENCE/MEETINGS/WORKSHOPS/SEMINARS/SYMPOSIA/EXHIBITIONS

Organized

1. National Workshop on “Lesser Known Non-Timber Forest Products: Status, Conservation, Management and Sustainable Utilization” was conducted on 28th and 29th March 2006. Workshop was sponsored by CSIR. A total of 63 delegates participated in the workshop. A total of 18 papers were presented in addition to 3 poster presentations. A session on experience sharing was also organized. Three technical sessions were organized. It was inaugurated by Dr. P.J. Dilip Kumar, IFS, PCCF (EWPR), KFD. Shri G.K. Prasad, DG, ICFRE participated in the Workshop on 29th March 2006 and gave special address.
2. Supported a one day workshop on water restoration conducted by National Water Development Academy on 23rd June 2006.
3. Two days training workshop for IFS officers on “Field applicability of forests and wildlife research outputs: Issues and strategies” was conducted on 10th and 11th October 2006. A total of 12 officers participated.



Participants in the two days training workshop for IFS officers on "Field applicability of forests and wildlife research outputs: Issues and strategies" at IWST, Bangalore

4. One-day Indo-Italian seminar on "Diagnostic on wood heritage: Fundamental tools for knowledge, restoration and conservation" organized on 1st December 2006. The seminar was sponsored by ICE, Mumbai and Italian Embassy, New Delhi. The seminar was inaugurated by Dr. Sivaramakrishna, Prof. (Retd.), University of Agricultural Sciences. A total of 7 presentations were made (3 from Italian side and 4 from Indian side) in the seminar.

Attended

1. All the Scientists of the institute attended the one day Joint Interactive Meeting of IWST-IPIRTI with Stakeholders at IWST Bangalore on 28th March 2007.
2. All the scientists of the institute participated in the Orientation program on Hindi at IWST, Bangalore on 14th March 2007.
3. Mr. P. Kumar participated in the exhibition of the Institute organised by Jata Mahotsava Committee, JSS Mahavidhya Peeta, Mysore between 15th to 16th January 2007.
4. Dr. R.V. Rao, Scientist-F, participated in the seminar organized by Research Wing of Andhra Pradesh Forest Department at Rajahmundry to demonstrate the Institute's technologies on 22nd and 23rd December 2006.
5. Dr. R.V. Rao, Dr. S.K. Sharma and Mr. A.K. Sethy attended Interactive Seminar for Forest Officers - Tree Farming for Sustainable Development, organised by Andhra Pradesh Forest Department at Tirupathi, Hyderabad, Warangal and Rajamundry in December 2006.
6. All the scientists of the institute attended one day Seminar on "Diagnostic on wood heritage: Fundamental tools for knowledge, restoration and conservation" (Indo-Italian seminar) at IWST, Bangalore on 1st December 2006.
7. Dr. R.V. Rao, Scientist F and Mr. P. Kumar, Scientist-B participated in the State Level Marketing Workshop on "Handicrafts of Karnataka" held on 29th November 2006 organized by the O/o the Development Commissioner (Handicrafts), Bangalore and gave lecture on "Alternative wood species for wood based handicrafts such as Lacquerware, Wood carving".
8. Dr. R.V. Rao, Scientist F attended Academic Council Meeting of FRI Deemed University on 14th September 2006 in the capacity of Member at Dehradun.



9. Dr. O.K. Remadevi and Dr. R. Sundararaj attended the National Symposium on “Biological Control of sucking pests in India” conducted by Society for Biocontrol Advancement, Project Directorate of Biological Control, Bangalore from 26th and 27th May 2006.
10. Raja Muthukrishnan, Sarasija, P., Deepa, B, Latheef and Debajyoti, C. attended the “International Conference on Zoology INCOZ 2006 Central College Campus, Bangalore University, Bangalore from 19th to 22nd November 2006.
11. Dr. O.K. Remadevi attended the 8th Pacific Rim Bio-based Composites Symposium from 20th to 23rd November 2006 at Kuala Lumpur, Malaysia.
12. Raja Muthukrishnan participated in the Interactive seminar on Technology Improvement from 12th and 13th December 2006 for forest officials, carpenters etc. held at Biotechnology Research Centre, Tirupathi.
13. Smt. H.C. Nagaveni attended meeting and presented programmed work of MoEF project in Research seminar in B.R. Hills conducted by DCF, Wild Life, Chamarajanagar.
14. Dr. R. Sundararaj attended a seminar on “Medicinal Plants” at Chennai on 24th and 25th January 2007.
15. Dr. O.K. Remadevi and B. Deepa participated in the III National Symposium on “Plant Protection in Horticulture: Emerging trends and challenges at Indian Institute of Horticulture Research, Bangalore from 7th to 9th March 2007 and presented a paper and got 1st prize for poster presentation.
16. Dr. R. Sundararaj and B. Deepa attended the National Conference on Organic Waste Utilization and Eco-friendly Technologies for Crop Protection held at Plant Protection Association of India at Hyderabad from 15th to 17th March 2007.
17. Dr. N. Rama Rao, Scientist E attended the Meeting of the Expert Committee on Plants for revision of species of the Wildlife (Protection) Act 1972, Ministry of Environment and Forests, New Delhi on 26th April 2006 and ICFRE, Dehradun on 16th October 2006 as an expert member.
18. Dr. N. Rama Rao, Scientist E attended the brain storming session on the Indian coasts: Planning and management, Centre for Studies of Bay of Bengal, Andhra University, Visakhapatnam on 22nd and 23rd May 2006.
19. Dr. M. Balaji and M. V. Rao, Scientists-C attended the Investing in fisheries for food security, Forum of Fisheries Professionals, India and Central Institute of Fisheries Technology, Visakhapatnam on 16th October 2006.
20. Dr. M. Balaji, Scientist C attended the Interactive Seminar on Tree Farming for Sustainable Development organized by Regional Forest Research Centre, Andhra Pradesh Forest Department, Rajahmundry on 23rd December 2006.
21. Dr. N. Rama Rao, Scientist-E, Dr. M. Balaji and M. V. Rao, Scientists C attended the *Energy Conservation in Fisheries*, Central Institute of Fisheries Technology, Visakhapatnam on 14th February 2007.
22. Dr. M. Balaji and M. V. Rao, Scientists C attended the Training programme on disease free shrimp seed production, Ocean Atmospheric Science and Technology Cell, Ministry of Earth Sciences, Andhra University, Visakhapatnam on 11th March 2007.

23. Dr. T.S. Rathore, Scientist E attended and participated in National conference on emerging trends and future challenges in Biotechnology at Bangalore on 22nd and 23rd September 2006, organized by the PES Institute of Technology, Bangalore.
24. Dr. T.S. Rathore, Scientist E attended and participated in National symposium on Plant Biotechnology *In vitro* regeneration and cloning techniques at Dehradun from 12th to 14th October 2006, organized by the FRI, Dehradun.
25. Dr. S. Viswanath, Scientist E attended and participated in the National Symposium on “Tree Improvement for Sustainable Forestry” held at JNKVV, Jabalpur, Madhya Pradesh from 4th to 6th November 2006.
26. Dr. S. Viswanath, Scientist E attended and participated in the National Symposium on Agroforestry for livelihood Security, Environment Protection and Biofuel Production at National Research Centre for Agroforestry (NRCA), Jhansi from 23rd to 25th December 2006.
27. Dr. S. Viswanath, Scientist E attended the workshop on Bamboo organized by Bamboo Co-ordinating Centre (BCC), GB Pant University of Agriculture and Tech., Pantnagar, Uttarakhand under the aegis of NMBA held at KFRI, Peechi from 22nd to 24th December 2006.
28. Dr. S. Viswanath, Scientist E attended National Workshop cum training on Bamboo Locational trial, Bambusetum and propagation from 14th to 16th February 2006, conducted by NMBA at Bamboo Co-ordinating Centre, GB Pant University of Agriculture and Tech., Pantnagar, Uttarakhand.
29. Dr. Arun Kumar, Scientist C participated in Regional Conference on “Scope of Production Forestry for Enhancing Carbon Mitigation in India” at National Institute of Advanced Studies, Bangalore on 14th and 15th December 2006.
30. Dr. Arun Kumar, Scientist C Participated in National Conference on “Increasing Forest Productivity: Genetic and Breeding Options” held at Jabalpur from 21st to 23rd February 2007.
31. Dr. Arun Kumar, Scientist C and Mr. Ashutosh Srivastava, Scientist C participated in National Conference on “Increasing Forest Productivity: Genetic and Breeding Options” held at Jabalpur from 21st to 23rd February 2007.

AWARDS

1. IWST got best stall prize in Krishi Mela 2006 organised by University of Agricultural Sciences, Bangalore which was held from 17th to 20th November 2006.
2. Dr. K.S. Shashidhar, IFS, Director, IWST was conferred “The Great Son of Karnataka” award on 28th May 2006. The award was given by All India Conference of Intellectuals during their Silver Jubilee Celebration.
3. Dr. R.V. Rao was conferred ICFRE Excellency Award in Forest Utilization.

DISTINGUISHED VISITORS

1. Shri B.S. Parsheera, IAS, Additional Secretary, MoEF visited the Institute on 6th May 2006.
2. His Holiness Sri Sri Sri Viswaprasanna Thirtha Swamiji of Pejaware Mutt, Udupi visited the institute on 13th June 2006.
3. Mr. Krishnamurthy, MD, Huber Chemical (India) visited the institute on 12th July 2006 to explore the possibilities of sponsored or collaborative project in the field of wood science.



4. Mr. Steen Moldrup, MD, Moldrup system, Singapore visited the institute to seek consultancy on testing wood preservative and collaboration work on 13th July 2006.
5. Mr. J.C. Kala, DG (Forests) and Special Secretary, MoEF, Government of India visited the Institute and addressed the scientists on 4th September 2006.
6. Ms. Minni Mathew, IAS, Chairman, Coconut Development Board visited the Institute regarding work on coconut wood and other related aspects on 5th September 2006.
7. Mr. R. Chandramohan, IAS, Joint Secretary, CC II, MoEF, Govt. of India visited the Institute on 19th September 2006.

MISCELLANEOUS

1. Environment day was celebrated on 5th June 2006. Dr. Syam Vishwanath, Scientist-D delivered a talk on "Poverty, Environment and Desertification".
2. World Forestry Day was celebrated on 20th March 2007.