

INSTITUTE OF FOREST GENETICS AND TREE BREEDING COIMBATORE

The Institute of Forest Genetics and Tree Breeding (IFGTB) is a national Institute established in April 1988 under the Indian Council of Forestry Research and Education (ICFRE), an autonomous Council under the Ministry of Environment and Forests, Government of India. The Institute conducts national level research on the subjects of Genetics and Tree Breeding of important forest tree species. It also attends to the local problems of the States of Tamil Nadu, Kerala, the Union Territories of Andaman and Nicobar Islands, Lakshadweep and Pondicherry.

PROJECTS COMPLETED DURING THE YEAR 2000-2001

Project 1: Genetic improvement of forest trees. (IFGTB/GTB/RP 1/47/FREEP)

Objectives: (a) To characterise the provenances of *Eucalyptus camaldulensis* and *Casuarina equisetifolia*. (b) To increase the productivity of *Eucalyptus camaldulensis* and *Casuarina equisetifolia* through selection and breeding. (c) To establish breeding populations of *Eucalyptus camaldulensis* and *Casuarina equisetifolia*. (d) To establish seedling and clonal orchards for production of improved seed.

Achievements: The breeding populations of *Eucalyptus camaldulensis* and *Casuarina equisetifolia* were evaluated, identified and thinned to remove the inferior trees and to convert the progeny trials into Seedling Seed Orchards. Outstanding trees of known origin in different trials were coppiced to produce juvenile shoots in Eucalyptus and spike cuttings were collected from selected trees of Casuarina and rooted using polytents. Clonal trials of Eucalyptus were established in Sathyavedu, Kulathupuzha and Sadiwayal to identify the best clones for each site.

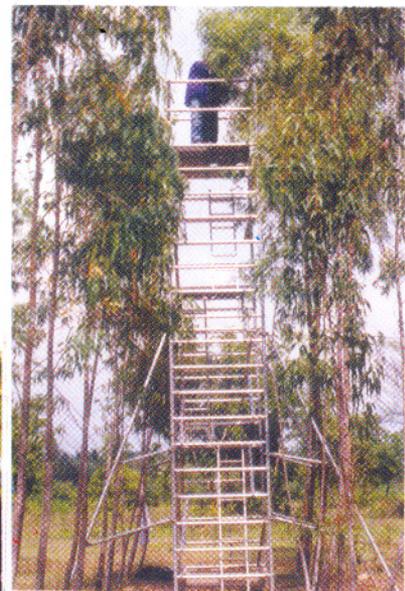
Project 2: Reproductive Biology of tropical trees. (IFGTB/GTB/RP 2/47/FREEP)

Objectives: (a) To understand phenology and floral biology. (b) To know pollen biology and pollen pistil interaction. (c) To study breeding systems and standardize hybridization techniques.



Pollen denoting in ⇒
Eucalyptus

⇐ Pollen collection in
Eucalyptus



Controlled pollination in Eucalyptus

Achievements : Seed output and reproductive success studies were conducted. Local land races such as South Arcot and Orissa showed the highest rates of reproductive success. Among the recently introduced resources, land race Beechai showed the highest rate of reproduction. Low levels of reproduction were recorded in Egypt and Kenya land races and in Solomon Island, Northern Territory, Australia natural provenances. A moderate fruit set of 60% was recorded in controlled self pollinating in *Casuarina equisetifolia*. Hybridisation studies were conducted in selected families of *Eucalyptus camaldulensis* and *E. tereticornis* in Panampally and Karunya Nagar. High fruit set upto 70% was recorded in interfamily controlled pollination.

Project 3: Evaluation of Genetic Variability of Teak in Peninsular India. (IFGTB/GTB/RP 3/47/FREEP)

Objectives : (a) To identify the natural and planted populations of Teak in Peninsular India and record morphological and physiological variability. (b) To estimate genetic variability existing within and among populations of Teak through biochemical and DNA markers. (c) To confirm the delineation of ecotypes and other varietal identifications of Teak in India and to understand inter-relationships among them. (d) Based on the results from above studies, to evolve appropriate selection and breeding strategies for successful genetic improvement of Teak.

Achievements: Twenty representative populations of Teak have been surveyed in different States of Peninsular India. Growth, morphological and phenological traits were studied in the field. Wood density did not vary significantly among different populations and it appears to be more influenced by environment than genetic control. Genetic variability within and between 10 populations was quantified using Randomly Amplified Polymorphic DNA (RAPD) assay. Natural populations (e.g. Kalakkad) showed higher diversity than plantation populations like Topslip and Konni.

Project 4: Evolving Clonal Propagation Technology for Teak to improve Productivity. (IFGTB/GTB/RP 4/47/ICFRE)

Objectives : (a) Standardize clonal propagation technique for mass multiplying superior or Plus Trees and quality seedlings of Teak. (b) Study the impact of seasons on rooting in Teak. (c) Establish clone banks, clonal multiplication garden and clonal trials of Teak. (d) Characterize clones based on growth, physiological and molecular markers.

Achievements : Clonal propagation technologies for mature Teak tree and quality seedlings has been standardized. Quality Teak seeds were collected from clonal accessions and seedlings were raised, multiplied vegetatively for clonal trials. A comparative trial has been laid out in Panampally, Kerala to study the growth performance of coppice shoot plants of mature trees.

Project 5: Genetic variability and selection in natural population of *Artocarpus* species. (IFGTB/GTB/RP 5/47/ICFRE)

Objectives: (a) To study the natural distribution of the species and develop strategy for in situ and ex situ conservation. (b) To evaluate genetic parameters in the natural population. (c) To develop effective selection strategy for the improvement of *Artocarpus integrifolia*, *A. hirsuta*, and *A. lakoocha*. (d) To study the genetic variability in the population using morphological, biochemical and /or molecular markers.

Achievements: The variation on wood density was minimum between trees samples of *Artocarpus hirsuta* collected. Considerable tree to tree variations were observed for these seed characters. Germinated seedlings are being utilized for biochemical / molecular characterization studies. Wild seedlings collected are maintained in the shade house. Rich natural regeneration of *A. integrifolia* were observed in Aandiparai reserved Shola forests. Only *A. integrifolia* was observed to occur in Valparai area.

OLD PROJECTS CONTINUED DURING THE YEAR 2000-2001

Project 1: Assessing growth and physiological variations like photosynthesis in fast growing Tree Species for improving yield. (IFGTB/PBT/RP 7/47/ICFRE)

Objectives : (a) Survey and selection of superior trees of *Casuarina equisetifolia* and Eucalyptus species and standardization of the procedure of cloning them. (b) To carry out physiological and genetic studies to find out interclonal variations in the identified superior performers. (c) To identify the salt tolerant clones of *Casuarina equisetifolia*.

Achievements :

Wood Fibre Characteristics of Eucalyptus Clones: Wood density was determined from the clonal plantations at the age of 4, 5 and 6. Sapwood content was measured and found that in some clones heart wood formation started very early limiting the amount of sapwood. Wood was also analyzed to study the variation in wood fibre characteristics between the juvenile and mature wood. The results showed that in some clones tremendous variation existed between these two regions while in some other clones the variation was almost nil making the wood more uniform. Various wood fibre characteristics like Runkel's ratio Isenberg / Rigidity Coefficient, Coefficient of Fibre flexibility, Felting Coefficient, and Fibre content were studied in clones of Eucalyptus.

Water Use Efficiency (WUE): It was found that the clones of *E. tereticornis* were more efficient than *E. camaldulensis*. Clone No.130, 231 and 132 were identified as excellent water users.

Variations in photosynthesis as a physiological marker for screening Clones for salt tolerance: *E. camaldulensis* was found relatively tolerant to salt stress as photosynthesis was not much affected when plants were subjected to salt stress.

Project 2 : Micropropagation and tissue culture studies on selected tree species including procedure for hardening, weaning and out planting. (IFGTB/PBT/RP 8/47/ICFRE)

Objectives: Standardization of micropropagation protocols for Bamboos, Eucalyptus, Neem, Teak and Acacia.

Achievements:

Micropropagation of Eucalyptus hybrid: Branch cuttings from twenty-nine years old natural putative hybrid between *E. torelliana*, *E. citriodora* were induced for sprouts and the axillary buds of the sprouts were used as explants for micropropagation. Culture initiation was carried. This method provides rejuvenated and responsive starting tissue for establishing *in-vitro* cultures of mature trees. Shoots with 4 to 5 cm height were used for rooting.

Sixty-two per cent of the rooted plantlets survived after acclimatization and developed into normal plants showing uniform growth pattern. All the plants were planted in the field when they attained 50-60 cm height.

Possibility for the propagation of a mature tree of *Eucalyptus tereticornis* (SMD-7) was assessed by both macropropagation and micropropagation techniques. Seven years old tissue culture raised plants were coppiced and the coppice shoots were used for macropropagation. The coppice shoot cuttings showed only one percent rooting, whereas micropropagated shoots showed 100 percent rooting. Therefore, micropropagation techniques can be used for the rescue of genotypes that show poor or no rooting potential.

Field trials for Tissue Culture raised plants of Eucalyptus:

***Eucalyptus* hybrid (*E. torelliana* x *E. citriodora*):** The 29 years old putative hybrid of *E. torelliana* x *E. citriodora* was successfully micropropagated.

***Eucalyptus tereticornis*:** The difficult-to-root plants of *Eucalyptus tereticornis* were micropropagated.

Micropropagation of *Acacia* hybrid: Fast-growing *Acacia* hybrid clones SU-3 and HT-7 were used in the present study. Rootability decreases, as the plants age. Therefore *in-vitro* approach has been utilized to explore increased propagule production and induction of juvenility. Explants for micropropagation were collected from the vegetative cuttings obtained from 4 years old hybrid clones maintained as hedges. The single pair of pinnae was paripinnate with long petiole, leaflets about 7 to 9 pairs, more or less distant, not overlapping and the rachis slightly extended and curved at the end.

Patent for *in-vitro* propagation of *Oxytenanthera stocksii*: A patent for the process developed for micropropagation of the bamboo, *Oxytenanthera stocksii* Munro was obtained through National Research Development Council, New Delhi in August, 2000. Patent Number: PAT/418.16/99108.

Project 3 : Biotechnology of Trees. (IFGTB/PBT/RP 9/47/FREEP)

Objectives: To establish a nucleus of scientists and develop laboratory facilities for non conventional tree improvement programs.

Achievements:

Regeneration studies in *Eucalyptus tereticornis*: Studies were undertaken to find out the effect of different explants, basal media, growth regulator and culture conditions on callus induction and somatic embryogenesis. The best concentration of NAA for friable callus induction from seeds and cotyledons was 2mg l^{-1} . A notable reduction in the efficiency of cotyledons collected from explants of different age groups was observed. The highest percentage of callusing was noted from the youngest (7 days old) explant while 28 days old explants showed the lowest frequency of callus induction. Somatic embryogenic cultures were initiated from different type of explants and an exogenic auxin was not required to initiate embryogenesis. Callus obtained from cotyledons of different ages exhibited marked differences in the ability to produce embryogenic cultures. The development of somatic embryos was stimulated after transferring the friable nodular callus to reduced levels of cytokinin (BAP). The best responses were obtained at 0.5mg l^{-1} concentration.

Direct somatic embryogenesis was obtained from immature cotyledons on MS media containing 0.2mg l^{-1} BAP. Different conditions of light were tried in order to increase the frequency of somatic embryo formation and to establish the best light condition for embryogenesis. A low light intensity with a 16-hr light and 8-hr dark was found to be well suited for somatic embryogenesis. The development of somatic embryos was mainly stimulated by the manipulation of hormonal balance in the nutrient medium. The

somatic embryos originated in embryonic tissue passed through a series of developmental stages similar to their zygotic counterparts to reach maturity.

Germination and conversion of somatic embryos into plantlets was achieved on the same medium used to develop somatic embryos without growth regulators. Well-developed plantlets were transplanted to different substrates for hardening. The effect of different substrates on hardening of plantlets was studied and most of the substrates except sand and a mixture of sand:soil (1:3) gave more than 50% hardening of plantlets. The highest survival rate was observed on red soil (91%) followed by coir pith (84.4%).

Investigation on antifungal proteins : Crude proteins were extracted from the leaves of *Rauvolfia tetraphylla*, *Andrographis paniculata*, *Piper longum*, *Terminalia arjuna*, *Terminalia catappa* and *Plumbago zeylanica* using sodium acetate buffer. The resultant protein extract was tested for its antifungal activity against three major forest pathogen, *Trichosporium vesiculosum*, *Macrophomina phaseolina* and *Aspergillus flavus*. The protein extract of *Rauvolfia tetraphylla*, *Andrographis paniculata* and *Piper longum* totally inhibited the spore germination of the 3 pathogens at the concentration of 66 mg, 30 mg, 48 mg respectively while the protein extracts from others inhibited only *T. vesiculosum* partially and showed no inhibition to the growth of other pathogens.

Production of Improved Planting Stock of Teak: Comprehensive method for good shoot multiplication, cost effective rooting and application to a wide range of genotypes was developed. Seeds collected from different clones of Clonal Seed Orchard were used for the establishment of cultures. Rapid shoot proliferation was done in alternate growth hormone concentration. Compared to conventional method where one ha. of CSO produces planting material for just 17.0 ha. micropropagation can increase planting stock by 500 times. The developed *in-vitro* protocol has been very successful and SPIC Agrobiotech is carrying out commercialisation of this method to enhance the availability of qualitatively improved planting stock.

Project 4 : Fingerprinting of economically important clones of Eucalyptus and Casuarina. (IFGTB/PBT/RP 10/47/2000/DBT)

Objectives : Develop techniques for fingerprinting of clones.

Achievements :

Identification of economically important Clones of Casuarina and Eucalyptus: Ninety-nine superior trees identified, have been propagated and maintained in the germplasm bank of IFGTB. Their traits have been recorded. In addition nearly 200 accessions undergoing trial in the Casuarina network are also available for the study. At first stage, following 12 clones of *Casuarina equisetifolia*, identified by IFGTB as superior performers were selected for fingerprinting studies. In addition, clones of *Casuarina equisetifolia* have been found suitable for pulping among the 15 clones analysed.

In the case of *Eucalyptus tereticornis* and *Eucalyptus camaldulensis*, 33 clones were selected from problem sites and are maintained in the germplasm bank of IFGTB. Additionally through clonal exchange programs over 75 clonal accessions have been made. Of these 10 clones are planted in large-scale, for which IFGTB has provided consultancy to Andhra Pradesh Forest Development Corporation and over 8000 ha are planted. Five clones were found highly suitable for fiber and pulping.

Fingerprinting studies in Casuarina: With the assistance of Centre for DNA Finger printing and Diagnostics, Hyderabad, methods were standardized for finger printing of Casuarina clones using Inter Sample Sequence Repeat – PCR (ISSR-PCR) and FISSR-PCR, and for Eucalyptus and Casuarina using RAPD technique.

Clonal fidelity studies in Eucalyptus: RAPD analysis has been applied to assess the genetic fidelity of plants derived *in vitro*. It has been observed that *Eucalyptus tereticornis* showed variation at DNA level occurs with repeated subcultures.

Project 5 : Variability studies with special emphasis on physiology, biometry and biochemistry in selected tree species for tree improvement. (IFGTB/PBT/RP 11/47/2000/ICFRE)

Objectives : (a) To grade the clones of Casuarina, Eucalyptus and Teak assembled by IFGTB based on physiological, morphological, and biometrical characteristics. (b) To study the genetic divergence. (c) To enhance rooting in difficult to root clones. (d) To Study the comparative performance of cuttings and seedlings with reference to physiological parameters. (e) To study the degree of tele-toxicity for screening clones for agroforestry. (f) To determine the tissue characteristics of juvenile and adult materials at the molecular level.

Achievements:

Screening of salt tolerant Clones of *Casuarina equisetifolia*: Data on biometrical traits and the interim results revealed that clones 51 and 15 were found to be superior in growth followed by clones, 1, 41, 64, 50, 35 and 6. Clones 9, 72, 40, 66, 48, 73 and 44 showed very poor growth response.

Biochemical studies on change in sex expression in clones of *Casuarina equisetifolia*: The phenomenon of change in sex expression in clones of *C. equisetifolia* was reported for the first time during 1998. Studies were initiated to understand this rare phenomenon at the molecular level. It was observed that the two types of plants namely the constants and the inconstants differed remarkably with respect to their protein levels. In monoecious individuals, the protein levels were comparatively higher during the flowering season, though the changes were marginal. In case of the inconstants, there was a remarkable change in protein levels. This may be effected as a result of the change in the sex expression in the transformants from either male or female to monoecious where it is required to produce female or male inflorescence additionally.

Project 6: Genetic transformation of Eucalyptus and Casuarina to enhance salinity tolerance. (IFGTB/PBT/RP 12/47/2000/ICFRE)

Objectives : (a) Evolving a standard protocol for routine transformation of *Eucalyptus tereticornis* and *Casuarina equisetifolia* using *Agrobacterium* mediated gene transfer and molecular analyses of transgene expression. (b) Transforming *Eucalyptus tereticornis* and *Casuarina equisetifolia* with P5CS gene and confirming the gene transfer using GUS assays, PCR and Southern blotting. (c) Raising R1 plants & assessing their tolerance to salinity.

Achievements : LBA 4404 and EHA 105 strains of *Agrobacterium tumefaciens*, *E. coli* strain DH5a and *E. coli* strain harboring pRK2013 were obtained from Madurai Kamaraj University. Twenty-nine pCAMBIA vectors harboring reporter genes like GUS and GFP were obtained from Center for Application

of Molecular Biology to International Agriculture, Canberra, Australia. The bacterial cultures are being stored and maintained and experiments are on to mobilize pCAMBIA vectors into *Agrobacterium tumefaciens*.

Regeneration of *Casuarina equisetifolia*: Shooting of callus obtained from cotyledonary leaves was observed in the clone CH-10-02 using the media 0.1 BAP and 0.001 NAA followed by subculturing in 0.5 BAP + 0.005 NAA.

Regeneration studies in *Eucalyptus tereticornis*.: Direct regeneration of Eucalyptus clone ET- 89 10 05 were observed from leaf explants obtained from tissue culture plantlets in MS media containing BAP 0.05 mg / ml.

Project 7: Identification and cloning of genes(s) encoding protein toxic to *Trichosporium vesiculosum* Butler. (IFGTB/PBT/RP 13/47/2000/ICFRE)

Objectives: (a) To identify the source of toxic protein(s) against the blister bark fungus *Trichosporium vesiculosum*. (b) To purify protein(s) to homogeneity and their partial characterization. (c) *In-vitro* testing of the proteins against *T. vesiculosum*.

Achievements : Crude proteins were extracted from leaves of *Plumbago capensis*, *Rauvolfia tetraphylla*, *Andrographis paniculata*; *Plumbago zeylanica*; *Terminalia cattappa*; *Terminalia arjuna* and *Piper longum* and the efficacy of the crude proteins for their antifungal activity were tested by microtitre plate assay method. The protein fraction collected after 75% precipitation was found to inhibit the spore germination at a concentration of 33 mg even after 72 hours while in the other fractions the spore germination occurred after 24 hours and profuse growth was seen after 72 hours.

Project 8: Screening of *Casuarina equisetifolia* and *C. junghuhniana* genotypes for plantation in problem soils of Tamil Nadu. (IFGTB/SIL/RP 14/47/ICFRE)

Objectives : (a) To screen the hybrids of *C. equisetifolia* and *C. junghuhniana* raised under rainfed conditions of drought, salinity and minespoils. (b) To evolve cultivars for environmental plantations.

Achievements: The ramets of the CPTs were collected from various agro-ecological zones and were multiplied and included in the *Casuarina* clonal trials established at Forest College Mettupalayam, Pondicherry and at Hosekote, Karnataka to study their performance in field.

Project 9: Impact assessment of intensive silvicultural practices on Seed Production Seed Orchards / Seed Production Areas in South India with reference to Teak and other mandatory species. (IFGTB/SIL/RP 15/47/ICFRE)

Objectives : (a) To assess the impact of intensive silvicultural practices on seed production. (b) To standardize and develop a package of silvicultural practices for Teak for different rainfall zones of Tamil Nadu and Kerala.

Achievements : Treatments trials of intensive silvicultural practices were imposed upon the *Eucalyptus tereticornis*, *E. camaldulensis*, *Acacia nilotica* and *Tectona grandis* trial plots at Forest Campus, Coimbatore and at *E. tereticornis* and *E. camaldulensis* trial established at various locations were surveyed for the effect of the treatments on the flower and seed production.

Project 10: Afforestation and productivity studies in the problem soils of Tamil Nadu. (IFGTB/SIL/RP 16/47/ICFRE)

Objectives : (a) To study the factors responsible for the degradation of soils in the problem soils. (b) To identify suitable remedial measures. (c) To ameliorate the problem soils apart from selecting suitable tree species.

Achievements : *Eucalyptus tereticornis*, *Acacia auriculiformis*, *A. holosericea* and *Casuarina equisetifolia* seedlings raised in the quartz sand as potting media in root trainers were planted in the quartz sand dumps with the respective biofertilizer treatments applied to the pits as amendments. Periodical data on the growth performance of the seedlings after outplanting were carried out and the initial results indicate that the combined inoculation of biofertilizer has resulted in better growth. This is followed by individual biofertilizer application.

Project 11: Standardization of germination methods in *Tectona grandis* and evaluation of vigour for seeds of different sources. (IFGTB/ST/RP 20/47/ICFRE)

Objectives : (a) To work out pretreatment requirement to get maximum germination. (b) To study the factors associated with seed germination. (c) To study source to source variation in germination capacity. (d) To study the dormancy mechanism operating in seeds.

Achievements: Teak drupes were collected from 30 different seed sources of various States, and were studied for their physical characters. Variation with respect to the germination percentage was also studied in relation to the above seed and fruit characters. Seed dormancy studies in Teak drupes were initiated.

Project 12: Standardization of seed handling procedures for commercially important forest medicinal plants. (IFGTB/ST/RP 21/47/ICFRE)

Objectives : (a) To identify most important commercially exploited species. (b) To study the phenology of fruiting and maturation of fruit / seeds. (c) To study the extraction procedure and pre-treatment requirement for germination. (d) To standardize the optimum storage condition.

Achievements:

***Feronium elephantum*:** Wet extraction method was found to be good. The germination percentage was improved up to 90%. The desiccation tolerances of the seeds as well as the tolerance to low temperature storage were found to be high. Methods to improve the germination percentage for *Aegle marmelos* were standardized. Different pretreatments were imposed on the seeds of *Emblica officinalis* to increase the germination percentage. The initial germination was found to be high for *Syzygium cumini* and the ambient stored seeds were viable for less than a month period only.

Project 13: Standardization of seed handling techniques for tropical recalcitrant seeds. (IFGTB/ST/RP 22/47/ICFRE)

Objectives : (a) To estimate the effect of initial condition of seeds (like seed maturity, mechanical damage and moisture content) on longevity of seeds. (b) To determine the bio-chemical changes associated with longevity of seeds. (c) To find out the effect of different atmospheric gaseous components in the storage container on the longevity of seeds. (d) To estimate the effect of seed moisture content on longevity of seeds. (e) To determine the influence of temperature on seed longevity (f) To find out the longevity of seeds in different storage methods and containers.

Achievements : The seeds of *Hopea* and *Vateria* were found to be recalcitrant in nature, while those of *Michelia champaca* were not found to be recalcitrant. The seeds were stored at different conditions to study their storage behaviour and standardize the optimum storage conditions.

Project 14: Development of Neem in various agro-ecological regions of India (Tamil Nadu, Andhra Pradesh and Karnataka). (IFGTB/ST/RP 23/47/2000/NOVOD)

Objectives : (a) To assess the seed sources of southern States of India. (b) To select the trees with higher fruit yield. (c) To develop suitable vegetative propagation method for clonal planting and establishment of clonal seed orchard. (d) To study on phenology of flowering and fruiting. (e) To study on medium and long term storage of neem seeds. (f) To evaluate of chemical composition of Neem seeds in different sources. (h) To develop technology package for cultivation of Neem. (i) To develop model village for transfer of technology on Neem cultivation.

Achievements: Seeds were collected from 146 Candidate Plus Trees from 10 provenances of various States. Data on growth parameters, tree architecture, health of CPTs and locality particulars were recorded. The seeds were also studied for their germination behaviour. The images of the fruits and seeds collected were captured in Image Analyzer and database of the CPTs with images of the tree, fruits and seed are being made. The seeds after extraction were sent to the various collaborating Institutes for further studies and trial.



A branch of neem CPT selected based on high fruit yield

Project 15: Nutrient cycling in Teak plantations of Tamil Nadu (World Bank Aided Project). (IFGTB/FPAF/RP 26/47/FREEP)

Objectives : (a) To estimate the biomass and productivity of Teak plantations in Tamil Nadu. (b) To develop regression equation to predict dry matter production on a regional basis. (c) To estimate the nutrient content in the standing crop of Teak plantation. (d) To quantify nutrients return through litter and rain wash. (e) To study nutrient uptake and nutrient cycling in Teak plantations. (f) To study nutrient cycling in young Teak plantations.

Achievements : Teak plantation details and samples from different age group stands in Tamil Nadu were collected. Soil samples were analysed for physico-chemical characteristics. Litter production and nutrients return study revealed 72% to 82% decreases of P_2O_5 and K_2O in old plantation from the young plantation.

Project 16: Productivity and Nutrient Dynamics in Agroforestry System. (IFGTB/FPAF/RP 27/47/ICFRE)

Objectives : (a) To study the dry matter production (including economic production) of Teak and Casuarina in Agroforestry System. (b) To work out the economics of Teak and Casuarina cultivation in agroforestry. (c) To study the effect of Teak and Casuarina cultivation on agricultural soils. (d) To study the nutrient dynamics in tree and agricultural crop.

Achievements : Growth measurements of trees (Teak and Casuarina) and yield of agricultural crops (cotton and gingilly) in fields were recorded.

Project 17: Investigation on wood properties of Teak in relation to variation in site factors and growth parameters. (IFGTB/FPAF/RP 28/47/ICFRE)

Objectives : (a) To study the influence of site factors on wood properties of Teak. (b) To study the wood properties of Teak in relation to growth parameters.

Achievements: Growth data of Teak plantations and soil samples collected from different regions were analysed for physico-chemical properties. Wood samples were collected from different plantations. Heartwood / sapwood ratio was worked out for sample trees.

Project 18: Management of *Casuarina equisetifolia* in agroforestry for sustainable economic returns. (IFGTB/FPAF/RP 29/47/ICFRE)

Objectives : (a) To manage the tree crown to optimize the productivity of trees and agricultural crops. (b) To manage root distribution of Casuarina in relation to productivity of trees and crops. (c) To study the effect of Casuarina on the growth and yield of agricultural crop in agroforestry. (d) To find suitable density, espacement, pruning schedule for maximising economic returns.

Achievements : Seedlings of Casuarina were planted, soil sampling was carried out. The treatments of root pruning and canopy management were imposed.

Project 19: Selection of pest resistant trees from wild population, provenances and exotic trials and Progeny tests. (IFGTB/FPAF/RP 31/47/ICFRE)

Objectives : (a) To survey and detect resistant individuals or races in conditions of pest attack, especially epidemic infestation. (b) To determine basic factors conditioning resistance and identifying inheritable resistance traits. (c) Preliminary selection of resistant Provenances / Progenies / candidates or individuals.

Achievements: Among the twenty seed sources available in one of these International Provenance trials of *Casuarina equisetifolia* 'Bako Borneo' from Sarawak and 'Pantai Moyog' from Sabah were found to have highest levels of susceptibility. The seed source 'Kilifi' from Kenya continued to remain unattacked by the pest. Increase of 'Fujian' Australia and in 'local' seed sources the pest incidence was generally low. Seed source like 'Danger Point' and 'Seventeen Seventy' showed very low levels of susceptibility.

Project 20: Selection of pest and disease resistant phenotypes of Teak, Eucalyptus and Casuarina (FREEP Sub-project). (IFGTB/FP/RP 32/47/FREEP)

Objectives : (a) Screening and identification of resistant clones / progenies / provenances of the targeted tree species to the key pests / diseases. (b) Distinguishing the pseudo and true resistance through analysis

of insect / disease plant interactions (physical and chemical) and environmental factors. (c) Preliminary selection of resistant candidates for tree improvement programme.

Achievements :

Pest Resistance: Studies on Teak pest incidence continued in the Germplasm Bank having 127 clones, the attack of the defoliator, *Hyblaea Puera* was comparatively low during the current year, while that of the skeletoniser, *Eutectona machaeralis* was moderate. Individual phenolic profiles of clones showed that vanillic and salicylic acids are the main fractions in almost all the clones studied except APNPL-6, which exhibited the presence of only orchinol. Interestingly, the clones APKKP-1 & APNPL-6 which are with higher phenols and additional flavonoids categorised under least attacked / unattacked by *H. puera*.

Casuarina : The intensity of attack of the bark caterpillar, *I. quadrinotata* was low in the International provenance Trial having 35 seed sources. The seed source from QL, Australia and Kenya continued to remain unattacked, while that from N.T. Australia showed consistency in having low level of infestation. Certain provenances from China and Tamil Nadu exhibited highest level of susceptibility to the attack of the caterpillar.



Borer grub of *Albizia procera* in-situ

Project 21: Development of package of practices for management of nursery pests / diseases. (IFGTB/FP/RP 33/47/ICFRE)

Objectives : (a) To survey and enumerate pest / disease problems in the selected nurseries. (b) To study the nature and extent of damage. (c) To identify the major pest / disease problems. (d) To study the periodicity of occurrence and factors pre-disposing the plants to pest / disease attack. (e) To develop and standardize pest management practices.

Achievements : Information on the damage, population level of the causality organisms and the biotic and abiotic factors prevailing were collected from the nurseries. Extracts of plants, botanical insecticides and chemical insecticides / fungicides available in the market were also evaluated and effective doses determined.

Project 22: Identification, isolation, evaluation and mass production of native fungi for the management of Teak and Casuarina stem borers. (IFGTB/FP/RP 34/47/ICFRE)

Objectives : (a) To identify, document and test the native fungi (entomopathogenic) including commercially available and thereby to select potential ones for management of the borers. (b) Developing mass production of the most promising field collected fungi (c) Testing of field efficacy and devising a sustainable method of management of the borers.

Achievements : A preliminary attempt with crude extract of the fungus isolated from *I. quadrinotata* to test the pathogenicity against the Teak stem and root borer *Sahyadrassus malabaricus*, results obtained were promising.

Project 23: Testing of promising plant derived chemicals against key pests (Component: Bio-active compounds from *Acacia nilotica* (Babul) against the major defoliators of Forestry tree species). (IFGTB/FP/RP 35/47/ICFRE)

Objectives : (a) To extract different tissues of *A. nilotica* to find out the efficacy of various crude extracts against the major defoliators of Forestry Tree Species. (b) To study the efficacy of extracts on other important Forestry pests. (c) Purification and characterization of insecticidal compounds. (d) Bioassay on target insects, nematodes and micro-organisms to be conducted with extracts and purified compounds.

Achievements : Efficacy of the Crude extracts of different tissues of *A. nilotica* in water and organic solvents like Methanol, Ethyl Acetate and Hexane was tested against different stages of the insect pests like *Tephрина pulinda*, *Ascotis* sp., *Epicrocis lateritalis*, *Hyblaea puera* and *Eutectona machaeralis*. The leaf extract was found to have ovicidal, larvicidal and anti-feedant properties, and also toxic to Teak defoliators. Methanol and Hexane extracts obtained from the flowers of *A. nilotica* were also found to be highly toxic against Teak defoliators.



Testing of promising plant derived chemicals against key Pests

Projects 24: Testing and evaluation of selected existing control methods for key diseases of *Casuarina* spp. with reference to blister bark and root rot. (IFGTB/FP/RP 36/47/ICFRE)

Objectives : (a) To study the effect of different fungicides / biocontrol agents *Trichoderma* spp. against key diseases of *Casuarina* spp. in field trials at different agro ecological zones. (b) To test and evaluate the efficacy of different biofertilizers including mycorrhizal fungi against key diseases of *Casuarina* spp. in field trials at different agro-ecological zones. (c) To investigate and assess the incidence of the diseases in the trials at periodical intervals. (d) To develop suitable methods of management of the targeted disease problems.

Achievements : Site for conducting experiments was identified, various biofertilizer inocula were collected and multiplied. An experimental design was chalked out.

Project 25: Studies on mycorrhizal fungi (biofertilizers) and their application in nursery and field. (IFGTB/FP/RP 37/47/ICFRE)

Objectives : (a) To investigate the type of mycorrhizal associations / colonization in different economically important tree species in Tamil Nadu and Kerala. (b) To characterize and identification of different mycorrhizal fungi. (c) To determine the factors influencing the distribution of different mycorrhizal fungi. (d) To test and evaluate the efficacy of different strains / isolates of biofertilizers for economically important tree species in nursery and field.

Achievements : Rhizosphere soil and root samples were collected from trees of *Casuarina equisetifolia* and tested. The root samples were found to be colonised by both ectomycorrhizal and VAM fungi. Out of three species of VAM fungi isolated, **Glomus** was found to be dominant.

Basidiomata of the ectomycorrhizal fungus, *Pisolithus tinctorius* collected from Eucalyptus plantations, were inoculated with biofertilizers and planted in the mine spoils, recorded better growth than uninoculated.

Project 26: Conservation* of some endangered and endemic plants of Tamil Nadu, Kerala and Andamans (* including cryo-preservation ** including medicinal plants). (IFGTB/BIO/RP 38/47/ICFRE)**

Objectives : (a) To prepare an enumerative list of red listed plants of Western Ghats of Tamil Nadu, Kerala and Andamans. (b) To survey and record the morphological characters of various populations of some Rare, Endangered and Threatened (RET) plants in the wild. (c) To conduct phenological and ecological studies on them. (d) To collect medicinal plants for germplasm collection and studies in *ex situ* condition. (e) To evolve *in situ* and *ex situ* conservation programmes for selected endangered plant species.

Achievements: An informative list of 130 rare, endangered endemic plants of Tamil Nadu and Kerala has been prepared. Field studies were initiated on 3 endangered and endemic tree species of *Vernonia shevaroyensis*, *Vateria macrocarpa* and *Dipterocarpus bourdillonii*. The cuttings of *Vernonia shevaroyensis*, collected were vegetatively propagated. The new sprouts were used for rooting with IBA. Rooting occurred after 45 days of planting.

Studies on ecology and phenology for *Vateria macrocarpa* and *Dipterocarpus bourdillonii* were initiated and their samples were collected for herbarium accessions. About 35 species of medicinal plants were collected for germplasm establishment in the botanical garden of the Institute. Seed germination studies were conducted on *Andrographis paniculata* and *Withania somnifera*. The seeds of former gave 88% germination while those of latter were difficult to germinate in *ex-situ* condition.



Medicinal Plants Conservation Area (MPCA) of Kollu hills, Tamil Nadu

Project 27: Developing a suitable database on Biodiversity. (IFGTB/BIO/RP 39/47/ICFRE)

Objectives : (a) To collect all the available published and unpublished information and data on biodiversity related studies of Tamil Nadu and Kerala. (b) To develop a user friendly information system for easy retrieval of biodiversity related information. (c) To mobilize and utilize the substantial amounts of data on biodiversity, with the research organizations and the forest departments, for planning and executing future studies.

Achievements: A detailed format consisting of various informations for 25 endangered plant taxa of Tamil Nadu and Kerala has been collected and recorded.

Project 28: Comparative growth studies of Teak (*Tectona grandis*) in farm lands and waste lands of different agro climatic zones of Tamil Nadu. (IFGTB/E&S/RP 41/47/ICFRE)

Objectives : (a) To study the growth pattern of Teak plantations under different agro climatic zones of Tamil Nadu. (b) To study the effect of spacing and cultural operations in total yield. (c) To study the irrigation effect on wood quality. (d) To study the climatic and edaphic factors in the study area to obtain optimum yield. (e) To study the impact of Teak farming on socio-economic status of rural community.

Achievements : Survey, soil and wood sample collection completed from all the zones. Wood samples were analysed for bark thickness, heart wood and sap wood ratio etc.

Project 29: Socio-economic studies of some important forestry medicinal plants in the tribal belt of Tamil Nadu. (IFGTB/E&S/RP 42/47/ICFRE)

Objectives: (a) To create data base for the medicinal plants in Tamil Nadu. (b) To study and record the important Forest medicinal plants in the selected area. (c) To create awareness among the tribal and local people on the importance of medicinal plants for cultivation by providing packages.

Achievements: Database completed for 250 commercially exploited medicinal plants. Cost benefit analysis of cultivation of medicinal plants worked out for *Gloriosa superba*. Networking established with N.G.O based at Salem for marketing *Gloriosa superba*, *Mappia foetida* and other farm grown medicinal plants for farming community.

NEW PROJECTS TAKEN UP DURING THE YEAR 2000-2001

Project 1: Standardization of containerized nursery practices for selected forest tree species. (IFGTB/SILVI/RP 17/47/ICFRE)

Objectives : To standardize the optimum potting media, container type and size, shade, water and fertilizer (including bio-fertilizer) requirements for selected forest tree species in root trainer under nursery conditions.

Progress made : Two separate trials were carried out. It was concluded that the potting media in the sand & mushroom bed compost in the ratio of 2:1 & 1:1 and Sand:Soil: FYM in the ratio of 1:2:1 can be utilized for raising quality seedlings of *Tamarindus indica* based on the availability of potting media components, locally. No significant effect was noticed due to the addition of biofertilizers (at all levels). The recommendation from this trial are that 25% shade nets and 300 cc individual cell / root trainers are best suited for raising *Tamarindus indica* in large numbers.

Project 2: Seed collection, germination, storage and propagation of rare and endemic medicinal plants of Silent Valley and Kolli Hills. (IFGTB/ST/RP 24/47/2000/FRLHT)

Objectives : (a) To study physical and physiological characters of seed and identification of seed problems. (b) To standardize seed testing methods for the rare and endemic medicinal plants. (c) To study the phenology of rare and endemic medicinal plants and develop suitable seed collection methods. (d) To develop seed processing and germination methods for rare and endemic medicinal plants. (e) To find out suitable seed storage techniques for rare and endemic medicinal plants. (f) To develop package of practices for large scale seed handling and seedling production.

Progress made : Collected rare and endangered plants and documented. Seed structure, initial germination and moisture content studies were initiated for *Canarium strictum*, *Myristica dactyloides*, *Persea macrantha* and *Aristolochia tagala*.

Maintenance of Seed Bank: Seeds of various important species viz. *Acacia nilotica*, *Aegle marmelos*, *Azadirachta indica*, *Casuarina equisetifolia*, *Dendrocalamus strictus*, *Emblica officinalis*, *Feronia elephantum*, *Gmelina arborea*, *Hardwickia binata* etc. collected from different localities were supplied to other divisions of the Institute, SFDs and NGOs on request. Seeds of different species of *Eucalyptus* received from Australian Tree Seed Centre, CSIRO Division of Forestry, Canberra were supplied to different divisions of the Institute and other outside agencies for laying out trials. International Provenance trial of *Azadirachta indica* is being maintained and the growth data are being recorded. The number of provenances included in the trial are 18, representing 8 countries.

Project 3: Studies on productivity of *Acacia mangium* plantations in Kerala and Tamil Nadu. (IFGTB/EPAF/3/3/61 (40))

Objectives : (a) To study the productivity of *A. mangium* under different planting systems (homesteads, block plantation etc.). (b) To study the productivity of *A. mangium* in different eco-climatic zones of Kerala. (c) To recommend management practices to increase the productivity in relation to eco-climatic variations. (d) To compare the productivity of *A. mangium* with other Multi Purpose Trees.

Progress made : Inventory of plantations is being prepared. Strategies to study the productivity of plantations / homesteads / small blocks in farm fields / farm forestry etc. are being worked out.

Project 4: Field research activities in Silent Valley and Kolli hills - Medicinal Plants Conservation Areas (MPCA) of Kerala and Tamil Nadu. (This project is funded by FRLHT, Bangalore). (IFGTB/BIO/RP 40/47/FRLHT)

Objectives : (a) Spatial distribution and mapping of red listed species distribution. (b) Population dynamics (density, girth class distribution, etc.) studies. (c) Identifying the threats to species survival (Extrinsic factors, over - exploitation, fire, grazing, etc.). (d) Standardising the seed collection methods of seeds of various tree species. (e) Intensive study of phenological characters for standardising seed collection. (f) Studies on the factors affecting the longevity of seeds. (g) Developing techniques for testing the viability of seeds. (h) Studies on the germination capacity of different species and provenances. (i) Standardisation of storage techniques for different types of forest tree seeds. (j) Biochemical aspects of ageing in seeds. (k) Studies on reproductive biology. (l) Studies on conservation genetics of the identified species of medicinal plants.

Progress made: Information collected for the 16 Red listed species by FRLHT. Reconnaissance survey was carried out in Kolli hills and Silent Valley. One permanent sample plot each was laid in Silent Valley and Kolli Hills, for studying the association, phenological and ecological aspects of the recommended species of medicinal plants

Project 5: Planting Stock Improvement Programme. (IFGTB/PSIP/RP 47/47/FREEP)

Objectives : (a) To establish Seed Production Areas, Clonal Seed Orchards and Seedling Seed Orchards as a source of quality seed production. (b) To establish Vegetative Multiplication Garden of *Casuarina*

equisetifolia, *Eucalyptus* sp., and *Tectona grandis* totaling 13 ha using clonal assemblages by way of selection of CPT's. (c) To establish Model nursery facility with a production capacity of 5 lakh plantlets including vegetative propagules - with vegetative propagation structures.

Progress made:

Seed Production Areas : Out of the target 250 ha assigned, identified about 219 ha in Tamil Nadu and Kerala states and 30 ha in Andaman and Nicobar Islands. Culling operation has been completed in 88.3 ha.

Culling operation completed in 5 ha *Eucalyptus grandis* seed stands at Gundalai-Munnar Division and 2.3 ha *Acacia auriculiformis* seed stand in Kerala. In Tamil Nadu 6 ha seed stand of *Acacia ferruginea* were converted into Seed Production Area in Salem MFP Division. An MoU was signed for establishment of 30 ha SPA in Andaman and Nicobar Islands. Training on **Establishment and Management of Seed Production Areas** was given to the officials of Tamil Nadu, Kerala and Andaman Forest Departments.

Seedling Seed Orchards : The Seedling Seed Orchards established in Tamil Nadu Forest Plantation Corporation, Tamil Nadu Forest Department and Kerala Forest Department. Lands were handed over to the respective organizations for maintenance and seed collection.

Clonal Seed Orchards: The Clonal Seed Orchards established in Tamil Nadu Forest Plantation Corporation, Tamil Nadu Forest Department and Kerala Forest Department land were handed over to the respective organizations for maintenance and seed collection.

Vegetative Multiplication Garden: 351 clones of *Eucalyptus* sp., 216 clones of *C. equisetifolia* and 149 Clones of *Tectona grandis* have been collected and assembled at various places in Kerala and Tamil Nadu. Those clones have been tested for their genotypic stability for the purpose of mass multiplication and deployment in the operation planting programmes. All the VMG plots were handed over to the respective State Forest Department for managing and exploiting them for meeting their vegetative propagule requirements. A management plan was prepared and handed over to SFDs, and Research Staff of TNFD and KFD have been trained to utilize the VMG facility created by IFGTB under this Project.



View of Eucalyptus ramets rooted in the Model Nursery

Model Nursery: A model nursery has been established over an area of 0.6 ha. with a production capacity of 5 lakh plantlets including Vegetative Propagules. Seedling production facilities have been established, and 95,545 seedlings were produced out of which 20,165 seedlings have been distributed to the PSIP and other Projects funded by the UNDP, NABARD etc. A green house of 300 m² area, shade house of 300 m² area and a mist chamber of 100 m² area have been constructed for vegetative propagation and subsequent hardening and these structures were made operational. Vegetative Propagules were produced and supplied for the establishment of Clonal Seed Orchards and Vegetative Multiplication Garden. 11744 ramets of Casuarina and Eucalyptus were rooted using the Vegetative Propagules collected from the clone banks and from the newly identified best performers from the PSIP. Trial plots were established under the FREEP. The rooted ramets were supplied for establishing clonal trials at various states. A composting yard has been established to produce compost for using as a potting media component. Root trainer of different capacities and types along with their stands have been procured.

Seed Harvesting, Handling, Testing and Storage:

Seed Germinator and Table-top- laboratory Oven were installed. Seeds collected from Clonal Seed Orchards, seeds of *Acacia nilotica*, *Aegle marmelos*, *Azadirachta indica*, *Dendrocalamus strictus*, *Embllica officinalis*, *Feronia elephantum*, *Gmelina arborea* and *Hardwickia binata* were collected from different localities. The seeds after assessing for the germination percentage and moisture content, were stored in Seed Bank and supplied to different divisions of the Institute and other user agencies on request.



Seed handling and testing in the laboratory



Paradise Tree *Simaruba glauca*

EXTENSION

Facilities generated and services rendered

i) Consultancy to various agencies

- Plants and plant products slated for export were examined and **258** phytosanitary certificates were issued to various organisations and individuals. The total revenue earned out of this is **Rs. 26,000.00.**
- Guest lectures on insect bio-diversity in Tropical Forests was delivered to the serving Forest Officers of DCF / ACF Rank.
- The pests and disease problems referred by the State Forest Departments, farmers and NGO's were investigated and suitable management practices advocated thereof.
- A consultancy on development, training and establishment of root trainer and clonal nursery was given to Kerala Forest Development Corporation.
- Consultancy services on pests and diseases related problems of forestry and their management were rendered to Kerala Forest Development Corporation and Shanthi Ashram, Coimbatore.
- Consultancy service was rendered to Shanthi Ashram, NGO on participatory agro-forestry for poverty alleviation.
- Gass Forest Museum: Magnificent collections of rare, exotic and educative exhibits related to Forestry and Natural History housed in the museum were maintained and awareness were created among the public and students on the importance of the nature's conservation. Thousands of people including many high dignitaries from India and abroad visited the museum during the year.

ii) Library and documentation - computer facilities

- An access to the library facilities were provided which gave wide range of information and documentation resources to the State Forest Departments, Research Institutes, Universities and Colleges. The total books available in the Library are 7170 and 40 foreign and Indian Journals were subscribed.
- Reference and Bibliographic; Circulation, Current awareness – New additions to the library – Paper clippings, display of the new arrivals; Literature Search / document supply service; CD-ROM facilities (CABI: TREECD and PEST CD) and Internet and E-mail service.
- Revenue earned through documentation and sale of publication is **Rs. 18,250.00.**

Computer facilities: 64 kbps Internet leased connection established through DOT / VSNL from March 2000. Domain name **ifgtb.res.in** is registered. Website created at our server : www.ifgtb.res.in Temporary Internet connections were given to different research units. Other services rendered by the Computer Centre are to develop and maintain data base on Tree Improvement of mandatory species and Modelling the growth of Eucalyptus in Tamil Nadu. Installation of software packages and attending problems to specific packages and computers. Statistical consultancy / statistical analysis of the data received from the researchers of the Institute. Downloading and browsing of forestry related information and other Internet related activities.

- ✓ **Other Extension Activities are reported in the Introduction - Forestry Extension, ICFRE.**

FINANCIAL STATEMENT DURING 2000-2001

I. PLAN		EXPENDITURE (RS. IN LAKH)
A.	REVENUE EXPENDITURE	
	(a) Research	117.94
	(b) Administrative Support	71.81
	(c) Others specify	32.04
B.	LOAN AND ADVANCES	
	(a) Loan Advances (Conveyance)	1.00
	(b) House Building Advance	2.00
C.	CAPITAL EXPENDITURE	
	(a) Building & Roads	- -
	(b) Equipments, Library Books	- -
	(c) Vehicles	- -
	(d) Others specify	- -
TOTAL FOR PLAN (A+B+C)		224.79
II. NON-PLAN		
A.	REVENUE EXPENDITURE	
	(a) Research	24.67
	(b) Administrative Support (Salary)	51.30
TOTAL FOR NON-PLAN		75.97
III. FUNDED PROJECT		
A.	World Bank Project	127.35
	UNDP Project	1.01
	NABARD Project	1.95
	FORTIP	4.07
	FDCM	2.13
	FRICONSULTANCY	0.65
	KFDC	1.26
	NOVOD	10.73
	BIO-TECH	13.59
	APFDC	17.34
	SHANTI ASHRAM	11.38
	FRLHT	1.34
	CSIRO	0.54
	ISFCOURSE	0.53
TOTAL FOR FUNDED PROJECT		193.87