

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 onestep 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/WBDMarine/ 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.

Project 17: Seed studies of some of the economically important species of Western Ghats [IWST/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* [IWST/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.