

INSTITUTE OF FOREST GENETICS AND TREE BREEDING, COIMBATORE

The Institute of Forest Genetics and Tree Breeding (IFGTB) is a national Institute formed in April 1988 under the Indian Council of Forestry Research and Education (ICFRE), an autonomous Council under the Ministry of Environment and Forest, Government of India. It was formed by upgradation of the Forest Research Centre (FRC), Coimbatore under the Forest Research Institute and College, existing since 15.12.1959. Certain other organizations and schemes viz., Forest Soil-cum-Vegetation Survey (FSVS), Coimbatore, Disease and Insect Survey (DIS), Coimbatore, Indo-Danish Project on Seed Procurement and Tree Improvement (IDPSPTI), Tropical Pines Research Centre (TPRC), Kodaikanal, Eucalyptus Research Centre (ERC), Ooty and Environmental Research Station (ERS), Ooty and merged with the FRC.

An abstract of projects run by the Institute is as follows:

	No. of projects completed in 2008-09	No. of ongoing projects in 2008-09	No. of new projects initiated in 2008-09
Plan Projects	7	16	14
Externally Aided Projects	8	6	3
Total	15	22	17

PROJECTS COMPLETED DURING THE YEAR 2008-2009

PLAN PROJECTS

Project 1: Genetic Improvement of *Eucalyptus tereticornis* through controlled pollination and molecular characterization [IFGTB/RP-3/2002-08]

Findings: Twenty clonal selections were made in *E. tereticornis* × *E. grandis* and *E. tereticornis* × *E. alba* from a 60 months inter-specific full sib family trial developed in Panampally. Both selections could be clonally multiplied. A trial was established using twenty clones (3 tree plots in five replications) at Panampally field station, Kerala.

Project 2: Genetic transformation of *Eucalyptus* and *Casuarina* to enhance salinity tolerance [IFGTB/RP-6/2000-05; 08]

Findings: Protocol for regenerating seedling explants and clonal genotypes was standardised. Sporadic shoot morphogenesis and rhizogenesis were obtained from *Casuarina equisetifolia*. Hairy root cultures were established in *Eucalyptus tereticornis*. *Agrobacterium tumefaciens* strains GV2260, EHA105, LBA4404 and pCAMBIA series of plasmid vectors, and gene constructs *Osmotin* and *AtNHX* were obtained and used for transformation studies in *Eucalyptus tereticornis*. Critical parameters for transformation like media supplements (Acetosyringone, Buffers and Sugars), strains and their concentrations, co-cultivation durations, sonication



duration and antibiotic concentrations were evaluated using the gene constructs/ vectors. Optimum distances for bombardment were found. Transient GUS expression was obtained in *Eucalyptus tereticornis* using Agrobacterium and particle bombardment methods.

Project 3: Identification of conserved motifs in genes conferring salt tolerance to develop strategies for gene isolation from salt tolerant tree species [IFGTB/RP-38/2005-08]

Findings: Genes conferring salt tolerance were classified and tables in excel sheets were created for input of gene information. DNA and protein sequence information for Sodium antiporters, Calcium Transporters, High Affinity Potassium Transporters, Low Affinity Potassium Transporters, Proton Transporters, Water Transporters, Transcription Factors, Cellular Signaling Components, Transcription Factors and Protein and Membrane Protection were downloaded into excel sheets. A prototype database for sodium transporters was created using MySQL and PHP. The sequences were analyzed using Clustal W and PRIFI for identification of conserved regions and deducing PCR primers that could be tested for isolation of genes from salt tolerant tree species.

Project 4: Origin, distribution and genetic diversity of *Jatropha curcas* in India [IFGTB/RP-43/2006-08]

Findings: Fifteen enzyme systems provided a total of 18 loci for the 56 accessions of *Jatropha curcas*. Twenty eight percent of the resolved isozyme loci were polymorphic on an average, 26.67% were found to be polymorphic and mean observed number of alleles per locus was 1.533. Average observed heterozygosity was 0.15 and expected value was 0.14 with a gene flow value of 0.24. DNA extraction procedures were standardized to avoid latex contamination. PCR protocols were optimized by carrying out variations in $MgCl_2$ concentration, primer concentration, DNA and buffer volume. A total of 120 bands whose size ranged between 300 and 2000 bp were produced using 25 primers. Genetic identities at the RAPD level varied from 0.951 to 0.998, not significantly different from the values obtained at the isozyme level. Comparison of genetic variation showed that RAPDs consistently revealed higher levels of variability than isozymes in terms of percentage of polymorphic loci, gene flow and gene diversity. Yet, the numerical congruence between the isozyme and RAPD data suggests an indication that in *J. curcas* the isozyme data provides a fairly good picture of the genetic structure.

Project 5: Evaluation of teak CSO at Walayar using DNA profiling [IFGTB/RP-54/2007-08]

Findings: Twenty teak clones from three different geographical locations namely Topslip, Tamil Nadu (TNT), Nilambur, Kerala (KLN and KLK), Sungam, Kerala (KLS) and South Bhadrachalam (SBL-1) of Andhra Pradesh were screened using seven RAPD primers. Of the 113 fragments, 36 were monomorphic (32%) and 77 were polymorphic (68.0%). Nei's genetic distance separated the 20 clones into 4 major clusters. DNA profiles of clone SBL 1 was unique from the rest. The clone KLN 2 was close to the TNT clones (genetic distance 0.1). TNT 1, TNT 3, TNT 4 and TNT 15 were identified as duplicates in the dendrogram corresponding to 100% similarity in RAPD bands shared between them.

Project 6: Studies on the diversity of bee fauna of the Nilgiris [IFGTB/RP-36/2005-08]

Findings: Survey was carried out in 32 sampling locations in the Nilgiris, covering 9 forest types and 4 plantations. Altogether 60 species of bees, coming under 14 genera were collected.

They include, *Apis* spp. (*Apis cerana*, *A. indica*, *A. florae* and *A. dorsata*), *Amegilla* spp., *Braunsapis* spp., *Ceratina* spp., *Chelostoma* spp., *Halictus* spp., *Heriades* spp., *Lasioglossum* spp., *Megachile* spp., *Nomia* spp., *Sphecodes* spp., *Thyreus* spp., *Trigona* spp. and *Xylcopa* spp.

Since the occurrence of bees is closely linked to the availability of flowering plants, data on the vegetation of all these locations was collected and phenological observations of the plants made. Among the natural forests, the Dry Deciduous Forests, Thorn Forests, Moist Deciduous Forests and the Semi-evergreen Forests were found to have the maximum diversity of bees, while the Montane Wet Temperate Forests, wherein cool conditions persist almost throughout the year, had the least diversity. The monoculture plantations of *Acacia mearnsii*, *Eucalyptus globulus*, Teak and Tea were also found to be poor in bee diversity, mainly due to lack of floristic diversity.

Data on the seasonality of various bee species, the frequency of occurrence and floral associations were also collected. The frequency of occurrence of bee species, in general, was high, during the months of March, April and May, when most of the plant species in the deciduous forests were in bloom. The occurrence was low during the winter and rainy seasons. About 100 species of plants were recorded as nectar/ pollen sources for the bee species in the study area. They include not only tree species, but also herbs and shrubs that flower in different seasons and this diversity enables the bees to sustain their populations throughout the year. The degradation of forests, due to fire and anthropogenic factors, resulting in habitat destruction and loss of floristic diversity were found to be the major threat factors on the bee fauna in this region. Although many species of exotic plants like *Ageratina adenophora*, *Cestrum* sp., *Cytisus scoparius*, *Lantana camara*, *Passiflora mollissima*, *Ulex europaeus* and *Wedelia trilobata* were also found to act as nectar/ pollen sources for some of the common bee species, the colonization of such exotic species in the forest areas is likely to adversely affect the floristic diversity and, in turn, the bee faunal diversity.

Project 7: Natural regeneration studies on important trees in Silent Valley National Park, Kerala [IFGTB/RP-32/2004-09]

Findings: Regeneration status of different trees in different ecosystems in Silent Valley National Park, Kerala has been studied. A total of about 150 tree species have been enumerated from the park and prepared their population structure. More than 100 species including herbs, shrubs and trees are recorded as addition to the flora of Silent Valley National Park, Kerala.

In forest areas, the regeneration of dominant species like *Palaquium ellipticum*, *Myristica dactyloides*, *Reinwardtiadendron anamallayanum*, *Syzygium laetum*, *Litsea oleoides*, *Dimocarpus longan*, *Mesua ferea*, *Aglaia lawii*, *Cullenia exarillata* and *Drypetes elata* etc. was found to be frequent, whereas, species like *Actinodaphne lawsonii*, *Aphanamixis polystachya*, *Appollonias arnottii*, *Diospyros nilagirica*, *Epiprinus mallotiformis*, *Holigarna nigra*, *Hydnocarpus alpina* and *Syzygium densiflorum* showed very poor regeneration.

Tree species recorded in the grasslands in their order of dominance are *Wendlandia thyrsoidea*, *Glochidion ellipticum*, *Elaeocarpus serratus* var. *serratus*, *Ligustrum perrottetii*, *Symplocos racemosa*, *Apodytes dimidiata*, *Phyllanthus emblica*, *Symplocos cochinchinensis*, *Syzygium cumini*, *Maesa indica*, *Ziziphus rugosa* and *Olea dioica*.

Species generally observed only in wet evergreen forests like *Palaquium ellipticum*, *Elaeocarpus tuberculatus*, *Litsea floribunda* and *Litsea oleoides* could also be recorded in various stages of growth viz. seedlings and saplings under the shade of above species.

EXTERNALLY AIDED PROJECTS

Project 1: Germplasm collection and production of improved planting stocks of *Terminalia chebula* Retz and *Terminalia bellirica* [IFGTB/EF-RP-25/2005-08]

Findings: Selection criteria for identifying superior trees in terms of fruit yield and quality have been standardized for *T. chebula* and *T. bellirica*. Superior trees of *T. chebula* (85) and *T. bellirica* (19) were selected based on fruit yield, fruit size and fruit color in various places viz., Talawadi, Kallar, Bargur, Kalrayan hills, Courtallum, Chitteri hills, Javadhu hills and Nagarcoil in Tamil Nadu. Nursery techniques including seed processing, seed treatment, biofertilizer dosage etc., have been standardized for both the species. Vegetative propagation in *T. chebula* and *T. bellirica* have been standardized. Among the rooting of branch cuttings, airlayering, budding and grafting the wedge grafting method found to be relatively successful. Grafting of selected trees was attempted and wide variation was observed for response to cleft grafting. A germplasm bank of 9 *T. chebula* and 3 *T. bellirica* clones has been established at Panampally. Methods for estimation of medicinally active major biochemical compounds have been standardized. Four distinct populations of *T. chebula* and five populations of *T. bellirica* were screened for medicinally important biochemical compounds like total phenols, tannins, gallotannin, free gallic acid and ellagitannins to investigate the relationship between geographic location and the biochemical content. Though different populations showed variation for all these compounds, the tree to tree variation was also high within a population. Significant levels of variation for various active compounds content in fruits of selected superior trees were also observed.

Project 2: Germplasm conservation and establishment of seed stands for production of quality seeds and seedlings [IFGTB/EF-RP-09/2003-06] (Extended up to 2008)

Findings: Tree selection strategies were developed for *Aegle marmelos*, *Saraca asoca*, *Asparagus racemosus*, *Gymnema sylvestre*, *Tinospora cordifolia*, *Embllica officinalis* and *Oroxylum indicum* based on their distribution patterns, medicinal importance and threatened status. Appropriate seed handlings methods were also worked out. Vegetation propagation techniques and seed germination methods were standardized. Population survey was conducted in the States of Tamil Nadu and Kerala to identify and select trees/plants used on the selection strategies. *Aegle marmelos* from 14 locations, *Asparagus racemosus* from 9 locations, *Gymnema sylvestre* from 9 locations and *Tinospora cordifolia* from 8 locations were collected, vegetatively propagated and assembled in the Medicinal Plants Seed Production System established in an area of about 1 ha at Anaikatti, Tamil Nadu. Accessions of the above medicinal species from different locations in the states of Tamil Nadu and Kerala were assembled in the Institute. These accessions have been utilized to establish a germplasm bank cum seed production system for medicinal plants at Anaikatti in Tamil Nadu. The system has been established in an area of 1 ha including wild accessions of *Tinospora cordifolia* (33), *Gymnema sylvestre* (15), *Saraca asoca* (6), *Asparagus racemosus* (20), *Aegle marmelos* (24), *Embllica officinalis* (6), *Strychnos potatorum* (1), *Oroxylum indicum* (2) and *Rauvolfia serpentina* (3).

Project 3: Field Performance of micro and macro-propagated planting stock of selected five commercially important Bamboo Species [IFGTB/EF-RP-17/April 2004-March 2009]

Findings: Twenty five hectares field plantations were established to study the performance of micropropagated plants of three species of bamboos, *B. bambos*, *D. strictus* and *P. stocksii* at four locations in Coimbatore and Salem districts. Among the three species tested, *B. bambos* showed better growth than *P. stocksii* and *D. strictus*, however the utility value of the culms



vary among the species. Micropropagated, seed raised and cuttings propagated plants show similar growth in the field conditions. Initially, cuttings raised plants showed lesser mean number of shoots, however, no significant variation was noticed after 3 years of planting. It may be due to the number of rhizomes developed during the initial phase of establishment. Bamboo propagules over 8 months old at the time of field planting were escaped from rabbit damage, hence to avoid the damage of the shoots by rabbits, it is essential to plant 8 to 12 months old plants. If the newly produced culm is thick, vulnerability to rabbit damage is less. Bamboos prefer well drained loamy soil and growth and production of new culms was highly affected in poor soils like gravel and rocky types. In irrigated conditions, the mean height of the tallest culm of micropropagated *B. bambos* at the age of 1.5 years was 4.2 m, whereas under unirrigated conditions, 4.5 years old plants showed 3.1m height. In unirrigated but good soil type micropropagated *D. strictus* was growing well than *B. bambos* and *P. stocksii*. Enough care need be taken for the plants during the initial years of establishment especially watering and weeding. Farmer's field is preferable for bamboo cultivation than unmanaged areas (Plate). Fire hazards are not uncommon in bamboo fields and to avoid the same regular weeding is essential during the establishment stages. Watering to the bamboo plants once in 15 days is essential in low rainfall areas atleast for initial three years. Number of shoots produced was similar among the propagule types and culm growth is determined by the water availability. Supply NPK along with farmyard manure promoted the growth of bamboo plants than providing farmyard manure alone. A bamboo germplasm garden with 37 genotypes belonging to 19 species was established under this project.

Project 4: Population Structure and Reproduction in *Bruguiera* and *Ceriops*: Implication on Conservation [IFGTB/EF-RP-26/2005-08]

Findings: Studies were concluded on the pollination, floral biology and reproductive success in seven rare true mangrove species namely *Bruguiera cylindrica*, *B. gymnorrhiza*, *B. sexangula*, *B. parviflora*, *Ceriops tagal* and *Ceriops decandra*. Detailed studies were conducted in 6 locations across the East and West Coasts. In the West Coast, Kannur and Ernakulam districts in Kerala were surveyed. The *B. cylindrica* populations in Pitchavaram, East Coast flower during April – May, whereas, in West Coast, they flower during October – November. Both sunbirds and insects pollinate *B. gymnorrhiza*. *B. cylindrica* pollinated by thrips shows the highest reproductive success. *B. sexangula* is exclusively pollinated by sunbirds exhibited the lowest reproductive success. In all the three species, the flowers produce enormous amount of pollen and show very high pollen to ovule ratio. *B. gymnorrhiza* and *B. sexangula* exhibit very high pollen fertility. Regeneration and development of families beneath mother trees was common in all the three *Bruguiera* species.

Project 5: Development of post harvest techniques for seed production in *Jatropha curcas* [IFGTB/EF-RP-24/2005-08]

Findings: Phenology studies conducted in a plantation at Anaikatti, Tamil Nadu, over two peak flowering-fruiting seasons indicated that *Jatropha curcas* has high reproductive efficiency. The studies on maturity revealed attainment of physiological maturity when fruits turn yellow as shown by no significant variation in germination percentage among later stages of fruit ripening. With respect to harvesting maturity, though oil content among different maturity stages did not vary significantly, fruit maturity stage had considerable effect on oil physico-chemical characteristics like Acid value, Iodine No., Peroxide Value & Viscosity. The results indicate that fruits need to be harvested at late yellow stage or black pulpy stage and is safer to avoid collecting fruits at dry stage. Effect of drying method on *Jatropha* oil was studied in seeds extracted from fruits at black pulpy stage. Considering the oil yield, shade drying for

10 days and oven drying at 40°C for 1 day were found suitable methods. However, desirable values for most of the oil characteristics in the oven drying treatment at 40°C for 1 day renders it superior to 10 days of shade drying treatment. Comparing the two fruiting seasons, it is found that during the second season (October-December) the oil yield and quality was more than the first (July-September). Studies on seed processing showed that it is essential to separate the shell or seed coat from seed in order to maximize oil recovery. Hence developed a prototype, "Seed Decoater" for processing *Jatropha* seeds which separates kernel from seed coat. The seed is broken by milling technique while the separation of seed coat from kernel is through air suction. The prototype is driven by a 1hp motor and a minimum of 10 kg seed per hour can be processed by this Seed Decoater. The separation (80% kernel and 20% seed coat) of kernel enables to check loss of oil through adsorption by seed coat and thereby maximize oil recovery. In addition, the oil from the processed seeds is found to have better physico-chemical characteristics compared to whole seed oil. Seed grading experiment revealed that soaking *Jatropha* seeds (insect attacked seedlot) for 24 hours in water followed by 2 hours drying helps recovery of good seeds as floaters while insect attacked seeds sink. The infection in the seeds was confirmed through the X-ray images. By this grading method the germination, percentage of a poor seedlot could be substantially improved. Effect of desiccation on *Jatropha* seeds showed that 6% moisture content is the Lowest Safe Moisture Content to which the seeds need to be dried both with regard to oil quantity and quality. Effect of storage container on seed oil parameters and viability was tested on seeds stored in different containers such as polybag, jute bag, cloth bag, paper bag and black polybag. The most apt material to store *Jatropha* seeds was found to be cotton cloth bag or jute bag. Effect of different temperatures on storability of *Jatropha* suggest that seeds need be stored at 10°C (normal refrigerated conditions) for a period of one year to obtain maximum oil content with desirable characteristics. From the midstorage correction trials, it was evident that both roll towel and wet sand treatments were good midstorage correction treatments for about 12 months storage.

Project 6: Evaluation of superior planting stock of *Acacia mangium* in agroforestry systems at different eco-climatic zones of Kerala and Tamil Nadu [IFGTB/EF-RP-11/2003-06]

Findings: Experimental plots were established with seedlings raised using the seeds collected from seed orchards of *Acacia mangium* (Mangium) in Panampally, Kerala along with ramets of superior trees of Mangium procured from Mysore Paper Mills both in Tamil Nadu and Kerala. Intercropping was done up to third year. Biological productivity was assessed at three years - half rotation age of tree component. Observation on growth parameters at the age of three years revealed that maximum growth was recorded in southern zone of Kerala by registering girth at breast height (gbh) of 36.0 cm and total height of 15 m. The mean commercial bole height recorded was 12.7m in this zone. Minimum growth recorded was in central zone of Kerala with gbh of 24.5 cm and total height of 6.6 m. The gbh and total height recorded in southern zone of Tamil Nadu was 30 cm and 6.1 m respectively. In turn, volume production was highest at southern region of Kerala registering 79.12 m³ ha⁻¹ compared to central zone of Kerala (13.56 m³ ha⁻¹) and southern zone (10.64 m³ ha⁻¹) of Tamil Nadu. Results on biomass studies revealed that estimated wood yield (on fresh weight basis) at 3 years was 54.0 MT ha⁻¹ in southern zone of Kerala which was 4-6 times greater than that registered in central zone of Kerala (12.0 MT ha⁻¹) and in southern zone of Tamil Nadu (9.0 MT ha⁻¹). While comparing the performance of seedlings of Mangium with that of hybrids of Mangium, more dry matter allocation in branch biomass was observed (17 to 28%) in hybrids of Mangium than in seedling raised plantations (5 to 16%). With heavy branching habit, the hybrids of Mangium are not suitable for agroforestry system.

Among different agricultural crops intercropped with *A. mangium*, blackgram, horsegram, fodder sorghum and beans were found to be compatible and onion was observed to be less compatible. The recommended agroforestry systems are (i) *Acacia mangium* + Green Beans based system for Tamil Nadu and (ii) *Acacia mangium* + Pepper based system for Kerala.

Project 7: Infrastructure development of the Botanical Garden of the Institute of Forest Genetics and Tree Breeding and *ex-situ* conservation of selected Rare and Threatened species (Funding Agency: MoEF) [IFGTB/EF-RP-27/2006-09]

Findings: Infrastructure development work like repair of green house, laying out path and irrigation pipeline and labelling of plants in the garden has been completed. 140 plant species have been introduced and maintained in the Botanical Garden.

Project 8: Establishment of seed production systems for NTFPs of Attapady Hills [IFGTB/EF-RP/2006-08]

Findings: Agriculture and sale of minor forest products are the two traditional income sources to the Attapady tribals. The species selected for the study are the major NTFPs yielding species for the tribal communities which face destruction due to their destructible harvest. Population status of the NTFPs was studied. Seed handling procedures were developed in *Acacia concina*, *Caesalpinia sappan* and *Terminalia chebula*. Different NTFP species harvested were collected from Attapady Reserve Forest; studies conducted and produced seedlings for the establishment of Seed Production System (SPS). A seed production system has been established in an area of 1.615 ha. The species *Aegle marmelos*, *Saraca asoca*, *Oroxylum indicum*, *Acacia concina*, *Terminalia chebula*, *Asparagus racemosus* and *Caesalpinia sappan* have been planted. The espacement followed is 5 x 5 m with pits of size 50 x 50 x 50 cm. The tribal farming society was involved in the establishment of the SPS right from the time of site preparation and has been giving protective watering and maintenance till date. The survival of the plants at the end of 3 months was 84 % on an average (ranging from 78-91 depending on the species) and at the end of 6 months it is 70 % on an average (ranging from 70-90 depending on the species). The Vattaluki Tribal Farming Society (VTFS) is the beneficiary of the project output.

PROJECTS ONGOING DURING THE YEAR 2008-2009

PLAN PROJECTS

Project 1: Genetic improvement of *Acacia auriculiformis* through half-sib progeny selection [IFGTB/RP-39/2005-10]

Status: Maintenance activities like weeding and fire tracing were undertaken in all the four progeny trials established at Pondicherry, Vadakkancherry, Panampally and Palode. The trials at Panampally and Pondicherry have been evaluated for growth parameters and stem form. Profound variations were observed for these characters among families and seed sources. Among the four seed sources (Panampally, Karunya, Behalli and Mumbaru) the families originating from Behalli and Panampally seed orchards were performing better than others.

Project 2: Phenotypic selection, reproduction and propagation in *Ailanthus excelsa*: Perspectives for safety matches industry and farmers in Tamil Nadu [IFGTB/RP-40/2005-09]

Status: Two germplasm banks have been established in BIOTRIM, Tirupati (Andhra Pradesh) and in Kuruvampatti (Tamil Nadu). The survival percentage is 83 and 90 % in Tirupati and



Kuruvampatti respectively. Periodical biometric data from both the germplasm banks have been collected. The analysis of growth of different seed lots collected from different agroclimatic zones in the States of Andhra Pradesh, Madhya Pradesh, Rajasthan, Tamil Nadu and Uttarakhand was undertaken. Results from the analysis showed that the growth performance of Cauvery delta zone (Tamil Nadu) was found to be performing better than other seed sources. Seed parameters also been studied for the seeds collected from different sources.

Project 3: Evaluation and characterization of clones of *Casuarina* with reference to yield, tree form, biomass, pulping characteristics and key nursery pests [IFGTB/RP-44/2007-12]

Status: Established two clonal trials of *Casuarina equisetifolia* (1) at Pugalur, Karur district (sodic site) and (2) at Sirugramam, Cuddalore district (Casuarina growing belt), Tamil Nadu (one hectare area each) in addition to the one at Mayiladumparai, Karur district (Farmer's land) established in the previous year. Eighty-seven clones have been planted in an Incomplete Randomized Block Design with 6 replications at a spacing of 3 x 1.5 m. Quantitative and qualitative data are being collected from these trials at six monthly intervals. The preliminary results from the one year old trial at Mayiladumparai revealed significant clonal variation with respect to the biometric and qualitative traits like stem straightness and branching habits.

A total of 220 clones are maintained in the nursery to study the key nursery pests. Observations (at 15 days interval) on incidence of the targeted insect pests viz., *Icerya purchasi* and *Eumeta cramerii* revealed that totally 131 clones have so far been infested by *I. purchasi* and 47 clones by *E. cramerii*. Intensity of attack of these pests was observed to range between low to severe. Severe infestation of *I. purchasi* has been observed on 35 clones while moderate to high infestation observed on 59 clones. Whereas, in the case of *E. cramerii*, high intensity of the attack has been observed on clones TNPP-3 and TNKP-1. Observations of feeding damage caused by the pest, population build up, abundance were also collected from individual clones. In addition to the targeted pest mentioned above information on incidence of the other pests like Myllocerus beetle, two species of Coccids sap suckers and a species of leaf hopper have also been recorded. Stock cultures of the targeted pests are maintained and their biology being studied.

Project 4: Improvement of teak through selection, quality seed production, hybridization and clonal evaluation [IFGTB/RP-45/2007-12]

Status: Selected around 400 outstanding teak trees from Parmbikulam, Topslip, Konni, Tholpatty and Nilambur in Kerala and Tamil Nadu States based on growth, stem form and branching characteristics. Seeds were collected from 230 trees and characterized for morphological characters using image analyzer. X-radiography of fruits was conducted to determine seed filling for 70 trees. Fruits of 82 trees were sown in nursery for raising seedlings. Flowering and fruiting (number of inflorescences per tree and number of flowers / fruits per inflorescence) was assessed in 475 trees in Walayar CSO and 170 trees in Panampally CSO. Pollinator visitation per unit time per tree was assessed in both the CSOs. Based on flowering behaviour, trees were selected at Walayar for carrying out the control crosses between clones. A partial diallele crossing design has been developed. The 40 selected clones in the VMG were coppiced and being multiplied and about 1100 clonal propagules were produced for establishing a clone trial. The rooting performance of the clones was studied. Thirteen new superior teak trees were selected in the plantations at Pattikadu and Machad Range in Thrissur Division (Kerala State). The teak clonal trial established at Tirunelvely has been evaluated for growth and form traits.

A Vegetative Multiplication Garden (VMG) of teak has been established with 56 clones. The clones were multiplied from VMG for establishing clonal trials. The rooting performance of different clones was studied. Twenty three superior teak trees were selected in the teak plantations in different parts of Kerala.

Project 5: Selection and conservation of red and sweet tamarind in southern India [IFGTB/RP-49/2007-10]

Status: Extensive surveys were made in different parts of Tamil Nadu, Karnataka and Andhra Pradesh States to identify and select the red and sweet tamarind trees. Fifty two individuals of red tamarind and 38 sweet tamarind trees were selected from different sites of the three States mentioned above. Biochemical characterization of red and sweet tamarind was done by quantifying anthocyanin, total sugars, titrable acidity, and ascorbic acid and anti oxidant properties. To test the compatibility levels between red and sweet tamarind trees, control pollination experiment was conducted in Chidambaram, Karaikal and Mayavaram and fruit set for seven full sib families were obtained. Vegetative multiplication of different red tamarind trees was carried out through cleft grafting method. The data were recorded on biometric characters, phenological and reproductive variation.

Project 6: Association analysis of adventitious rooting traits using STS markers in *Eucalyptus tereticornis* and DNA profiling of *Eucalyptus* clones [IFGTB/RP-53/2007-10]

Status: Phenotyping to identify individuals with contrasting rooting parameters for the generation of association population was conducted by rooting the cuttings collected from coppice shoots over different seasons. Identified association population was analyzed using ten polymorphic SSRs having genome wide distribution for population structure and the STRUCTURE software showed the unstructured nature of the population and its suitability for association analysis. Thirty three Sequence Tagged Site (STS) primers for vegetative propagation traits were PCR amplified with poor and best rooters. One hundred and ten *Eucalyptus* clones were profiled with 6 RAPD primers and ninety three clones were screened with 7 ISSR primers.

Project 7: Assessment of Population structure using SSR and molecular characterization using RAPD [IFGTB/RP-52/2007-10]

Status: 60 clones of *Casuarina equisetifolia* planted in IFGTB clone bank were screened with 15 ISSR primers. PCR reactions were set up in a 11 ul reaction volume containing 60 ng of template DNA, 1.0mM of ISSR primer, 100mM dNTPs, 2.5mM MgCl₂, 10mM Tris-HCl, pH 8.8 and 0.3 U of Taq DNA polymerase. PCR was performed on a JH bio thermal cycler with an initial denaturation at 94°C for 3 min, followed by 30 cycles at 94°C for 0.30 min, 58°C for 0.30 min, 72°C for 1 min, and the last step of final extension at 72°C for 10 min. 30 cloned samples of *Casuarina* possessing the inserts of SSR fragments were successfully sequenced. The sequence data were assessed using WEBTROLL software for the identification of SSR locii. Simple sequence repeats were identified as (C)₁₀, (CACCT)₂, (TGTGC)₂, (TG)₈, (AG)_n, (GA)_n, (CA)_n (GAT)_n and (AT)_n rich repeats. Among the assessed locii of SSR, the CA and GA repeats were found in most of the clones. The (CACCT)₂, (TGTGC)₂ and (TG)_n repeats are not common in all the clones. 10 SSR primer pairs were identified (PRIMER-3 database) and it is found to be the most suitable for assessing *Casuarina* clones.

Project 8: Assessment on carbon pool potential of important tree species at different ages, sites and management regimes [IFGTB/RP-41/2006-11]

Status: Two hundred trees were felled from 69 *Casuarina* plantations in Cuddalore, Nagapattinam Villupuram, Kanchipuram, Tiruvallur, Ramanathapuram, Pudukottai and Thanjavur districts of Tamil Nadu. Carbon pool of the standing crop under different soil types and under irrigated and rainfed conditions was estimated. Sixty *Eucalyptus* trees were sampled from 20 plantations in Pudukottai and Aranthangi in Tamil Nadu. Dry matter production of *Eucalyptus* on per tree basis in 20 plantations was estimated. Soil samples collected from these plantations were analyzed for organic carbon and various other properties.

Project 9: Demonstration of agroforestry technologies for enhancement of livelihood opportunities in different agroclimatic zones of Tamil Nadu [IFGTB/RP-46/2007-10]

Status: This project is being implemented in collaboration with the National Research Centre for Agroforestry, Jhansi and Forest College & Research Institute, Mettupalayam. The agroforestry systems being practised by the farming, communities in five agroclimatic zones were documented along with major tree species and annual crops. Agroforestry demonstration plots were established in 15 ha area in five agroclimatic zones (3 ha per zone) with tree components like *Casuarina equisetifolia*, *Casuarina junghuhniana*, *Melia dubia*, *Tectona grandis*, *Eucalyptus* spp. and *Ailanthus excelsa* and horticultural species like Mango, Guava, Sapota and lemon along with the annual crops. In the established agroforestry demonstration plots, intercropping activities have been carried out under above mentioned agroforestry systems and the yield assessed. *Casuarina* with cotton registered highest net income of Rs. 31, 250/ha in Cauvery delta zone followed by Lemon with sunflower (Rs. 18, 750/ha) in Southern zone, Teak with black gram and cowpea (Rs. 14, 650/ha and 12, 500/ha respectively) in western zone and *Ailanthus* with black gram and cowpea (Rs. 12, 840/ha and 10, 230/ha respectively) in North-eastern zone.

Project 10: Studies on the population structure and reproduction of *Pterocarpus marsupium* in Tamil Nadu and Kerala [IFGTB/RP-37/2005-08]

Status: Based on the Forest map of South India prepared by the French Institute of Pondicherry, *Anogeissus latifolia* – *Pterocarpus marsupium* - *Terminalia* spp. forest type (>600 msl) under the category of Dry Deciduous Forests in Tamil Nadu and under the category of Deciduous Climax Forests and degradation stages in Kerala was located. Based on physical barriers separating distribution of *Pterocarpus marsupium*, 17 distinct populations on the eastern aspect of Western Ghats in Tamil Nadu and 14 distinct populations on the Western aspect of Western Ghats in Kerala was short listed for field studies. All the 17 populations of Tamil Nadu and 6 populations of Kerala have been surveyed, tagging 579 trees in Tamil Nadu and 133 trees in Kerala for observation. Herbarium specimens have been made for 214 specimens. Morphometric readings of seeds from 72 trees using image analyser have been collected. Morphological parameters and phenological variations have been observed.

Project 11: Evolving silvicultural practices for *Casuarina junghuhniana* ssp. *timorensis* [IFGTB/RP-33/2005-09]

Status: A total of eight field trials have been established at Kattukuppam, Veeravanallur, Vedaranyam, Erakudy, Sriharikota, Tirupathi, Edapady and Uppar dam. Effect of spacing and irrigation is being studied in all the trials spread over five agroclimatic zones of Tamil Nadu. The nursery trials to study the effect of different concentrations and rooting media on root of *Casuarina junghuhniana* and the effect of biofertilizers on seedling growth has been initiated.



Project 12: Assessment of insect pest problems of selected fast growing indigenous tree species in Tamil Nadu and Kerala [IFGTB/RP-42/2005-08]

Status: Pest surveys at nurseries, plantations and in natural forest ecosystem of the selected tree species of *Ailanthus excelsa*, *Melia dubia*, *Gmelina arborea*, *Thespesia populnea*, *Morus alba*, *Bombax* sp. and *Dalbergia sissoo* were carried out at 12 selected locations in Tamil Nadu and 9 selected locations in Kerala. Totally 28 tours were undertaken. Out of 35 insect species recorded, 6 insect species on *A. excelsa*, 5 insects species on *M. alba*, 4 insect species on *B. ceiba*, 6 insect species on *D. sissoo*, 6 insect species on *G. arborea*, 4 insect species on *T. populnea* and 4 insect species on *M. dubia* were recorded.

The cercopid, *Clovina* sp. on *G. arborea*; the lepidopteran leaf roller, *Sylepta derogata* and the sap sucker *Paracoccus marginatus* on *T. populnea*; the mealy bug, *Rastrococcus iceryoides* on *B. ceiba*; the sap sucker, *P. marginatus* on *A. excelsa*; the defoliator, *Abirus* sp. on *D. sissoo* were recorded for the first time on these host plants. 3 different *Coccinellid* beetles on the mealy bug, *P. marginatus* of *A. excelsa* and *M. alba* and 2 different species of spiders on *Atteva fabricilla* were recorded as predators. A strain of entomopathogenic fungus was isolated from the naturally infected pupae of *Eligma*, the *Ailanthus* defoliator. Influence of biotic and abiotic factors such as temperature, humidity and soil factors on the pests incidences were also recorded.

Project 13: Performance of selected clones of *Casuarina equisetifolia* for insect pests and disease tolerance and their response to biofarming practices [IFGTB/RP-48/2007-10]

Host plant resistance for insect pest

Status: A clonal trial at Sirkali (Nagapattinam district, Tamil Nadu) was established to assess the incidence of bark feeder, *Inderbela quadrinotata* and, thereby, to select the resistant candidates. Field screening of trees in the clonal and provenance trials of *Casuarina* at Coimbatore and Punducherry for incidence of the bark feeder carried out. Feeding preference and growth of the bark feeder, *I. quadrinotata* on different *Casuarina* clones studied in the lab and field condition. Wood samples of selected provenances of *Casuarina* were analysed for phenols, lipids and tannin contents to correlate the feeding preference or deterrence of the bark feeder.

Pathogenicity test was carried out by inoculating *C. equisetifolia* seedlings with trichosporium spores under controlled condition and symptoms of infection identified and assessed. Analysis of physical properties of the soil samples showed that the alkaline pH and poor drained clay soil tends to enhance infection by *T. vesiculosum* at Panampally Field Research Station in Kerala. Blister bark disease symptoms was not observed in the trees grown in fertile sandy soil with low moisture holding capacity at Karunya Nagar, Coimbatore.

Chemical properties of macro, micro-nutrients and growth regulators of Panchagavya and Dasagavya were analysed. Seedlings of *Casuarina*, *Eucalyptus* and *Teak* in a nursery trial were sprayed with 12 concentrations of Panchagavya & Dasagavya. Spraying of 3-10% solution of Panchagavya and Dasagavya in nursery showed reduction of 25% gall infection in *Eucalyptus*, 15% reduction of scale insect in *Casuarina* and 15% reduction of Mealy bug in *Teak* as compared to control.

Project 14: Screening and identification of potential isolates of Ectomycorrhizal fungi for increased productivity of *Acacia*, *Casuarina* and *Eucalyptus* tree species in nursery [IFGTB/RP-51/2007-10]

Status: Pure cultures of different isolates of Ectomycorrhizal (ECM) fungi such as *Laccaria fraterna* and *Pisolithus albus* were made and maintained in the culture bank. Standardized



suitable culture medium for mass production of different isolates of selected ECM fungi under *in vitro* condition.

Data on growth parameters such as shoot & root lengths, leaf numbers, collar diameter, fresh and dry weights of shoot and roots of both ECM inoculated and uninoculated (control) seedlings of *Acacias* viz, *Acacia auriculiformis* and *A. mangium* were recorded at different intervals of time. The results revealed that the seedlings inoculated with basidiospore and vegetative mycelial inocula of ECM fungi showed better growth performance, followed by alginate bead and basidiospore inoculum of ECM fungi over uninoculated control.

Studies on morphological and anatomical features of roots of both ECM fungi inoculated and uninoculated (control) seedlings of *Acacia* species for assessing the persistence of the inoculant ECM fungi revealed that more mycorrhizal tips in the roots of *Acacia auriculiformis* and *A. mangium* grown in sterilized (autoclaved) potting medium as compared to unsterilized potting medium.

Project 15: Evaluation of improved germplasm of *Eucalyptus camaldulensis* and *E. tereticornis* for productivity, wood traits, tolerance to insect pests and diseases and management for higher seed production [IFGTB/RP-47/2007-10]

Status: Wood samples of 37 prioritized clones collected from Karunya and Sathyavedu were submitted to IWS, Bangalore, Kerala Agricultural University (KAU) and Tamil Nadu Paper Mills Ltd., for various wood traits (the fibre length, fibre width, lumen width, wall thickness, fibre length/fibre width ratio, and specific gravity) and pulping quality (Kappa number, Pulp yield, Strength properties such as Tear factor, Breaking length and Burst factor, soft wood, hard wood and bark ratio). Analysis of pulping characters for 37 clones and wood traits for 14 clones have been completed. Among 37 clones, 7 were found to be the best for pulp yield and pulp quality.

Continued Insect pests and diseases surveys carried out on 80 clones of *Eucalyptus* in 5 replications at Sathyavedu, 50 clones in 5 replications at Kulathupuzha, 100 clones in 5 replications at Karunya and 27 clones at Forest campus, Coimbatore at a regular intervals revealed the incidence of different species of insects (stem borer, termite, aphid, grass hopper) and diseases (leaf spot caused by *Cercospora eucalypti*, leaf blight caused by *Alternaria* and Pink disease caused by *Cylindrocladium*), including the major problem of gall insect during different seasons. The per cent incidence and intensity of attack and identity of these pests and diseases and influence of biotic and abiotic factors on occurrence and spread of the pest and diseases were assessed. Based on the field observations so far collected, the clones were categorized (less susceptible, Moderately susceptible and Highly Susceptible) for the key pests and diseases problems.

Pretreatment observations on seed yield viz., number of fruiting branches, number of bunches in each branch and number of fruitlets in each bunch at two SPAs of *Eucalyptus camaldulensis* and *E. tereticornis* completed and the trees were selected and marked for imposing treatments to increase seed yield. The data on height and gbh of selected *Eucalyptus* trees were recorded. Initiated action for imposing different treatments to increase seed yield in Karunya (Tamil Nadu) and Panampally (Kerala).

Project 16: Studies on efficacy of secondary plant derivatives of *Aegle marmelos* on important insect pests of teak [IFGTB/RP-50/2007-09]

Status: Variation of different groups of bioactive compounds of secondary plant metabolites were analysed from the extracts of three different tissues of *A. marmelos* and *A. sapota* (fruit,

unripen fruit and seeds). The identified elutants of phenols, phenolics and polyphenols were further fractionated and analysed through TLC-UV method of characterization, and about 11 fractions of each tissue (total 30 fractions) were purified by HPLC and GC-MS-MS methods in comparison with 11 standards (sigma standards). About 13 individual compounds (identified from 3 tissues of *A. marmelos* and *A. sapota* viz. fruit, unripen and seeds) were tested for their bioactivity on the target pest, *H. puera* larvae. Only three compounds were showing biopesticidal effect at the concentrations ranging from 250 to 1000 ppm. Project got extended for two years (2009-2011) for conducting further experiments in order to conclude the results for making preformulation.

EXTERNALLY AIDED PROJECTS

Project 1: Establishment of Bamboo model Plantations in different Agroclimatic Zones of Tamil Nadu using Quality planting Stock [IFGTB/EF-RP-21/2005-08]

Status: Bamboo model plantations were created in 20 ha area during 2006-07, 40 ha in 2007-08 and 30 ha in 2008-09 using quality planting stock raised through seedling, macro-propagation and tissue culture of *Bambusa bambos*, *Bambusa nutans*, *Bambusa tulda*, *Bambusa vulgaris*, *Bambusa balcooa*, *Dendrocalamus strictus* and *Dendrocalamus stocksii*. The plantations were raised in different locations covering six agroclimatic zones of Tamil Nadu namely North-Western zone, North-Eastern zone, Northern zone, Cauvery Delta zone, Western zone and high altitude zone. A total of 90 ha plantations have been created as against the target of 100 ha. Preparatory works are on in remaining 10 ha area and planting will be carried out during monsoon. Bamboo Planting stocks of various species (seedling, macropropagated and Tissue Culture) are maintained in the nursery for planting out in the field. The growth performance of bamboo species within a location and across locations have been assessed periodically. Data on rainfall, temperature, humidity have been collected and soil analysis both for macro and selected micro-nutrients were completed for all locations. *B. tulda*, *B. nutans* and *B. balcooa* grow well in all the zones. *B. vulgaris* produces more culms while *B. tulda* produces moderate number of culms in all the zones. *B. bambos* grows well in plains with moderate culm production. Further observations are required to arrive at definite conclusion. The project has been extended till 2010.

Project 2: Bamboo Location Trial (BLT) – Funded by NMBA, TIFAC, DST [IFGTB/EF-RP-23/2005-07]

Status: This is a coordinated project carried out throughout the country, funded by the National Mission on Bamboo Applications, through the Bamboo Coordinating Centre, GB Pant University of Agriculture and Technology, Pantnagar. In Tamil Nadu, the trials were laid out at IFGTB Field Station, Bharathiyar University Campus, Coimbatore during September–October 2007. The trials include species trial and Irrigation trial, Fertilization trial and Spacing trial with one species. The trials are not yet due for assessment. The project has been extended till 2010.

Project 3: Ecorestoration for Tsunami devastated coastline of Andaman Group of Islands [IFGTB/EF-RP-20/2004-08] (Extended upto June 2009)

Status: The objective of the project is to create "bioshield" in 60 ha along the vulnerable coastal area of different islands of Andaman group of Islands. Out of the total target, an area of 50 ha. has been completed so far in Sippighat, Chouldari, Kadakachang, Adajig, Rangat, Long Island and Casuarina Bay. About 300 Forest Department staff of Andaman have been trained in the establishment and management of nurseries and plantations. Insect pest problem on the

younger plantation was addressed. The nursery and planting activities has provided opportunities for the local people to improve their economic status.

Project 4: Bio-production of secondary metabolites from *Aegle marmelos* [IFGTB/EF-RP-28/2007-09]

Status: Metabolite profile of roots, stem, leaves, and primary branches of the wild plants was developed. Compact callus aggregates for callus obtained from different explants was optimized for increased growth in suspension cultures. Analysis of secondary metabolites in suspension cultures was carried out. Plant and human pathogens were tested with extracts from callii obtained using different explants to assay the efficacy of the active principles in the callii. Active principles present in the callii showed inhibitory effects on the pathogens.

Project 5: Differential Analysis of Transcript Expression in *Casuarina* – *Trichosporium* Interaction to Isolate Defense – Related Genes [IFGTB/EF-RP-26/2006-10]

Status: The project aimed at isolating defence-related genes from *Casuarina equisetifolia* during pathogen elicitation. Profiling was conducted in untreated and elicitor treated tissues of *C. equisetifolia* and differentially expressed transcripts were identified. The transcripts showing significant similarity to existing genes in public domain database included chitinase, glucanase, resistance genes, nodulin, arabinogalactan, proteasome and cytochrome oxidase. Presently, full length gene isolation is in progress for chitinase, glucanase, resistance gene, arabinogalactan and cytochrome oxidase. A simple and cost effective protocol for isolation of total RNA from different tissues of tree species using non hazardous chemicals and the downstream synthesis of cDNA synthesis using un purified RNA has been developed and is in the process for filing of patent.

Project 6: Developing strategies for describing, testing and registering varieties of forest tree species in India [IFGTB/EF-RP-30/2006-08] (Extended up to 2009)

Status: The project aims at development of descriptors for genetically superior genotypes of Eucalyptus and Casuarina for the purpose of testing and registration of varieties. IFGTB has developed genetically superior clones of Eucalyptus and Casuarina through the systematic breeding programmes implemented during the past decade. These clones were studied for their unique characters to discriminate each of them. Leaf samples were collected from the trial plots of *Eucalyptus camaldulensis*, *E. tereticornis*, *Casuarina equisetifolia* and *C. junghuhniana* and characterized for their leaf morphology. Flower samples were also collected from these clones and subjected to image analysis. Probable characters which can be used as descriptors for these species were identified. These characters include both vegetative and reproductive characters. About 30 clones of Eucalyptus were characterized using morphological descriptors and Image Analyser data. The characteristic features of cladodes of Casuarina clones were recorded. The needle colour, number of scaly leaves per node and cladodes thickness was studied to distinguish the clones.

NEW PROJECTS INITIATED DURING THE YEAR 2008-2009

PLANPROJECTS

Project 1: Progeny testing of selected clones for establishment of clonal and seedling seed orchards in Eucalyptus [IFGTB/RP-55/2008-14]

Status: The Institute has identified about 110 clones from the first generation seed orchards of Eucalyptus. These clones have been tested for their growth superiority in three different

locations established during 2000. In this project, the genetic worthiness of their progenies need be tested and Clonal Seed Orchards (CSO) be established with tested clones for production of genetically superior seeds. During this year, the clonal trials of Karunya Nagar, Sathyavedu and Kulathupuzha were assessed and identified about 50 best performing clones. Seeds of these clones were collected and their progenies were raised in the nursery. About 25000 seedlings belonging to 50 families were raised for establishment of progeny test in two different locations. A Vegetative Multiplication Garden (VMG) was established for mass multiplication of these best performing clones. Shoots were collected from the VMG and multiplied clonally for establishment of CSOs. About 10,000 clonally multiplied plants belonging to 50 clones were raised for establishment of CSOs in 10 ha area in Tamil Nadu and Andhra Pradesh.

Project 2: Developing Genetic Improvement of *Casuarina* Species through Second Generation Orchards [IFGTB/RP-56/2008-14]

Status: Selected 250 outstanding trees in terms of growth, form and wood traits from 8 first generation orchards located in Andhra Pradesh, Punducherry and Tamil Nadu. Collected open-pollinated seeds from the selected trees and raised seedlings with family identity. Established two progeny trials-cum-second generation seedling seed orchards with 150 families each at Pugalur (Tamil Nadu) and Tirupati (Andhra Pradesh). These trials were planted in incomplete block design with 6 replications and each family was represented by a 4 trees plot in each replication. Assessed all the plants in both the trials for survival and growth at 6 months age. The survival has been above 90% in both the trials with a mean height of 2.5 m in Pugalur and 2 m in Tirupati.

Project 3: Developing Cloning Techniques for Raising High Yielding Clonal Plantations of *Casuarina equisetifolia* L. [IFGTB/RP-57/2008-11]

Status: Identified the experimental sites at Karunya Nagar and Panampally and initiated the studies. Selected trees were coppiced at various heights (15, 30, 45, 60, 100 and 150 cms from the ground level) and applied 3 treatments (fertilizer, mulching and growth regulator application). Coppice shoot initiation was observed in 89% of the trees felled. Coppicing at 45 and 60 cm was found to be better for shoot induction. Cladodes and needles collected from these coppice shoots were kept for rooting studies in the model nursery. Rooting could be observed in both cladodes and needle explants. Attempts are being made to standardize the technique to develop plantlets from individual needles.

Project 4: Allelic diversity of CCR gene in *Casuarina equisetifolia* [IFGTB/60/RP-2008-11]

Status: Fifty clones of *Casuarina equisetifolia* wood samples were collected using increment borer from IFGTB Model nursery. Cellulose content was estimated using UV/VIS spectroscopy method. Based on the absorption mean, twenty five clones were selected for the proximate analysis. An estimation of hollo cellulose and lignin content was evaluated for 25 selected clones. The range between the hollo cellulose was 74% to 80%, whereas in lignin, content was 24% to 53% among the twenty five clones. Nucleotides of CCR gene in Eucalyptus, Leuceana, Pines and *Populus* species were downloaded from NCBI data Library. Twenty two CCR gene primers were designed and synthesized.

Project 5: Identification of biochemical markers linked to sex determination in *Casuarina equisetifolia* [IFGTB-61/RP-2008-11]

Status: Twelve Isoenzymes (AAT, ADH, EST, PPO, POD, GDH, IDH, SOD, MDH, ME, LDH and G6PDH) were optimized in *Casuarina equisetifolia* clones. *Casuarina* young needles were collected from IFGTB model nursery and leaf tissues were extracted using 0.1M Tris Hcl

extraction buffer with additives. Isoenzymes were profiled in 10% polyacrylamide gel electrophoresis system, stained with specific substrates for 12 different isoenzymes and the images were documented. Observations were made on the banding patterns of male female individuals, five enzymes (AAT, POD, IDH, LDH and GDH) were shown distinct banding profiles between male and female clones.

Project 6: Quantitative Trait Loci (QTL) mapping in eucalypts for salinity tolerance and adventitious rooting [IFGTB/RP-62/2008-11]

Status: Pollen and seed parents of *E. camaldulensis*, *E. tereticornis* and *E. grandis* were selected for the development of inter-specific hybrids. Controlled pollination work on *E. camaldulensis* x *E. grandis* was completed to generate F₁ hybrids for the establishment of mapping population. Twenty microsatellite primer sets were synthesized and their transferability to *E. camaldulensis* was assessed.

Project 7: Identification of secondary xylem specific cellulose synthase genes from *Eucalyptus tereticornis* [IFGTB/RP-63/2008-11]

Status: Nucleotide and protein sequences of Cellulose synthase were assembled from public domain database, aligned and primer pairs were generated. The primer pairs targeting different groups of cellulose synthase were amplified in the wood tissues of *E. tereticornis* with complementary DNA as the template. Amplicons generated were sequenced and their similarity with the existing genes was determined.

Project 8: Studies on response of important tree species to elevated CO₂ levels under simulated temperature and moisture regimes at seedling stage [IFGTB/RP-69/2008-09]

Status: Project was initiated in July 2008. Fabrication of Open Top Chambers (OTC) with CO₂ analyzer and the SCADA platform-the controlling device is in progress. After the OTC becomes operational, the experiments will be initiated in June 2009.

Project 9: Studies on the suitability of *Eucalyptus tereticornis* and *E. camaldulensis* clones for various agroclimatic zones of Southern India [IFGTB/RP-58/2008-13]

Status: Shoots of thirty clones of *Eucalyptus tereticornis* and *E. camaldulensis* were collected from Satyavedu and Karunyanagar clonal trials and raised in the root trainer. With these ramets Vegetative Multiplication Garden (VMG) was established in Bharathiar University during September 2008. Forest departments of Pondicherry and Andhra Pradesh and the Agricultural College at Karaikal have allotted land for the trials. Land has been inspected in six locations, viz., Pondicherry, Karaikal, Warangal, Rajmundry, Hyderabad and Tirupati. The multiplication of the clonal material is in progress.

Project 10: Status and influence of microbial inoculants associated with *Eucalyptus* clones in established breeding populations [IFGTB/RP-65/2008-11]

Status: Rhizosphere soil samples collected from 31 clones of *Eucalyptus* at three different clonal trials of *Eucalyptus* located at Sathyavedu (Andhra Pradesh), Karunya (Tamil Nadu) and Kulathupuzha (Kerala) were analysed for presence of AM fungi and PGPRs. AM fungi, *Glomus viscosa* and *G. geosporum* and the PGPRs, *Bacillus megaterium*, *Pseudomonas striata*, *Azotobacter insignis* and *Azospirillum brasilense* isolated from the soil samples of certain clones were multiplied in sterilized soil and artificial media respectively. Interestingly, specific association of certain PGPRs with certain clones was observed. These PGPRs were multiplied in nutrient broth as well as carrier material (Charcoal) as shelf life forms.

The PGPR, *Bacillus megaterium* was tested on Eucalyptus stem cuttings and found that it induces rooting in stem cuttings. Stem cuttings of 17 selective clones collected from Sathyavedu and Karunya clonal trials and inoculated with PGPRs. Stem cuttings treated with IBA were kept as control. The results obtained showed significant variations on rooting percent age and time taken for rooting among the clones tested. The rooting percentage was observed to vary from 45-81 while the time taken for rooting varied from 14-20 days.

Project 11: Characterization and evaluation of allelochemical profiles of some economically important, insect pest resistant tree species [IFGTB/RP-68/2008-10]

Status: Regular field screenings of *Acacia mangium*, *A. auriculiformis* and *Ailanthus excelsa* populations for selection of insect pest resistant candidates were carried out and level of incidence and extent of damage caused by the pests, *Mylokerus* sp. on *Acacia* sp. and *Eligma narcissus* and *Atteva fabricella* on *Ailanthus* seed sources/ provenances were assessed. In order to understand the biochemical basis of resistance in Casuarina, Teak and Eucalypts against the targeted key pests estimation of chemical constituents like Tannins, phenols lipids in the leaves of teak and Eucalypts and bark and wood of Casuarinas carried out.

Project 12: Characterization of Eucalyptus clones for Physiological and Nutritional parameters [IFGTB/RP-59/2008-11]

Status: For establishment of field trials to evaluate the Eucalyptus clones for water and nutrient use efficiency, vegetative multiplication garden was established and the production of ramets is under progress. Fields were identified in Tirunelveli, Sivagangai and Pudukottai for establishment of field trials. For the short-listed 30 Eucalyptus clones, parameters like chlorophyll A, chlorophyll B, total chlorophyll and total leaf area were worked out. For carrying out the carbon isotope discrimination studies for estimation of water use efficiency of 30 clones, wood samples were collected and powdered for analysis at University of Agriculture Sciences, Bangaluru.

Project 13: Some phytochemical, toxicological, pharmacological investigations of *Aegle marmelos* for a new product [IFGTB/RP-66/2008-11]

Status: The different tissues, leaf, ripened & unripened fruits of *Aegle marmelos* were sequentially extracted with aqueous and other organic solvents. Extracts fractionated through XAD- 16 resin packed column were analysed for chemical analysis such as primary nutrients, phenols, alkaloids, flavonoids, tannins, saponins, enzymes like PO, PPO, PAL, TAL, individual fatty acids etc. in order to evaluate the tissue specific pharmacological screening of the extracts. And, assessed the efficacy on CUMS (Chronic Unpredictable Mild Stress) especially on stress, antioxidant, behaviour etc. The dried micro-sieved crude powder of those tissues tested for preliminary pharmacological screening on animal showed, that leaves shown less antioxidant activity in super oxide and nitric oxide scavenging activity, ripen and unripen fruits exhibited similar antioxidant activity in super oxide and nitric oxide scavenging activity and all the three crude extracts shown similar reducing power activity. Among the three antioxidant activity studied super oxide scavenging activity found to be better. The observation has to be further confirmed and compared with the extracts. The work is in progress.

Project 14: Bioinformatic approach to data mine wood forming genes of Eucalyptus [IFGTB/RP-64/2008-11]

Status: Sequences have been downloaded for the following wood formation genes PAL (Phenylalanine Ammonia-Lyase), 4CL (4-Hydroxycinnamoyl CoA ligase), C3H (p-Coumarate 3-hydroxylase): Identification of conserved regions and primer designing carried out for the above genes.

EXTERNALLY AIDED PROJECTS

Project 1: New biocontrol opportunities for prickly *Acacia* : exploration in India [IFGTB/EF-RP-32/2008-11]

Status: Availability data of young *Acacia nilotica* plantations with the State Forest divisions of 17 districts of Tamil Nadu and 3 districts of Karnataka were collected. Field visits were made to the plantations at these districts and 20 suitable sites for regular surveys selected. Two rounds of Surveys at *Acacia nilotica* tank bed plantations, isolated trees in the agricultural lands and at the roadside at 63 locations in 17 districts of Tamil Nadu and 1 round of survey at 9 locations in 3 districts of Karnataka were carried out. About 48 species of insects and 13 species of pathogens infesting different parts of *A. nilotica* were documented.

Out of 48 insect species, 29 were identified.

Out of 13 species of pathogens, 8 were identified.

Herbarium of (32), host (19) and pathogens (13) and preservation and pinning and labeling of 48 species of insects were done.

Out of 48 species of insects and 13 species of pathogens recorded so far, 4 species of insects (1 sap sucker and 3 defoliators) and 6 species of pathogens were prioritized for further host specificity and pathogenicity studies. Stock culture of these species were raised and being maintained in the lab. Host specificity study with 2 species of defoliators and Pathogenicity study with 3 species of pathogenic fungi were initiated at the glass house. Exclusion trial to assess the impact of insects and pathogens on seedlings of *A. nilotica* has been established and 12 data on incidence of insects and pathogen and 6 data on growth parameters have so far been collected.

Project 2: Improving productivity of bamboo in farmlands of Tamil Nadu [IFGTB/EF-RP-34/2008-11]

Status: The project is funded by the National Bamboo Mission. During April-May 2008, a visit was made to North-East India and planting stock for silvicultural trials and germplasm for the bambusetum were procured and assembled in Coimbatore from the States of Assam and Arunachal Pradesh. Around 30 species for bamboo germplasm bank were collected from Assam and Arunachal Pradesh while 24 Candidate Plus Clumps (CPCs) for bamboo multiplication garden were assembled from Rain Forest Research Institute, Jorhat, Assam. Around 9,180 nos. of quality planting stock belonging to 4 species for the silvicultural trials were assembled from Forest Department nurseries at Guwahati & Kokrajhar in Assam and from State Forest Research Institute, Itanagar in Arunachal Pradesh. Silvicultural trials have been established at Alagampatti, K. Nedungulam and Kayathar in southern agroclimatic zone.

Project 3: A value chain on industrial agroforestry in Tamil Nadu [IFGTB/EF-RP-34/2008-11]

Status: In this project funded by the World Bank through the Indian Council of Agricultural Research, as a part of the National Agricultural Innovation Project, through a Consortium consisting of Research Institutes, Paper Industries and Farmers, the Institute is required to produce and supply genetically improved quality planting stock of Eucalyptus and Casuarina for planting in the farmers' fields and also identify new genetic material for improved productivity. During the year, a Vegetative Multiplication Garden of Eucalyptus was established



over 0.5 ha and a clonal plantation of Eucalyptus was established over 1 ha. A progeny trial of *Casuarina equisetifolia* was established in 2 ha.

TECHNOLOGY ASSESSED AND TRANSFERRED

- Standardized suitable culture medium for mass production of different isolates of Ectomycorrhizal fungi (*Laccaria fraterna* and *Pisolithus albus*) under *in vitro*.
- Serious pest problems in nursery and plantations of fast growing indigenous tree species such as *Ailanthus excelsa*, *Melia dubia*, *Gmelina arborea*, *Thespesia populnea*, *Bombax* spp. and *Dalbergia sissoo* in Tamil Nadu and Kerala were identified.
- Eucalyptus clones categorized based on the susceptibility for key pests and disease problems.
- Post harvest techniques on *Jatropha curcas* was disseminated to farmers and foresters.
- Seed handling techniques of important NTFPs was disseminated to farmers in the technical workshop on tree cultivation.

EDUCATION AND TRAINING

A. Conducted

- Profitable cultivation of *Casuarina* at Solasiramani village, conducted by Sehsasayee Papers and Boards Limited, Erode on 9th October 2008 and 19th March 2009.
- Profitable cultivation of *Casuarina* and *Eucalyptus* at Tamil Nadu Newsprint and Papers Limited, Kagithapuram on 23rd February 2009.
- Training programme for Foresters, Farmers, NGOs and others on Tree Borne Oilseeds with special emphasis on *Jatropha curcas* on 12th and 13th August 2008, IFGTB, Coimbatore.

Training Programme on Tree Borne Oil Seeds.

The National Oilseeds and Vegetable Oils Development Board sponsored five “Farmers training programmes and two Trainers Training Programmes”. The Training of Trainers (ToT) programme for field functionaries of Forest, Agriculture, Horticulture and Rural Development departments, on Tree Borne Oil Seeds (TBOS), was organized on 2nd February 2009 and 26th March 2009 to enhance their skills and knowledge on TBOS with the objective to train the farmers and other user groups involved in cultivation and management of TBOS. It was also to popularize such crops among farming community for adoption. About 200 officials participated in the training programme. The farmers training programme was organised at Coimbatore (30th January 2009), Tiruvannamalai (13th February 2009), Sathyamangalam (28th February 2009), Tirunelveli (20th March 2009) and Salem (25th March 2009) to reach out to a larger section of the farmers across districts in the State. A total of more than 600 farmers participated in the training. The training covered all aspects of TBOS like cultivation and management of important oilseed crops suitable for Tamil Nadu, seed handling and storage techniques, TBOS based agroforestry models, genetic improvement strategies and pest and disease management.

Training Programme on Bamboo Cultivation and Management

The Institute organized three five days training programme on Bamboo Cultivation and Management for officers of the Agriculture and Horticulture Departments of Tamil Nadu. The Training Programme was sponsored by Tamil Nadu Horticultural Development Agency

(TNHDA). A total of 100 officers were trained. The officers were provided with an overview of the bamboo resources in India, the cultivation and management of various bamboo species in farm fields, bamboo cultivation in agroforestry, nursery management, disease and pest management, harvesting of bamboo, the marketing issues, etc. The participants were taken to fields where bamboo is planted and managed, Bambusetum maintained by the institute, KFRI and Bamboo Development Society at Palakkad. Hands on training was imparted on nursery techniques. The training was conducted by the internal resource persons and persons from KFRI, Peechi.

Training on Post Harvest Techniques of *Jatropha*

- Hands on training on post harvest techniques of *Jatropha curcas* was given for Tribal Women's Self Help Group of Vattalukki village, Attapady on 23rd March 2009 at IFGTB, Coimbatore. The training was sponsored by Department of Biotechnology, New Delhi.
- Hands on two days training programme for farmers, foresters, NGOs and others on "Tree Borne Oilseeds with special focus on *Jatropha curcas*" under the DBT project on *Jatropha curcas* on 12th and 13th August 2008 at IFGTB.

B. Attended

- Molecular methodologies for assessing and applying genetic diversity in crop breeding conducted by ICRISAT, Hyderabad from 17th to 28th November 2008.
- 'Project formulation, Implementation and Evaluation' from 21st April to 2nd May 2008 at the Administrative staff college of India, Hyderabad.
- Research Management at the Administrative staff college of India, Hyderabad during March 2009.
- Main Streaming Biodiversity for Impact Assessment at Wildlife Institute of India, Dehradun from 18th to 22nd August 2008.

LINKAGES AND COLLABORATION

- Following a request from the Orissa Forest Sector Development Project, prepared a project proposal titled "Establishing Advance Generation Seed Orchards of Casuarina species in Orissa" and sent to Orissa Forest Department for collaborative implementation.
- Following a request from the Forest Department of Gujarat, prepared a technical guidelines and statistical design for "Evaluation and selection of genetically improved Eucalyptus seeds source(s) suitable for planting in Gujarat" and sent along with seedlots on 21st July 2008.
- Linkages and collaboration were established with the Rhizogenesis group, Institute de Recherche pour le Développement (IRD), 911 Avenue Agropolis, BP 64 501, 34394, Montpellier Cedex 5, France in the areas of Development of post transcriptional gene silencing approaches as a tool for functional analysis in Casuarina.
- The research cum extension project on 'Demonstration of agroforestry technologies in different agroclimatic zones of Tamil Nadu' has been formulated in discussion and collaboration with National Research Centre for Agroforestry (NRCAF) and Forest College and Research Institute (FC&RI) to disseminate the agroforestry practices and technologies developed by IFGTB, NRCAF and FC&RI. The project is being implemented from July 2007. Interaction meeting was held at IFGTB on 13th May 2008 with scientists from NRCAF- Dr. O.P. Chaturvedi, Dr. A.K. Handa, Dr. A. Venkatesh, and Dr. M.P. Divya, Associate professor, FC&RI. In the discussion meeting, suggestions were made on the promising tree components for different agroclimatic zones of Tamil Nadu.

- The National Agricultural Innovation Project (NAIP) is being implemented in collaboration with the Forest College & Research Institute of the Tamil Nadu Agricultural University, Tamil Nadu Newsprint and Paper Ltd., Seshasayee Paper and Boards Ltd. and clusters of farmers in two districts.

PUBLICATION

- Nicodemus, A., 2009. *Casuarina: A Guide for Cultivation*. Institute of Forest Genetics and Tree Breeding, Coimbatore.

CONSULTANCIES

- Andhra Pradesh Paper Mills, Rajahmundry on genetic improvement of *Casuarina* through seed orchards from 31st July to 2nd August 2008 and from 18th to 20th March 2009.
- A consultancy for three months period (January 2008 to April 2009) on DNA profiling of *Eucalyptus* and *Acacia* hybrids for Mysore Paper Mills, Bhadravathi, Karnataka.
- Preparation of Forest and Ecological Management Plan for Sriharikota Island, awarded by the Department of Space, Government of India.
- Preparation of Catchment Area Treatment (CAT) Plan for bauxite mining in Jarrela blocks of Reserve Forests, Visakhapatnam, Andhra Pradesh, awarded by Andhra Pradesh Mineral Development Corporation (APMDC) Ltd., Hyderabad, Andhra Pradesh.
- Preparation of Environmental Impact Assessment (EIA)/Environmental Management Plan (EMP) for diversion of forest land for bauxite mining in Jarrela blocks of Reserve Forests, Visakhapatnam, Andhra Pradesh, awarded by Andhra Pradesh Mineral Development Corporation (APMDC) Ltd., Hyderabad, Andhra Pradesh.
- Preparation of Environmental Impact Assessment (EIA)/ Environmental Management Plan (EMP) for diversion of forest land Iron ore mining areas in Ankua Iron ore deposits, Manoharpur, Jharkhand, Awarded by JSW Limited, New Delhi.
- Preparation of Environmental Impact Assessment (EIA)/Environmental Management Plan (EMP) for Sankosh multipurpose Hydroelectric project, Bhutan awarded by Tehri Hydro Electric Development Corporation Ltd.

CONFERENCE/MEETINGS/WORKSHOPS/SYMPOSIA/EXHIBITIONS

1. Attended

The representatives from Institute of Forest Genetics And Tree Breeding, Coimbatore attended the Workshops/Seminars/Conferences/Symposia as given below during the period under report:

(a) International

1. "Advanced Protein Domain Workshop" at Lyon, France from May 18th to 20th 2008.
2. "Forest Adaptation 2008" an International conference organized by the FAO of UN, IUFRO and SLU, Sweden at Umea, Sweden from 24th to 28th August.
3. International Congress of "Global Warming on Biodiversity of Insects: Management and Conservation", organized by Department of Zoology, School of Life Sciences Bharathiar University, Coimbatore, from 9th to 12th February 2009.
4. International Seminar on "Multidisciplinary Approaches in Plant Systematics", from 11th to 13th October 2008, Kalyani University, Kalyani, West Bengal.



(b) National

1. National symposium on "Agroforestry Knowledge for Sustainability, Climate Moderation and Challenges Ahead" held from 15th to 17th December 2008 at National Research Centre for Agroforestry, Jhansi.
2. National symposium on "Herbal Drug Research" held on 25th and 26th September 2008 at Bharathiar University, Coimbatore.
3. National symposium on "Sustainable Utilization and Conservation of Medicinal Plants" held on 21st and 22nd August 2008 at Department of Biology and plant Biotechnology, Nirmala college for Women, Coimbatore.
4. National Seminar on "Biodiversity- Status, Conservation and Management", organized by Kongunadu Arts and Science College, Coimbatore on 12th and 13th September 2008. (Sponsored by the Indian Science Congress Association, Kolkata.
5. National workshop on "Sustainable Management of NTFP" on 18th and 19th January 2008, TFR, Jabalpur.
6. National Seminar on "Bamboo: Plantation, Management and its Utilization" organized by Arid Forest Research Institute, Jodhpur from 17th to 19th March 2009.
7. National Seminar on "Progress, Prospects and Problems in Bamboo Research", Department of Botany, Mercy College, Palakkad.
8. Seminar on "Bamboo Cultivation Practices", Department of Horticulture, Tamil Nadu, at Anamalai hills.
9. International Conference on "Improvement of Bamboo Productivity and Marketing for Sustainable Livelihood", New Delhi from 15th to 17th April 2008.
10. Participated in a Workshop on "Tree Cultivation" on 7th and 8th March 2009 at IFGTB.
11. "Two Institutional Bio-Safety Committee" (IBSC) meetings were organized from 15th October to 30th December 2008.
12. National symposium on "Herbal Drug Research" at School of Life Sciences, Department of Botany, Bharathiar University, Coimbatore on 25th and 26th September 2008.
13. "Facets of Cecidology : Intricacies of Insect – Plant Interactions" organized by Prof. T.N. Ananthakrishnan, Ex-Director Zoological Survey of India, Chennai on 5th December 2008.

2. Organised

1. One week refresher course on "Recent advances in forestry research" was organized for IFS officers from 1st to 5th December 2008.
2. IFGTB organised Tree Growers Workshop on 7th and 8th March 2009 in collaboration with the Extension wing of Tamil Nadu Forest Department. The workshop was inaugurated by Dr. C.K. Sreedharan, PCCF, Tamil Nadu, Dr. Rabindra Kumar, DDG (Extension), ICFRE presided.
3. An interactive meeting was held between the officials and scientists of IFGTB and officials of the Tamil Nadu Forest Department on 12th November 2008 at the Forest Headquarters, Chennai. Dr. C.K. Sreedharan, IFS, Principal Chief Conservator of Forests delivered the key note address and emphasized the need for research on catchment area management,



biodiversity assessment, planting on private lands, carbon trading, etc. relevant for the state.

4. An interactive meeting between Department of Environment and Forests, Andaman and Nicobar Islands and IFGTB on Forestry Research was held on 12th January 2009.
5. An interactive meeting was held with the Punducherry Forest Department at IFGTB on 6th February 2009. Dr. P. Devaraj, Conservator of Forests and Chief Wildlife Warden, Punducherry explained in detail the activities carried out by the Department.
6. Meeting on Finalization of List of Non-target species (Plants & Insects) for Safety Testing for Parasitoids of Eucalyptus Gall Wasp was held at IFGTB on 25th February 2009. The Meeting was chaired by Dr. R.J. Rabindra, Director, National Bureau of Agriculturally Important Insects (NBAII), Bangalore. Dr. N. Krishnakumar, Director, IFGTB, co-chaired the meeting. The list of non-target plants /insects for safety testing was drawn.
7. An Interactive workshop between IFGTB and wood based industries of Tamil Nadu and Kerala was held on 5th March 2009 at IFGTB.

MISCELLANEOUS

- Womens' harassment cell meeting was conducted.
- Quality seeds of *Eucalyptus camaldulensis*, *Casuarina equisetifolia* and *C. junghuhniana* were collected from seed orchards established by IFGTB and supplied to Forest Departments, farmers and wood based industries.
- Organized International biological diversity day on 22nd May 2008 at IFGTB Coimbatore.

