

**FOREST RESEARCH INSTITUTE  
DEHRA DUN**

Forest Research Institute (FRI), Dehra Dun has its root in the erstwhile Imperial Forest Research Institute established in 1906 to organise and lead forestry research activities in the country. The Institute caters in particular, to the research needs of the Indo - Gangetic plains of Punjab, Haryana, Chandigarh and Uttar Pradesh as well as the new State of Uttaranchal. This Institute is also a Deemed University and presently offers Post - Graduate courses in Forestry Economics and Management, Wood Science and Technology and Environmental Management, Post - Graduate Diploma courses in Plantation Technology, Pulp and Paper Technology, Biodiversity Conservation, and Doctoral programmes on various forestry aspects.

**PROJECTS COMPLETED DURING 2000-2001****Project 1: Anatomical variation vis-à-vis wood quality in different clones of *Populus deltoides*. [FRI-97/BOT-12]**

**Objectives:** (a) To study the variation in anatomical parameters and specific gravity in different clones of *P. deltoides* grown in plantations with a view to select superior / better clones for different end uses. (b) To develop a quick evaluation method for prediction of whole tree fibre length and specific gravity.

**Results:** Significant interclonal variations conducted in 10-year-old trees of 18 clones of *Populus deltoides* suggests that the potential to select individual clone with superior raw material quality for intended use e.g. solid wood, paper and pulp etc. Best clones in terms of wood quality, growth rate may be projected for large scale plantation for various end uses.

**Project 2: Effluent treatment in Pulp and Paper Industry - Production of nitrogen fertilizer / soil conditioner. [FRI-94/C&P-13]**

**Objectives:** (a) Recovery of commercial lignin from black liquors, purification and characterization. (b) Optimization of reaction conditions for Oxidative ammonolysis of lignin to incorporate highest possible amount of nitrogen in lignin.

**Results:** Modified soda lignin and lignosulphonate obtained upon ammonolyses were tested for their efficacy as fertiliser and soil conditioner. It has been observed that N-modified lignin has marked advantage over unmodified lignin, control and urea in the growth of plants.

**Project 3: Ecological monitoring of biodiversity and the strategy for conservation thereof in U.P. [FRI-83/Eco-2]**

**Objectives:** (a) To determine the ecological succession and future of ecosystem. (b) Conservation strategy (*in-situ*) of rare and threatened species. (c) To determine the population structure and community organization based on resource availability. (d) Plant trait and their strategy with relation to altitudinal variation. (e) To determine the seed bank reserve as per the gradient.

**Results:** The result of high diversity index of Golatappar slope is an indicator of more stable system compared to that of Thanu, which appears to be highly disturbed. In the study in Sal forest, the larger gap showed low diversity index and created homogeneous condition which is found favourable for tree species.

**Project 4: Phytochemical examination for the utilisation of leaves, barks, fruits and root of Indian forest trees. [FRI-53/Chem-3(i)]**

**Sub-Project: Studies on vegetable dyes from *Pinus roxburghii*, *Populus deltoides*, *Shorea robusta*, Lantana and Teak.**

**Objectives:** To develop natural dyes from hitherto unexplored abundantly available plants to protect the environmental pollution.

**Results:** Methods were standardized to isolate dye from *Populus deltoides*, *Pinus roxburghii* and other species. Optimum dyeing conditions using these dyes and mordants were determined. Fascinating shades with good fastness properties were developed on silk, wool and cotton using *Populus deltoides*, *Pinus roxburghii* and other dyes. Practical demonstration of dyeing with natural dyes was demonstrated during Virasat Mela on World Environment Day and on Technology Day. Dye extracted plant material could be converted to compost.

**Project 5: Studies on nursery diseases of *Dalbergia sissoo*. [FRI-139/Path-9]**

**Objectives:** To study diseases in nurseries and prepare a disease calendar.

**Results:** Periodic monitoring of diseases in nurseries and plantation were done. In New Forest nursery out of 56 clones of Sissoo, 3 clones were found to be free from rust infection. Out of 29 clones at Lacchiwala, 7 clones exhibited disease index below 5%. At Ponta Sahib (Himachal Pradesh), assessment of 16 clones showed very rare occurrence of the rust. Disease incidence of Colletotrichum leaf blight in and around Dehra Dun and in Haryana was recorded. An experiment conducted at Lacchiwala to manage the rust disease, a significant Bayleton was found effective in controlling the disease followed by Dithane M - 45 and Bavistin.

**Project 6: Bio-geochemistry of forest ecosystems of Chakrata and Mussoorie Forest Divisions. [FRI-72/ FSLR-5]**

**Objectives:** (a) To determine the effect of geomorphology and topographic positions on the properties and nutrient status of soils and the variations in the forest composition and the distribution of flora and ecological species groups. (b) To study the interrelationship between soil, geomorphology and vegetation will be worked out and utility maps will be prepared.

**Results:** Studies carried out in Rajpur and Clordend blocks of Mussoorie forest division. The surface horizons of all the soils are rich in organic matter. Further, it has been seen that there is definite relationship between soil, floristic composition and parent material.

**Project 7: Studies on cultivation and optimum time of harvesting of tropical and subtropical medicinal plants of high market value. [FRI-28/NWFP-1]**

**Objectives:** To develop the suitable package for large-scale cultivation of medicinal plants.

**Results:** Cultivation package for *Spilanthes oleracea* was optimized. The plants were propagated successfully through seed germination. Maximum yield was achieved under a growing medium consisting of soil + FYM soil treatment in ratio of 1:1. The per hectare yield was 3.56 quintals.

**Project 8: Preparation of Volume and Yield Table of promising (D-121 and G-48) clones of *Populus deltoides* in North India [FRI-33/RSM-3].**

**Objectives:** Preparation of Volume and Yield Table of D-121 and G-48 clones of *Populus deltoides*.

**Results:** The volume table of two clones of Poplar was published in Indian Forester.

**Project 9: Marketing mechanism for Farm Forestry Trees – A case of important North Indian markets. [FRI-37/RSM -7]**

**Objectives:** (a) To study the combinations of forestry tree species (along with agricultural crops) in the farming systems. (b) To examine existing market structure (network) and price – spread for selected forest trees in sample markets. (c) To document and analyse farmer's perceptions about the role of existing harvesting laws for farm forestry trees. (d) To explore possibilities for effecting efficiency in the present forest tree marketing systems.

**Results:** Most of the project work related to collection of socio-economic and marketing data from field completed. Data related to tree growers' perception regarding the prevalent farm forestry tree harvest is being collected. Analysis of the data is in progress.

**Project 10: Poplar Improvement in India. [FRI-2/Silva-2]**

**Objectives:** (a) Multiplication and colonel testing of selected Poplar clones, genotypes x site interaction studies. (b) To investigate the genetic variability and diversity with the help of molecular method. (c) Nursery screening and field-testing of U.S.A. germplasm for releasing F.R.I. series Poplar clones. (d) Control and open pollinated progeny testing for evolving site specific clones. (e) Establishment and enrichment of national germplasm bank, breeding orchard, breeding nursery and gene bank of Poplar and finger printing of Poplar clones.

**Results:** Annual data were recorded and evaluated pertaining to plantations in Sultanpur and Rai Bareilly districts. 50 promising clones were planted at two sites in three replications. Third Phase of 20 promising clones with 5 best check were planted in the field by different coordinating centres as per prescribed schedule. Annual data were recorded for U.S.A. Germplasm, best 100 individuals were selected, multiplied and planted in three replication along with 10 best check for the releasing of the new clones of FRI series. Best 5 individuals were selected from each of 10 combinations and 20 open pollinated progeny of 1999, multiplied and planted in R.B.D. design. Rest of seedlings of progeny trial of hybrid and open pollinated were planted in the field at Amroha, Bijnor and Unnao in R.B.D. design in three replications. Two year old breeding orchard having 40 promising male and female clones have been established.

**Project 11: Resin tapping by “Borehole” method in *Pinus roxburghii*. [FRI-127/Silva-10]**

**Objectives:** (a) To study the effect of Borehole method technique on physiological behaviors and growth of the trees. (b) To see the feasibility of conservation and management of Pine resources in India by this method. (c) To analyze labour productivity.

**Results:** The new technique of “Borehole” tapping will minimize the damage of Pine resources of India and will produce pure resin in less labour.

**Project 12: Transplantation of tall plants. [FRI-128/Silva-11]**

**Objectives:** (a) To standardize nursery practice of raising tall plants of various species suitable for avenue planting and landscaping. (b) To compare the economics and performance of different types and sizes of bags required for raising tall plants. (c) To develop technique and equipments for digging out, loading, unloading and transportation of semi-mature plants.

**Results:** The objective of raising plants in nursery was completed. Growth data of seedlings of various species recorded and compared.

**Project 13: Studies on reducing drying time in solar kiln. [FRI-40/FPD (WS)-3]**

**Objectives:** To explore the possibilities of reducing the drying time in solar kiln using dehumidifier.

**Results:** Nearly 15 percent saving in the drying time achieved by using dehumidifier as an extra unit in solar kiln.

**Project 14: Studies on wood working, carving and wood finishing on plantation timbers and developmental work on utility processes and performance. [FRI-46/FPD(WWF)-9]**

**Objectives:** (a) To evaluate wood working, carving and finishing properties on Indian timbers. (b) To carry out developmental work on wood finishing aspects including surface improvement of juvenile timbers. (c) To develop utility package for technology transfers to the forest based industries.

**Results:** The working quality indices for few forestry species were evaluated to make meaningful comparisons and groupings for end uses in the furniture and joinery sector. Data on about 85 species have been generated.

**Project 15: Development of laminated wood from Eucalyptus and Poplar for joinery and furniture item. [FRI-109/FPD(WWF)-22]**

**Objectives:** To develop laminated wood from Eucalyptus and Poplar for joinery and furniture items.

**Results:** The laminated wood concept developed from plantation species have shown that these woods, small girth logs could well be used against solid counter parts and even has an edge due to freedom of arrangements and associated ease in processing. Marked anisotropy reductions have also been noticed in the laminated wood forms including stress balance and other parameters vis a vis solid wood forms.

**Project 16: Chemical plasticization and densification of Poplar wood for making suitable bent wood component for furniture and joinery. [FRI-120/FPD (WS)-27]**

**Objectives:** To produce compressed wood from Poplar after vapour phase ammonia treatment and testing its properties for arched doors, window frames and oval table tops etc.

**Results:** A new design of bentwood chair using vapour phase ammonia plasticization technique was made and demonstrated to various entrepreneurs dealing with furniture industry.

**Project 17: Developing computerized control kiln drying system. [FRI-121/FPD(WS)-28]**

**Objectives:** (a) To systemise the existing Indian standards kiln drying schedules and develop computerized programme. (b) To develop system for computerized application of kiln drying schedules and control of kiln drying conditions.

**Results:** Based on the diffusion theory of drying systematization of Indian Standards kiln-drying schedules were completed and developed a computer software to evolve kiln-drying schedules for new species. Specification for the procurement of automatic kiln control components was prepared in consultation with Director, USIC, Roorkee University.

**Project 18: Evaluation of physical and mechanical properties of *Populus deltoides*, *Ailanthus excelsa*, *Salix alba* and *Paulownia fortunei* and classification and grading of timber for different end uses. [FRI-134/FPD(TM)-30]**

**Objectives:** To test and evaluate physical and mechanical properties of *Populus deltoides*, *Ailanthus excelsa*, *Salix alba* and *Paulownia fortunei* for different end uses.

**Results:** The strength data indicates that *Salix alba* (Nainital, U.P.) except in one property i.e. toughness, meets the weight and strength requirements of willow clefts for cricket bats specified in IS:4422. From the present studies it is suggested that it is suitable for cheaper varieties of sports goods, artificial limbs, handicrafts, toys etc. besides packing cases and crates. Physical mechanical properties of 18 clones of *Populus deltoides* were also evaluated to study the effect of different clone on strength properties of this species. Studies on the effect of age 2,3 and 4 years of *Paulownia fortunei* trees on specific gravity and strength properties have indicated that most of the strength properties increases with age. It is also observed that variation of strength properties along tree heights of *Paulownia fortunei* is not significant. Studies on comparison of *Paulownia fortunei* and *Populus deltoides* have indicated that species gravity and strength properties of *Paulownia fortunei* are lower than two years old *Populus deltoides*.

## EXTERNALLY AIDED PROJECTS

**Project 19: Reclamation and ecological monitoring of Iron ore mines in Saranda Bonai range. [FRI-23/FSLR-6; SAIL]**

**Objectives:** To develop appropriate ecorestoration technology for iron ore mines in Bihar & Orissa.

**Results:** The dumping of over burden, waste and iron ores fines have resulted in major degradation of land in the mining area at Bolani, a hilly terrain. It is therefore, recommended to take up ecosystem regeneration in these areas immediately, after preparing the surface according to appropriate soil and moisture conservation measure.

## OLD PROJECTS CONTINUED DURING 2000-2001

**Project 1: Computerisation of anatomical database of Indian hardwoods for the purpose of their identification. [FRI-17/BOT-7]**

**Objectives:** To develop a software for computer assisted wood identification and a CD having the wood anatomical details for all Indian hardwoods alongwith their microphotographs.

**Achievements:** Data collection and entry was carried out under different modules for Microphotographs of three sections viz. transverse, radial and tangential of 25 species were taken and stored. Data of 2000 wood samples present in F.R.I. Xylarium were entered.

**Project 2: Computerization of Herbarium of Forest Research Institute, Dehra Dun. [FRI-15/BOT-5]**

**Objectives:** (a) To computerize F.R.I. Herbarium through development of database on whole of the generic and species diversity and type specimens typical of Indian forest biodiversity as represented in the repository. (b) To develop a multimedia – oriented CD / CD-ROM covering taxonomic and phytogeographic entities on the species of economic importance.

**Achievements:** Studied and catalogued 100 type specimens for the purpose of computerization. 50 specimens of Bamboo housed in FRI herbarium were studied. Generic entity of 100 taxa was nomenclaturally studied for database incorporation.

**Project 3: Flora of stress sites of Sultanpur and Rai Bareilly. [FRI-98/Bot.-13]**

**Objectives:** To study the flora and ethnobotany of different regions of the area and select / recommend plants of economic / medicinal importance for planting in such areas.

**Achievements:** Survey of flora and ethnobotanical investigations have been carried out in the area and species have been screened for planting in such areas.

**Project 4: Selection, identification and evaluation of wild plant species for urban planting [FRI-99/ Bot-14].**

**Objectives:** (a) To survey, select and propagate the wild plant species of ornamental value for urban planting. (b) To conserve the species through *ex-situ* conservation measures.

**Achievements:** Enumerated 25 wild species with details. Germplasm materials of 5 species were collected for multiplication and is available for the end users. Packages developed for cultivable medicinal plants.

**Project 5: Survey, selection, *ex-situ* conservation and propagation of Himalayan Bamboo. [FRI-100/ Bot-15]**

**Objectives:** (a) Survey of Bamboo forests. (b) To analyze the threat index of various Bamboo species of higher altitude.

**Achievements:** Field studies on hill Bamboo growing in different parts of Garhwal Himalaya for the selection of best quality of arundinaria species were carried out. It is found that the best quality are distributed in Yamuna and Mussoorie areas.

**Project 6: Morphological studies on the infra-specific taxa of *Bambusa bambos* (Linn.) Voss and *Dendrocalamus strictus* (Roxb.). [FRI-114/BOT-17]**

**Objectives:** (a) To study infra-specific ranks under *Bambusa bambos* and *Dendrocalamus strictus* and prepare a taxonomic account for their identification. (b) To develop database for GIS integration on the taxa of phytogeographical conservation values.

**Achievements:** 100 specimens with vegetative features of taxonomic significance representing the specimens of *Bambusa bambos* and *Dendrocalamus strictus* representing Himachal Pradesh, Jammu and Kashmir, Uttaranchal, Uttar Pradesh and Madhya Pradesh were examined for studying the variability at intra specific level. Field observation on introduced and wild forms of the above mentioned species growing in New Forest and vicinity was made.

**Project 7: Environmental protection through modified pulping and bleaching processes - Alkaline peroxide pulping and bleaching of non-woods. [FRI- 87/C&P – 6]**

**Objectives:** To get better pulp with lesser pollution load.

**Achievements:** Oxygen delignification studies of wheat straw soda pulp (kappa no 28) were carried out and compared with conventional bleaching sequence (CEH) with respect to pulp yield, bleachability, strength properties and effluent characteristics. It was found that introduction of oxygen gave better results in all respects.

**Project 8: Studies on modification of industrial lignin for imparting delignifying properties. [FRI- 91/C&P – 10]**

**Objectives:** To identify economically viable chemical additive for accelerating delignification for higher pulp yield, and reducing chemical demand during bleaching.

**Achievements:** A new chemical additive has been identified. The results on Bamboo and Eucalyptus are encouraging with respect to increase in pulp yield, reduction in kappa number and improvement in strength properties. The resulting pulps required less bleaching chemicals to achieve same level of brightness, thus reducing pollution load and help to conserve the resources. A patent is being filed.

**Project 9: Improved utilisation of raw materials for pulp and papermaking including juvenile tree utilisation [FRI-129/C&P – 14].**

**Objectives:** To explore and identify new raw materials for the manufacture of various grades of paper particularly from plantation grown and juvenile wood.

**Achievements:** Kraft pulping of eighteen clones of *Populus deltoides* was carried out and their papermaking characteristics were evaluated. Elemental free chlorine free bleaching of six clones was carried out and the properties of bleached pulps as well as effluent characteristics were determined. Cold soda high yield pulps of nine clones were prepared. 40-45 % reduction in kappa number with 70-99% brightness gain was achieved by oxygen pretreatment.

**Project 10: Studies on isolation and characterization of polysaccharides of abundantly available seeds, trees, shrubs, leaves, bark and exudate gums. [FRI-51/Chem-1(i)]**

**Objectives:** To study the structural investigation of *Cassia tora* Linn. seed polysaccharide.

**Achievements:** The moisture content and ash content of the isolated cold water soluble and hot water soluble polysaccharides have been determined. Presence of galactose and mannose was confirmed. Optical rotation of cold water soluble was also determined.

**Project 11: Studies on isolation and characterization of polysaccharides of abundantly available seeds, trees, shrubs, leaves, bark and exudates gums [FRI-51/Chem-1(v)].**

**Objectives:** To evolve chemical modification of polysaccharide for industrial applications.

**Achievements:** Carbamoylethylated derivatives of *Cassia tora* gum and guaran (pure polysaccharide isolated from guar gum) were prepared and their rheological studies were also carried out. Acrylamide grafted product of *Cassia tora* gum prepared and when dissolved in cold water formed a gel of commercial

importance at very low concentration (0.75%). Grafting of Methyl Meth Acrylate into Guar Gum has been carried out and different reaction parameters have also been optimized to get the desired products.

**Project 12: Studies on isolation and characterization of polysaccharides of abundantly available seeds, trees, shrubs, leaves, bark and exudate gums. [FRI-51/Chem-1(vi)]**

**Objectives:** To investigate *Kydia calycina* bark polysaccharide.

**Achievements:** Three oligos were isolated. Structure of oligo-1 has been established by spectral and chemical means. Remaining two oligos were hydrolysed, determined their optical rotation and melting point, and also prepared their alditol derivatives for Gas Liquid Chromatography analysis.

**Project 13: Development of adhesives from renewable sources. [FRI-52/Chem-2]**

**Objectives:** To develop adhesive from renewable sources.

**Achievements:** Analysis of the resins developed from tannins of *U. gambier* and *A. catechu* showed replacement of phenol upto 50% by both the tannins in Phenol Formaldehyde (PF) resin. However, *U. gambier* tannin gave better results than standard PF resin and *A. catechu* tannin both in Dry testing and Boiling Water Resistance grade. Methods were developed to modify Tamarind Kernel Powder (TKP) and *Cassia tora* gum to prepare products of commercial importance. Modified TKP and *Cassia tora* gum both and TKP alone have been found to be a substitute of sodium alginate and pectin, in textile printing and in confectionery, respectively. Modified TKP and CTG have also been tested in ONGC for oil well drilling applications and favourable results are obtained.

**Project 14: Phytochemical examination for the utilisation of leaves, barks, fruits and root of Indian forest trees. [FRI/53-Chem-3(iii)]**

**Objectives:** To isolate and characterize novel bioactive compounds from *Cephalotaxus harringtonii* needles.

**Achievements:** The structure of two compounds namely CH-B and CH-H isolated earlier from the acetone extract of the needles were elucidated as Heveaflavone and 1, 3-propanediol-2 (4-hydroxy-3-methoxyphenyl) on the basis of spectral data [UV, IR, NMR (<sup>1</sup>H, <sup>13</sup>C, 2D) and MS]. Isolation of pure alkaloids is in progress. Essential oil was also isolated from the needles and twigs for the first time.

**Project 15: Phytochemical examination for the utilisation of leaves, barks, fruits and root of Indian forest trees. [FRI/53-Chem-3(iv)]**

**Objectives:** To isolate and characterize the chemical compounds from *Vitex negundo* and screening their biopesticidal activity.

**Achievements:** Different extracts isolated from the leaves were screened for their anti-pest activity against store grain insects *Sitotroga cerealella*. Screening of essential oil for its pesticidal activity against *Sitotroga cerealella* in detail and analysis of the data was completed. The larva of *Clostera fulgurita* (Poplar leaves defoliator) collected from the field and cultured in laboratory conditions at Entomology Division is being tested for the above mentioned insecticidal activity. More amount of essential oil was isolated from the leaves by hydrodistillation method for the screening of its insecticidal activity against *Clostera fulgurita*. Different extracts (benzene, acetone and methanol) of the bark were prepared and their TLC pattern studied.



**Project 16: Studies on Tree – Bearing oilseeds. [FRI-54/Chem-4(ii)]**

**Objectives:** To find sources of oils and wetting agents from tree borne oilseeds.

**Achievements:** Physico-chemical constants and composition of the fatty oil isolated from *Garuga pinnata* seeds were determined. Essential oil of *Fraxinus micrantha* seeds was isolated by hydrodistillation and analysed by GC-MS, which showed the presence of 30 compounds of which 16 were identified. Physico-chemical constants of the oil were also determined. Results revealed that wetting agents prepared from *Holarrhena antidysentrica* were better than Turkey red oil (sulfated castor oil) while that of *Jatropha curcus*, *Prunus padus* and *Dillenia pentagyana* were comparable to sulfated castor oil.

**Project 17: Regeneration, mortality and species diversity in Sal forests of U.P. [FRI-22/Eco-1]**

**Objectives:** (a) To assess the cause of poor regeneration and mortality. (b) To develop the methods for restoring species diversity, regeneration and mortality of Sal forest. (c) To assess the carrying capacity and sustainable productivity of Sal. (d) To find out the impact of cultural operations on the growth and productivity of regenerating of Sal forest.

**Achievements:** It has been observed that *Syzygium cummini* is the best indicator of Sal regeneration. Similarly normal population curve was obtained in Lacchiwala slope with *Mallotus philippensis*, *Syzygium cummini* and *Ehertia laevis* as one of the most common associates of the Sal. Further the seedling and sapling population were maximum in between 9-17% moisture regime. With regard to mortality the photo imagery and satellite imagery from 1959 to 1999 has clearly shown that the corridor in Barkot Range has shrunk by 21%. Increase in temperature has ultimately affected the health of Sal since 1980 onward and exhibit the sign of mortality since 1990.

**Project 18: Impacts of pollutants on tree species in Doon valley. [FRI-116/Eco-3]**

**Objectives:** (a) To assess eco-physiological changes due to pollutants. (b) To see the efficacy of Sal forests in pollution abatement on highways.

**Achievements:** Concentration of atmospheric SO<sub>2</sub> and suspended particulate matter (SPM) was collected from State Pollution Control Board for roadside at one place only. Collection of surface soil samples from different gradients along the highway has been done. Analysis of these samples in the laboratory is being carried out. Periodical sampling of leaf samples for leaf area, chlorophyll a, b, leaf moisture, leaf pH etc. were done at the different gradients and along the high way on either side.

**Project 19: Role of forest in soil and water conservation. [FRI-117/Eco 4]**

**Objectives:** To study hydrology and nutrient dynamics in forest watershed of Shiwaliks.

**Achievements:** Hydrology and soil parameters were studied in Kulhal forest watersheds (Bhura Shah Rao) of Shiwaliks in Dehra Dun district of Uttaranchal. Forest watersheds had higher organic matter content, higher nutrient content (NPK) and moisture regime in comparison to tree less watershed. Surface runoff of water in forest watersheds was lesser than the treeless watersheds. Soil loss (t/ha/y) 7.3 in forest area and 19 in treeless watershed was observed. In wet periods treeless watersheds return 80 to 85% rainfall as stream flow, whereas forest watersheds return 15 to 20% of rainfall. Water loss is approximately proportional to the stream flow and varies from about 0.1 mm per day in the driest period to about 3.0 mm per day in wettest period.

**Project 20: Plant growth strategy characterization, diversity and vegetational dynamics of rehabilitated and derelict mined ecosystem in western Himalaya. [FRI-130/Eco-5]**

**Objectives:** (a) To provide inputs for eco-restoration of degraded habitats in the Himalayan region. (b) To assess the biological diversity in degraded habitats.

**Achievements:** Vegetation survey was carried out in different microhabitats identified under rehabilitated and derelict mined ecosystems. Soil samples were collected and analysed. Phenological observations of plant growing in different microhabitats were recorded. Microhabitats having low nutrient status were found to be colonized by woody species like *Wendlandia exserta*, *Buddleja asiatica* and *Rumex hastatus*.

**Project 21: Role of forest cover in landslides in the Himalaya. [FRI-131/Eco-6]**

**Objectives:** (a) To study the implications of forest cover and deforestation on landslides. (b) To study the surveillance of past landslides and analysis of possible causes.

**Achievements:** Higher incidence of landslides in the middle Himalaya were found to be associated with *Pinus roxburghii* dominated forests. Similarly in the upper Himalaya, the higher incidences were to be associated with *Alnus nepalensis* dominated forests.

**Project 22: Effect of Trees on Agricultural Crops. [FRI-8/SF-1]**

**Objectives:** (a) To study the effect of leaf litter of Eucalyptus, *Populus deltoides* and *Dalbergia sissoo* on germination and growth of agricultural crops. (b) To study growth and yield of different varieties of wheat in block plantations of Poplar. (c) To study performance of papaya and shade-bearing crops in block plantation of Poplar.

**Achievements:** Eucalyptus, Poplar and Sissoo were found to have no significant allelopathic effect on germination, growth and yield of wheat crop. Grain yield of six varieties of wheat, which are commonly grown by farmers was found to be in the same order in a 3 years old block plantation of Poplar as in the open field. This suggests that all these varieties are equally sensitive to shade of Poplar.

**Project 23: Paulownia propagation and introduction. [FRI-73/SF-2]**

**Objectives:** (a) To develop nursery and planting technology for *Paulownia* species. (b) To establish new clones of different species of Paulownia, their evaluation and multiplication. (c) To layout field trials to study the field performance of Paulownia clones.

**Achievements:** The best 50 clones of previous year's nursery trial were identified and planted in nursery for further multiplication. Introduction of trial have been laid out using stump planting now at Gurgaon, Kaithal (Haryana), Phillaur (Punjab), Khatauli, Saharanpur, Nagina (Uttar Pradesh) and Tehri (Uttaranchal).

**Project 24: Studies on Agroforestry Systems and development of suitable agroforestry models in Punjab, Haryana and Uttar Pradesh. [FRI – 118/SF-3]**

**Sub-Project (i) : Investigation on the structure and functional dynamics of Agroforestry Systems.**

**Objectives:** (a) To survey the Agroforestry Systems in Punjab, Haryana and Uttar Pradesh. (b) Studies on crop-combination and geometry of plantation. (c) Studies on growth, yield and economics of various

combinations and their sustainability. (d) System inventory description to undertake studies on interaction between different component and existing management practices. (e) Domestication of plant species. (f) Study viability of the system vis-à-vis socio-economic conditions of the rural people.

**Sub-Project (ii): Selection of species under Agroforestry Systems, establishment of germplasm bank and conduct field trials.**

**Objectives:** (a) Evaluate important species growth traditionally and introduced under different systems. (b) Select superior stands, collection and propagation (c) To establish germplasm bank and standardize nursery and plantation technology suited to agroforestry practices and to establish field trials.

**Sub-Project (iii): Development and evaluation of suitable agroforestry models.**

**Objectives:** (a) To study geometry of plantation vis-à-vis crop combination of *Populus* spp., *Paulownia* spp., *D. sissoo*, *Albizia procera*, *Bombax ceiba*, *Tectona grandis*, *Gmelina arborea* and *Anthocephalus chilensis*. (b) To study interactions between different components and management practices. (c) To investigate nutrient cycling and addition, allelopathic effects. (d) To evaluate productivity of annuals and perennials. (e) To monitor the soil properties and also microclimatic changes. (f) To develop integrated agroforestry models.

**Achievements:** Survey completed in District Yamunanagar and District Kurukshetra. Established clonal trial of *Populus deltoides* in District Panchkula and nursery trial of *Populus deltoides* at central nursery and also recorded growth data of old experiments in Haridwar and Yamunanagar districts. In RIMC established trials of clonal block, row plantation of forestry species, the studies of intercropping of wheat, Soyabean and Toria were conducted.

**Project 25: Forest Community Interface – A Study on the Impact of Participatory Forest Management on the Status of Forests and on Socio-Economic Development of Rural People in Dehra Dun District of Uttaranchal [FRI-133/SF-4]**

**Objectives:** (a) To study the impact of PFM in Dehra Dun district of Uttaranchal on the status of forests and environment. (b) To assess the socio-economic benefits accruing to rural people through PFM in these areas. (c) To identify the prime ingredients of the PFM programmes responsible for bringing about change if any in the status of rural people. (d) To study management prescriptions i.e. successful approaches / components of PFM programmes in the area.

**Achievements:** Action plan implemented. Questionnaires developed, tested for results and standardised. Surveys conducted to study the impact of PFM in Dehra Dun District of Uttaranchal on the status of forests and environment in the villages.

**Project 26: Management of Sal heartwood borer in natural forests. [FRI-63/FED-2(i)]**

**Sub-Project : Management of Sal heartwood borers by conventional methods.**

**Objectives:** (a) To protect Sal forest from Sal heartwood borer *Hoplocerambyx spinicornis* and evolve environmentally safe and economically viable management methods for the control of Sal heartwood borer. (b) To develop integrated approach for management of Sal borer and studies on the epidemiology of Sal heartwood borer. (c) To test and analysis of the oozing sap (Kairomone) and use of Kairomone for management. (d) To work out possible biological control agents and their efficiency. (e) To develop integrated approach (IPM) for the management of Sal heartwood borer.

**Achievements:** The study revealed that the incidence of attack decreased because of the large scale trap tree operation conducted in Shiwalik Circle, Dehra Dun. The total number of beetles captured and destroyed during trap tree operation were 4,8,403 beetles of *H. spinicornis* (Sal borer), reduced the incidence of attack of the borer. The extracts of fresh bark, wood and resin in solvent ether, petroleum ether methanol and other chemicals in different formulations so as to test the efficacy and attractiveness toward borer is under trial.

**Project 27: Management of Sal heartwood borer in natural forests. [FRI-63/ FED-2(ii)]**

**Sub-Project: Phytochemical investigation of Sal (*Shorea robusta*) to isolate suitable kairomones for the management of Sal heartwood borer (*Hoplocerambyx spinicornis*).**

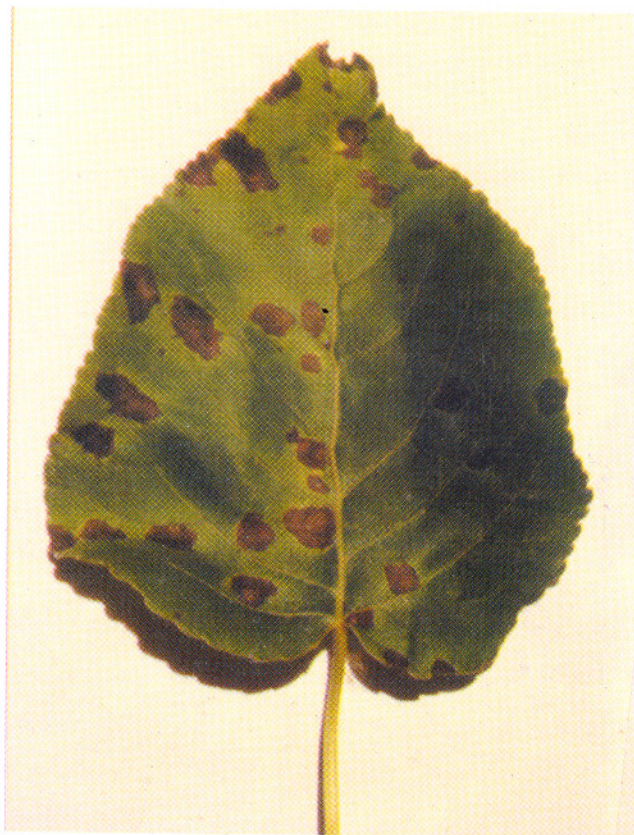
**Objectives:** To isolate and identify suitable compounds (kairomones etc.) for the management of heartwood borer.

**Achievements:** Essential oil isolated earlier from resin and heartwood showed the presence of 37 and 24 compounds, of which 17 and 9 compounds were identified respectively. Analysis also showed that these oils were the mixture of sesquiterpenes and monoterpenes. Germacrene-D was found to be the chief constituent of both the oils. This is the first report on heartwood and resin oil of *Shorea robusta*. Essential oil was also isolated from the bast by hydrodistillation, which on analysis showed the presence of 28 compounds, out of which 9 sesquiterpenes were identified.

**Project 28: Evaluation of natural resistance in different clones / hybrids of *Populus deltoides* against important defoliators. [FRI-76/FED-6]**

**Objectives:** (a) To identify rank resistant and susceptible clones of *Populus deltoides* against its important defoliators and recommend suitable ones for plantation. (b) To evaluate rank clones as immune > high resistant > low resistant > low susceptible > high susceptible. (c) To find out physical characteristics of the plant (clone) such as leaf shape, leaf size, height, sprouting time, leaf fall and growth, factors correlated with resistance / susceptibility. (d) To determine the feeding potential of the pest on different clones influenced by sex of the pest.

**Achievements:** A total of 400 clones / hybrids of *Populus deltoides* have so far been tested and rated for their relative natural resistance to its prime defoliator, *Clostera cupreata*. It appears that there is an economically useful variation in the susceptibility of Poplar clones to *Clostera*. Amongst these clones, 14 have been found to be relatively more resistant to this defoliator as compared to rest of the other clones.



*Phyllosticta adjuncta* foliar pathogen on *Populus deltoides*

**Project 29: Bio-ecology and management of some important key defoliators of agroforestry species. *Ascotis selenaria imparata* Walk and *Selepa celtis* More. [FRI-132/FED-7]**

**Objectives:** (a) To evaluate the present status of the key defoliator species of economically important tree species mainly Sal, Poplar, Teak, Amla, Mulberry, Gamhar, Jamun, Babool, Bahera infested by *Selepa celtis* and *Ascotis selenaria* infesting on Sal, Shisham, Teak, Toon, Sandal, Casuarina and Castor, causing severe defoliation in epidemic. (b) To work out biology, ecology, population dynamics of the pests. (c) To develop suitable control measures following IPM methods so as to prevent insect outbreaks and management of the two key pests.

**Achievements:** Surveyed nurseries and plantation to study the situation, incidence and extent of damage due to *Selepa celtis* and *Ascotis selenaria*. There are 6 generation in a year in *Ascotis* starting from March onward while in *Selepa*, it starts from July-August and completes 5 generations.

**Project 30: Study on disease resistance of newly introduced germ plasm (Progenies of *P. deltoides*). [FRI-136/Path-6]**

**Objectives:** To evaluate the internal resistance of newly introduced germplasm against potentially important pathogens.

**Achievements:** Clones (102) raised at Brandis Road, FRI, Dehra Dun were assessed for the foliar pathogens. In 2000 all the 102 clones were found infected with *Alternaria* and *Phyllosticta* sp. and the disease severity was noticed on higher side, whereas all these clones showed resistance in 1999.

**Project 31: Seed mycoflora of important tree species and its management. [FRI-137/Path-7]**

**Objectives:** To detect and study seed fungi causing loss of seeds and workout their management.

**Achievements:** The seeds of *Albizia lebbek* were collected from different provenances in Haryana, were identified for mycoflora. Effect of leaf and stem extracts of *Ricinus communis* was tested on the seeds of *A. lebbek* for inhibition of mycoflora. Ether extract was found to be the most effective.

**Project 32: Parasitic and symbiotic associations of tree species used for harsh site afforestation. [FRI-138/Path-8]**

**Objectives:** (a) To monitor the plant health in nurseries and plantations. (b) To identify diseases and suggest their management. (c) To scan the profile of symbiotic associations like arbuscular mycorrhizal fungi (AMF). (d) To establish a correlation between symbiotic fungi and their hosts vis-a-vis soil.



*Camptomeris albiziae* on *Albizia lebbek*

**Achievements:** Information and symptoms / signs on common forestry diseases at field level for the use of farmers, staff, etc. were compiled. Work on fungicidal properties of *Pongamia pinnata*, a species suitable for sites, has been initiated.

**Project 33: Sustainable Management of Sodic Soil. [FRI-27/ FSLR-4]**

**Objectives:** (a) Use of farm and Industrial wastes in biological rejuvenation of sodic soils. (b) To find out suitable and cost effective substitute of gypsum and organic residue.

**Achievements:** Data collected so far indicate that height of Siris was higher in the treatment containing Gypsum (G)+ Rice husk (R) +Fertilizer (F) + Fly Ash (FA) followed by F + FA and F+( FA : soil 1:1). For the collar diameter, G+R +F+FA was best followed by F+FA and G+F +R +(FA : soil 1:1). For survival G+F+R+(FA : soil 1:1) was best followed by G+ F +FA and G+R+FA+F.

**Project 34: Studies on sustainability of soil fertility in natural forest ecosystems of Doon Valley. [FRI-123/ FSLR-10]**

**Objectives:** (a) To collect base line information on selected wet land forest ecosystems of Doon Valley. (b) To work out soil indices for sustainability of soil fertility. (c) Use of GIS on selected sites for mapping.

**Achievements:** Analysis of soil sample, collected from six selected sites from Golatappad natural forest area have been completed for different physico-chemical attributes. Vegetation, litter and ground flora studies in all sites have been completed.

**Project 35: Evaluation of the ameliorative role of tree plantation on soil properties in sodic areas. [FRI-124/ FSLR-11]**

**Objectives:** To investigate efficiency of different species in bio-rejuvenating the sodic soils.

**Achievements:** Three years old plantations have ameliorated the soil up to 30 cm depth, whereas the older plantations have made impact up to 1 meter depth. Mixed plantations have proved more efficient in reclaiming the soil in comparison to monoculture plantation. *L. leucocephala* of 12 years age has caused relatively maximum amelioration followed by *P. juliflora* and *D. sissoo*.

**Project 36: Soil geological studies in the degraded land and problem soils for sustainable afforestation. [FRI-84/ FSLR-7]**

**Objectives:** (a) To determine interrelationship between geology, soil and vegetation. (b) To evaluate the ameliorative role of trees on sodic soils through geological and micromorphological studies. (c) To identify geological parameters of degraded and sodic soils for establishment of trees.

**Achievements:** Data from degraded sites at Raipur Range of Mussoorie Forest Division indicated that organic matter content was higher in different forest vegetation at high altitudes than at lower ones. Micromorphological observation confirmed that sodic soils have been enriched with secondary carbonates. Further, it has been observed that dominance of sodium in the release element from the different Salt bearing parent material might have lead to the formation of these sodic soils.

**Project 37: Efficiency of organic vis-a-vis chemical fertilizers in improving the productivity of sodic soils. [FRI-85/ FSLR-8]**

**Objectives:** (a) To compare the effects of applied chemical and organic fertilizers on the performance of tree species in sodic soils. (b) To assess the soil amelioration due to applied nutrition and tree species under test. (c) To find out efficient, cost effective and eco-friendly substitute of chemical fertilizers.

**Achievements:** Data collected indicated that growth was better in the plot applied with chemical fertilizer. This indicates that nutrients from chemical fertilizers were available immediately to the plant while organic residues are slow in releasing. Availability of nutrients to the plants is ensured for a longer duration under organic residue treatments.

**Project 38: Ecological Impact Assessment of bio-reclamation Projects in Rai Bareilly and Sultanpur. [FRI-86/ FSLR-9]**

**Objectives:** To assess the impact of biological reclamation on the development of plant communities in relation to improvement of soil, interception of rainfall, and infiltration.

**Achievements:** Floristic structure and composition evaluation have been completed. Rainfall interception studies completed. Quantification of fuel, fodder and timber production is in progress.

**Project 39: *In vitro* multiplication of Chirpine and Bamboo. [FRI-20/G&TP-2(i)]**

**Objectives:** (a) To develop a protocol for multiplication of Chir Pine through somatic embryogenesis, axillary bud proliferation and adventitious bud differentiation. (b) To develop tissue culture technique through axillary bud break and its multiplication for rapid *in vitro* production of Bamboo plantlets.

**Achievements:**

***Dendrocalamus asper*:** Field parameters of Tissue Culture raised plants were measured. The flowering patterns in the field were studied and nodal segments of flowering plants were cultured under *in vitro* conditions. The callus is raised from young leaves of *in vitro* multiplied shoots. *In vitro* developed plantlets were transferred in mist chamber for hardening.

***Bambusa wamin* and *Gigantochloa atter*:** Experiments were standardized for *in vitro* shoot multiplication in both the species. 5-6 fold shoot multiplication was obtained on media formulated in case of *B. wamin* and 3-4 fold in *G. atter*. Rooting experiments conducted with *in vitro* raised shoots yielded 40-60% success in both the Bamboo.

**Chir Pine:** The axillary shoots maintained were cultured for further multiplication. The best shoot elongation is obtained on half strength MS medium with 0.5% activated charcoal. Adventitious buds were differentiated from mature zygotic embryos on cytokinin enriched media. Effect of pulse treatment was also studied to induce buds.

**Project 40: *In vitro* multiplication of Shisham and Eucalyptus. [FRI-20/G&TP-2 (ii)]**

**Objectives:** (a) To produce Eucalyptus planting stock material through tissue culture from already identified Plus Trees. (b) To develop procedure for hardening and acclimatization of plantlets to obtain 100% field transplantation. (c) To develop tissue culture technique for rapid *in vitro* production of Shisham plantlets.

**Achievements:** Tissue Culture techniques were developed for axillary bud proliferation and *in-vitro* shoot multiplication for *Dalbergia sissoo* and *Dalbergia latifolia*. Limited success was obtained. A technique for somatic embryogenesis through cotyledon explant was standardized to get somatic embryos. Eucalyptus tissue culture protocol has been developed and tested. The technology is being transferred to Haryana State Tissue Culture advance Centre for Eucalyptus multiplication.

**Project 41: *In vitro* multiplication of Teak and Neem. [FRI-20/G&TP-2(iii)]**

**Objectives:** (a) To develop a cost effective protocol for the production of Neem and Teak on mass scale for afforestation and performance testing of tissue culture raised material in the field. (b) To increase the quality and quantum of the harvestable produce. (c) To increase the productivity of plantations by planting the clonal planting stock with wider genetic base.

**Achievements:** A complete tissue culture protocol has been developed for *in-vitro* multiplication of Neem using explant (starting material) from 7 years old tree. This methodology can be delineated for the multiplication of selected CPTs for desired traits like high oil yield, and high azadirachtin content. An efficient protocol has been developed for the regeneration of plants with leaf and internode as explant. This methodology has potential use in future in genetic transformation studies. Somatic embryogenesis has been reported by taking explant from mature tree. After improvising the methodology for embryo maturation, encapsulation, this has wider prospects for mass multiplication of the desired phenotypes / genotypes.

**Project 42: Genetic Improvement of *Pinus roxburghii* including Provenance research. [FRI-21/DGTP-3]**

**Objectives:** (a) Survey and selection of superior trees, Stands / Provenances, and collection of planting material. (b) Studies on variation based on qualitative and quantitative traits. (c) To identify the Provenance(s) that give(s) the highest possible economic gain based on the observations recorded from the field trials.

**Achievements:** Four Provenances were identified at age six and they continued to be most promising Provenance at age 19. None of the Provenance has been observed bearing female cones. Two Provenances were identified having high specific gravity as compared to average. Needle length varies from 17.25 to 22.58 cm.

**Project 43: Genetic Improvement of *Grewia optiva* .[FRI-125/G&TP-5]**

**Objectives:** (a) To study the variation in respect of growth parameters of selected superior phenotypes from different area and standardize the technique for vegetative propagation viz. rooting of cuttings and grafting. (b) Establishment / Conservation of germplasm and establishment of breeding orchard. (c) To have preliminary information on growing of the *G. optiva* and survey of superior phenotype of different areas.

**Achievements:** Survey was conducted for *G. optiva* in Districts of Uttaranchal. 1500 cutting collected from the superior trees selected were planted, treated with hormone in 1:1:1 ratios of sand + soil + compost. Seeds of *G. optiva* have been collected for progeny trial. Arrangement has been made for sowing of 10 superior tree seeds collected from different Provenance.



**Project 44: Studies on cultivation and optimum time of harvesting of temperate & alpine medicinal plants of high market value. [FRI-30/NWFP-3]**

**Objectives:** (a) To assess the resource of medicinal species in the UP, HP & J & K hills. (b) To collect the germplasm and identify the best Provenances rich in active principles. (c) To study *in situ* & *ex situ* behavior of the species and develop suitable cultivation techniques.

**Achievements:** Soil studies revealed that the occurrence, density and regeneration of *Taxus baccata*, *Nardostachys jatamansi* and *Picrorrhiza kurroa*, is significantly regulated by the interplay of various chemical and physical properties of the soil. Stem cuttings of *T. baccata* rooted earlier and transplanted in field were observed for their growth behaviour to determine the annual growth rates.

**Project 45: Identification of high gum yielding varieties of *Acacia nilotica* for future regeneration and socio-economic development. [FRI-80/NWFP-4]**

**Objectives:** (a) To find out optimum gum yielding method and the best time of tapping. (b) To identify high gum yielding trees for future plantation. (c) To study the working quality of newly designed tool with reference to production of gum.

**Achievements:** No data could be recorded due to heavy rains during last season of tapping.

**Project 46: To study and develop the techniques of cultivation of *Uncaria gambier* to propagate it in the field and popularize the species in India. [FRI-126/NWFP-6]**

**Objectives:** (a) To collect germ plasm of *U. gambier*. (b) To develop suitable cultivation technique for mass production of *Uncaria gambier*. (c) To extend technology to SFD and farmers in India.

**Achievements:** The requisite permit to obtain germ plasm of *Uncaria gambier* from native country Indonesia was obtained from National Bureau of Plant Genetics Resource, New Delhi. The germ plasm will be collected from donor country and the propagation, cultivation and utilization of *Uncaria gambier* will be studied in Indonesia.

**Project 47: Improvement of the nursery techniques of commercially important forestry species. [FRI-4/Silva-4]**

**Objectives:** (a) To study the effect of seed size and weight on germination and growth of the seedlings of *Hardwickia binata*. (b) To assess the depth of seed sowing of Teak, *Juglans regia*, *Hardwickia binata* etc. in nursery. (c) To evolve proper orientation of seed sowing of *Hardwickia binata*. (d) To assess the requirement of shade and mulching for the better germination of *Juglans regia* and *Hardwickia binata*.

**Achievements:** The results indicated that the commencement of the seed germination is earlier in mulching bed than and germination delayed in shaded bed. Highest germination percentage in mulching bed than in shaded bed was observed. The growth of the seedlings was recorded higher in mulching in comparison with shaded bed. Studies were also carried out on pre-sowing treatment of *Juglans regia*. The results indicated that higher germination was found in the treatment stratification of seeds in pits. It is concluded that stratification in pits using soil : sand : F.Y.M. as stratification media is proved to be the best technique for pre-sowing treatment.

**Project 48: Chemical modification of wood particle and fibres for enhanced durability and performance of solid wood reconstituted panels. [FRI-110/FPD (WP)-23]**

**Objectives:** To produce commercially viable, low cost improved panels of enhanced durability and dimensional stability, from different types of materials.

**Achievements:** The boards prepared from acetylated and formalin treated *Eucalyptus* hybrid particles were tested for their resistance against termites and fungus. The results showed that the boards are more resistant to biological agencies than the control.

**Project 49: Development and evaluation of Eco-friendly wood preservatives. [FRI-112/FPD (WP)-25]**

**Objectives:** To develop non-hazardous and Eco-friendly wood preservatives.

**Achievements:** Toxicity of the composition ammoniacal copper zinc borate has shown its effectiveness against *Poria monticola* and retention against termites. Chir and Semul samples treated with copper-lignin complex at three retentions having copper content have shown good resistance against fungi / termites as compared to control samples. Benzene and alcohol extractives of *Ipomea carnea* leaves were tested for their toxicity against white and brown rot fungi by petri-disc method.

**Project 50: Studies on natural durability, and efficacy of preservatives in Bamboo and plantation grown wood species. [FRI-135/FPD (WP)-31]**

**Objectives:** To evaluate natural durability / treatability of Bamboo and plantation grown wood species and efficacy of preservative on land.

**Achievements:** Culms of *Dendrocalamus strictus* and *Bambusa arundinacea* treated with CCA and CCB by Boucherie and Wick methods in green condition at three retention levels, analysed for chemical content and samples of size 30 cm length were prepared and installed in the test yard, Dehra Dun along with control samples. 20 years data collected from Dehra Dun and Jodhpur for one lot was statistically analysed and published.

## EXTERNALLY AIDED PROJECTS

**Project 51: Revision of forest flora of Andaman and Nicobar Islands. [FRI-155/Bot-21]**

**Objectives:** To revise and update the forest flora including medicinal plants of the Andaman & Nicobar Islands.

**Achievements:** Forests of Andaman and Nicobar Islands were surveyed. Collections of plant samples were made. Work on identification and description is in progress. Survey work will also continue during 2001-2002.

**Project 52: Bamboo Improvement Scheme for APFDC. [FRI-164/Bot-25]**

**Objectives:** (a) To improve the planting stock of Bamboo (*Dendrocalamus strictus*) for improving growth and output from Bamboo plantations. (b) To improve the sustainability of the present Bamboo Scheme of APFDC Ltd., Hyderabad.

**Achievements:** Inception report prepared and got it approved. Bamboo improvement scheme and action plan prepared and submitted to APFDC Ltd., Hyderabad. Training given to APFDC staff on Bamboo

propagation, including establishment of rhizome banks, inoculation with VAM and macroproliferation. Training given on selection, collection, multiplication and evaluation of promising genetic material. Twenty clones of *D. strictus* were supplied to APFDC Ltd., Hyderabad.

**Project 53: Development of Binsar and Chaukori Villages, Kumaon Hills, Uttarakhand. [FRI-186/Bot.-27 (funded by Tourism Dept., Uttarakhand)]**

**Objectives:** (a) Development of tourist village through integration of knowledge on the biodiversity of the region. (b) Floristic survey for the preparation of field guide on the plants of tourist attraction. (c) Conservation of rare, threatened and spectacular species typical of the region.

**Achievements:** Survey, selection, collection and identification of 100 rare, threatened and spectacular plants of conservation *vis-à-vis* tourists' attraction were made. Indigenous knowledge on the flora of the region from the conservation point of view was gathered for its potential role in development of tourist villages.

**Project 54: Tree Improvement. [FRI-157/G&TP-6; WB funded]**

**Objectives:** (a) To study the floral biology and breeding system to develop hybrids specific to site in order to maximize productivity of *Eucalyptus tereticornis*, *Dalbergia sissoo*, *Populus deltoides* and *Pinus roxburghii*. (b) To develop technique for rejuvenation of mature plant tissue to maximize multiplication rate. (c) To develop *in vitro* and *in vitro* propagation technique for mass multiplication of selected genotypes.

**Achievements:** Floral biology and breeding system of *D. sissoo* were studied. Diallel crosses attempted among the selected clones including control selfing. The species was found to be both self as well as cross-fertilized and was observed under the given conditions. As meagre quantity of seed could be available following controlled hybridization due to high percentage of premature abortion of pods under controlled condition, an innovative approach to multiply the precious hybrid seed via tissue culture was adopted, where in seed were excised from immature abscised pods for *in-vitro* multiplication of immature hybrid zygotic embryos and the work is in progress. Continued the studies to produce hybrid seed by attempting crosses between selected clones.



*In-vitro* proliferation of *Pinus roxburghii*

In *Populus deltoides* intraspecific crosses made were screened at nursery level and best individuals were selected which were further multiplied for nursery screening. Replicated trials for 24 families at 3 sites were laid out. Field trial of tissue culture raised plants of selected clones laid out at Bithmera (Haryana) alongwith plants raised through seeds was evaluated. Clones F6, E-5, D-4 raised through tissue culture were found quite promising. Average height at age 2 yr. was 8.02 to 6.93 M.

In Shisham and in Eucalyptus multiplication of juvenile shoot has been perfected. In Shisham about 400 ramets were produced belonging to different clones. *In vitro* clonal propagation technique for mature trees (CPT's) of Shisham developed. Experiments were conducted for *in-vitro* rooting of juvenile cuttings of *Pinus roxburghii*. Success in rooting of cuttings 50-62% was obtained from different clone. *In vitro* cultures have also been successfully established.

**Project 55: Planting Stock Improvement Programme. [FRI-172/G&TP-9; WB funded]**

**Objectives:** (a) To improve the quality of Planting Stock produced at ICFRE Institute through adopting proven techniques, providing not only the greater quantities of better planting material but most importantly providing demonstration of technologies to SFDs. (b) To survey, select, establish and maintain Seed Production Areas, Clonal Seed Orchards, Seedling Seed Production Areas, Seed harvesting, handling and storage services. (c) To develop Central Nursery and multiplication garden.

**Achievements:** Under Planting Stock Improvement Programme the progress achieved with *Eucalyptus tereticornis*, *D. sissoo* and *Pinus roxburghii* in respect of various components namely Seed Production Areas of 181.80 ha against the target of 160 ha; Seedling Seed Production Area of 25.1 ha against the target of 19 ha; clonal Seed Orchard of 28 ha against the target of 19 ha and Hedge Garden / Vegetable Multiplication Garden of 4.10 ha against the target of 4 ha were achieved for the above said species. The established Seed Production Areas have become fully productive after upgrading by selecting and favoring seed trees, which were superior in vigour and health. In *Populus deltoides* 86,500 stem cuttings were produced and supplied to the farmers for agroforestry plantation. Standardization of hedging schedule and rooting of juvenile cuttings were undertaken to refine the technique and achieve perfection. A central facility has been created at FRI.

**Project 56: Central scheme for development of Agrotechniques and cultivation of medicinal plants used in Ayurveda, Siddha, Unani and Homeopathy. [FRI-173/NWFP-8; funded from CSDA, Min. of Health & Family Welfare, GOI]**

**Objectives:** To develop complete package of practices of Agrotechnology for cultivation of the assigned species and transfer of technology from lab to land.

**Achievements:** *Prunus cerasoides* seedlings raised in Chakrata Nursery were shifted to field, three species of medicinal herbs were intercropped with *Prunus*. The species are *Withenia sominifera*, *Spilenthesis acimella* and *Hedychium adoratus*. 70% germination has been recorded in the seeds after various pre-sowing treatments. The tubers of *Microstylis wallichii* and *Habenaria intermedia* collected from nature were raised in Chakrata Nursery under different soil mixtures regimes and types of beds. Maximum sprouting was recorded in raised beds containing a mixture of sand+soil+wood chips in the ratio of 1:1:2. Less success has been achieved in propagating *Elaeocarpus ganitrus* through seeds and stem cuttings. However, 65% success has been recorded in air layering experiments. Plants raised by air layering have been transplanted.

**Project 57: Studies on Himalayan Pines. [FRI-175/Silva-13; USDA funded]**

**Objectives:** (a) Identification, selection and collection of seeds from superior provenances of Chir (*Pinus roxburghii*) and Himalayan blue Pine (*Pinus wallichiana*) from their natural distribution range. (b) Study of seed source variation in *Pinus roxburghii* and *Pinus wallichiana*. (c) Studies on Seed Biology *Pinus roxburghii* and *Pinus wallichiana*.

**Achievements:** Conducted provenance trial of *P. roxburghii* (seeds collected from 61 sources) at three sites. Observations regarding germination, survival, mortality and pattern of shoot elongation have been recorded. Cones of *Pinus wallichiana* were collected from 15 sources in Himachal Pradesh. Seeds extracted were tested.

**Project 58: Biological control of important forest insect pests and screen forest seed for insect infestation. [FRI-156/FED-10]**

**Objectives:** (a) To survey indigenous parasitoid and predator fauna of key defoliator of Poplar in tarai region of U.P., Uttaranchal and Haryana. (b) To screen parasitoids for promising biocontrol agents of identified key defoliator of *Populus deltoides* and develop techniques for mass culture. (c) To develop field practices for biological control of key defoliator of Poplar.

**Achievements:** The coccinellid beetles including eight predacious species were recorded for the first time.

**Studies on parasitising potential of egg parasitoid *Telenomus colemani*:** Parasitisation potential of *T. colemani* could be enhanced to 136.42 eggs and longevity to 10 days by replacing dead males with fresh ones. A phytophagous species were also recorded.

**Studies on occurrence of superparasitism in the eggs of *Clostera cupreata*:** On an average, emergence of 5.44 parasitoids was recorded from a superparasitised egg of *C. cupreata*.

**Studies on field release of parasitoids:** Egg parasitoid, *Trichogramma poliae* identified as candidate for future use as biological control agent against *Clostera cupreata* was mass reared in the laboratory. It was observed that parasitising percentage was increased in the field and defoliator's population was proportionately reduced. A new approach to study comprehensive parasitisation potential of egg parasitoid, *Trichogramma poliae* was developed. Parasitisation was found to have been declined in the progenies from 1 to 13 and a mated female of different progenies (1 to 13) during subsequent oviposition in total lifetime parasitised egg declined. Average longevity of the females also declined.

**Project 59: Study on alternative eco - friendly wood varieties for handicraft & futuristic wood availability in Rajasthan and Kerala State. [FRI-168/FPD(WWF)-36; Consultancy Project]**

**Objectives:** (a) To project the futuristic demands of traditional and alternate timber species for handicrafts sector with regard to Kerala and Rajasthan States up to 2020 AD. (b) To evaluate carving qualities of timber species and suggest alternate timbers for handicrafts.

**Achievements:** The survey of Rajasthan and Kerala States for wood availability was completed. A report has been prepared and sent to Development Commissioner (Handicrafts). The report is yet to be accepted as some modifications in the report has been suggested by the funding agency DC(H) Govt. of India Ministry of Textiles.

**Project 60: Commissioning and installation of wood plasticization plant and ammonia fumigation chamber at Jodhpur and Trivendrum. [FRI-169/FPD (WS)-37; Min. of Textiles, GOI funded]**

**Objectives:** Fabrication of wood plasticization plant and transfer of wood bending technology to be executed through National Research Development Corporation, New Delhi.

**Achievements:** Installation work is under progress by NRDC, New Delhi.

**Project 61: High yield pulping and bleaching of plantation grown wood species and bagasse using Alkaline Peroxide Mechanical Pulping (APMP) process. [FRI-153/C&P-16; IPMA funded]**

**Achievements:** The experiments were conducted using prex system at initial stage with respect to dewatering efficiency and subsequent chemical treatments for preparation of high brightness, high yield pulps using APMP process. For large-scale trial compression cum dewatering unit was designed, got fabricated, procured and installed to increase the dewatering efficiency. Using this equipment APMP process was applied for pulping Poplar and Bagasse. Work on Poplar has been successfully completed with respect to dewatering efficiency and brightness improvement. 78% brightness at 80% yield with adequate strength properties was achieved.

**Project 62: Production of high molecular weight and high purity alpha cellulose. [FRI-154/Chem-6; GACL funded]**

**Achievements:** Alpha cellulose from Cotton linter and Bamboo were prepared at 1 Kg batch in laboratory. The alpha cellulose produced had 99% purity with 80% brightness and DP in the range of 800-2200. The technology was demonstrated to GACL, Gujarat. Work on Eucalyptus is in progress.

**Project 63: Examine biofertilizers beneficial to economically important tree species and develop practical methods for field application. [FRI-158/Path-10]**

**Objectives:** (a) To identify different species of VAM fungi, Rhizobium and Frankia occurring in different tree species like Albizias, Acacias, Sissoo, Bamboo, Casuarina and Teak, etc. (b) To select different effective strains of above mentioned symbiotic organisms. (c) To produce inoculum in bulk for inoculation of tree species and standardization of techniques. (d) To boost up the plant growth in nursery and plantations through application of biofertilizers.

**Achievements:** Studied VAM associations with *Dalbergia sissoo* plantations in different places. A total of eight species of *Glomus*, one species each of *Acaulospora*, *Sclerocystis*, *Scutellospora* and *Entrophospora* were recorded from Chidyapur, and four species of *Glomus*, one species each of *Acaulospora* and *Entrophospora* were recorded from Chhichhroli, Haryana. A nursery experiment set up to study the growth response of *D. sissoo* to VAM and Rhizobium inoculation alone and in combination with different doses of fertilizers was evaluated. Treatments comprise control, NPK full dose, NPK half dose, NPK one-fourth dose alone and combination with Rhizobium and VAM alone. An increase in diameter was recorded with VAM inoculation and VAM with Rhizobium. Shoot height was also found maximum with NPK full dose and VAM inoculation, respectively. Field performance of Mycorrhized seedlings of *Dalbergia sissoo* and *Eucalyptus tereticornis* is being monitored regularly. Pot cultures of *Glomus mosseae*, *G. deserticola*, *G. macrocarpum* and two cultures from phosphate mine area were

multiplied and maintained. A nursery experiment was set up to study the relative performance of different clones of *Populus deltoides* raised in soil having indigenous mycorrhizal population.

**Project 64: Market Monitoring of Tree Products. [FRI-159/RSM-8; WB]**

**Objectives:** (a) To collect market intelligence for tree products. (b) To publish monthly price bulletin and publicise market information. (c) To analyze price trends and suggest policy measures to give impetus to planting of trees.

**Achievements:** Market intelligence on monthly basis was collected from various timber markets of Uttaranchal, Haryana, Punjab, Delhi and Chandigarh and from Forest Development Corporations. Price trend analysis of different species was also done. It indicates that the market price of Indian timber species i.e. Teak, Sal and Pine is higher than that of imported timber species. It also indicates that the price of imported Teak are showing a decreasing trend from March 1997 to December 2000 while there is a steady increase of about 5 % per annum in the prices of Poplar, Eucalyptus and Indian Teak during the same period. The data were compiled and published as monthly "Market Prices of Forest Products" Bulletin. Twelve issues of the Price Bulletin were published during 2000-2001. Research Data Base Management System package was developed by a Consultant for providing the timber price data on worldwide net. Its installation is under progress.

**Project 65: Storage of Forest Tree Seeds. [FRI-160/Silva-12]**

**Objectives:** (a) To develop protocols for the storage of seed of forestry importance, rare and endangered tree species for short to medium term storage to maintain quality. (b) To assess the viability and vigour and to develop standard techniques to determine field planting value.

**Achievements:** Established orthodox storage physiology of seeds of *Dalbergia sissoo*, *Grewia optiva*, *Ulmus wallichiana*, *Acer caesium* and Bamboo species and intermediate storage physiology of *Azadirachta indica*. Determined optimum conditions for the storage of seeds of the above species. Indices of proper seed maturity and optimum time of seed collection established for *D. sissoo*, *G. optiva*, *U. wallichiana*, *A. caesium* and *A. indica* was determined. Optimum conditions for the laboratory germination and suitable rapid viability test was determined for all the above species.

**NEW PROJECTS TAKEN UP DURING 2000-2001**

**Project 1: Planting Stock Improvement through clonal propagation. [FRI-140/Bot-19]**

**Sub-project (i):** Clonal propagation of *Dalbergia sissoo*.

**Sub-project (ii):** Clonal propagation of *Tectona grandis*.

**Sub-project (iii):** Clonal propagation of Bamboo.

**Sub-project (iv):** Clonal propagation of other economically important species.

**Objectives:** (a) To understand the causes of early onset of maturity. (b) To develop suitable methods to rejuvenate mature clones. (c) To increase juvenile growth in hedge gardens. (d) To develop methods / treatments for mass productions of superior quality clonal planting stock.

**Progress made:** Investigations were made for rooting behaviour of cuttings of *Tectona grandis*, *Dalbergia sissoo* and Bamboo. Mature cuttings of *Dalbergia sissoo* showed marked seasonality in respect of rooting behaviour. Juvenile cuttings are easy to root and the best season for rooting are months of May-July.

Mature cuttings of *Tectona grandis* are difficult to root and survive, where as juvenile cuttings are easy to root. In mature cuttings NAA 100 mg/l treatment stimulated rooting and shoot growth whereas juvenile cuttings rooted easily even without auxin treatment. Age of clumps of Bamboo had strong effect on rooting and sprouting of culm cuttings. Auxin treatment had only a weak promoting effect.

**Project 2: Effect of water stress on some clones and provenance's of *Dalbergia sissoo*. [FRI-148/Bot-20]**

**Objectives:** (a) To identify the suitable clones and provenance for plantations to the dry regions i.e., arid and semi-arid zones of India. (b) To study the effect of water stress on various clones and provenance of *Dalbergia sissoo*. (c) To study the moisture stress tolerance of individual clone / provenance and find out critical soil moisture condition required by a clone / provenance to keep it alive. (d) To quantify the effect of water stress on water consumptive behaviour and resource use efficiency. (e) To investigate into various clonal / provenance strategies and physiological mechanisms contributing to water stress resistance. (f) To find out suitable treatments to combat the ill effect of water stress. (g) Screening and identification of drought resistant clones and provenance's of *sissoo* for large-scale plantation in the arid and semi-arid regions of the country.

**Progress made:** Six promising clones were identified and multiplied to desired number of ramets. Various observations are being made. The rooted cuttings of these clones were transplanted in the earthenware pots and allowed to grow under different water stress conditions.

**Project 3: Complete elimination of Sulphur and Chlorine compounds in pulping and bleaching by MILOX process. [FRI-150/C&P-15]**

**Objectives:** (a) To eliminate the use of Sulphur compounds in pulping by replacing kraft pulping liquor by Peroxy Acids. (b) To eliminate use of Chlorine compounds in bleaching by replacing bleaching sequences using Chlorine and / or chlorinated compounds by Alkaline Hydrogen Peroxide bleaching.

**Progress made:** *Eucalyptus tereticornis* chips were pulped in three successive stages using peroxy formic acid followed by formic and again with peroxy formic acid using four different doses of chemicals. Pulp were evaluated for strength properties and brightness. The pulps exhibited adequate level of strength properties and brightness for variety of end uses.

**Project 4: Studies on isolation and characterization of tree / shrubs, leaves, bark and exudate gums. [FRI-51/Chem-1(vii)]**

**Objectives:** To investigate the structure of *Prosopis juliflora* seed polysaccharide and find its applications.

**Progress made:** Pods of *Prosopis juliflora* collected from Jodhpur were separated to obtain testa, endosperm and seed kernel. All the parts were analysed for isolation of cold and hot water soluble polysaccharides. Endosperm was identified as potential source for cold-water soluble polysaccharide and were analysed for protein content. Presence of galactose and mannose sugars was estimated. The seed oil content was determined.



**Project 5: Phytochemical examination for the utilisation of leaves, barks, fruit and root of Indian forest trees. [FRI-53/Chem-3(v)]**

**Objectives:** To develop natural dyes from hitherto unexplored abundantly available plants to protect the environmental pollution.

**Progress made:** Methods were standardized to isolate dye from *Ageratum conyzoides* and *Parthenium hysterophorus* and its application in dyeing of different fabrics using mordants. A number of shades with good colour fastness were obtained on silk, wool and cotton. Methods were also standardized for dyeing of Poplar veneer with *Populus deltoides* and *Eucalyptus* hybrid bark dye.

**Project 6: Ecological study of *Dalbergia sissoo* (Roxb.) with special reference to mortality. [FRI-147/Eco-7]**

**Objectives:** (a) To work out ecological indices (indicative values) to ascertain the cause of mortality in *Dalbergia sissoo* growing naturally or in plantations. (b) To compare the physico-chemical properties of the soil and seasonal foliage nutrient variations in the mortality and non-mortality sites. (c) To study leaf phenology (moisture and longevity) in *Dalbergia sissoo* in both the sites. (d) To find out the adaptive mechanism of *Dalbergia sissoo* to cope up with the changing climatic conditions.

**Progress made:** Preliminary study of mortality has been carried out in Pathri, Thano and Lalpani. Various causes of mortality were apparently observed in these sites.

**Project 7: Bio-ecological studies on insect pests of Bamboo and their management. [FRI-144/FED-8]**

**Objectives:** (a) To develop integrated approach for management of the insect pests of Bamboo. (b) To study, identify, extent of damage, peak period of activity of insect pests in nurseries, plantations and natural stands. (c) Bio-ecological studies of insect pests of economic importance and their management.

**Progress made:** Surveyed Bamboo forests, nurseries, plantations and natural stands to record the incidence and extent of insect damage due to insect attack. It was found that *Estigmene chinensis* is a major borer in the localities surveyed in addition to *Oregma bambusae*, a sap sucking aphid species. The other injurious xylophagous species *Chlorophorus annularis* and termites was also recorded.

**Project 8: Environmental conservation strategies for land use in lower Western Himalayas: Butterflies as indicators in monitoring environmental changes in urban gradients. [FRI-145/FED-9.]**

**Objectives:** (a) To suggest guidelines for land use planning for protecting the environment of the Lower Western Himalayas (Dehra Dun Valley) and conserving its native bio-diversity with special reference to butterflies as probe taxa for insects. (b) Identification of the original pre-developmental / native butterfly community and diversity of Dehra Dun Valley i.e. native of tropical moist deciduous Sal forests and its comparison with butterfly diversity and community found under different land use pattern.

**Progress made:** Selected study plots in the Dehra Dun Valley on the basis of satellite imaginary of forest cover as recorded (FSI, Dehra Dun) and also based on extensive ground surveys. A total of 4 Sal forest

sites spread all over the study area with each site having 8 plots of 1 ha., each were selected. Each site has been sampled 3 times seasonally for butterfly species richness and abundance. A total of 112 butterfly species were sampled. Besides, data on resources critical for these butterflies, habits, feeding, mating and oviposition time, are also being collected. Identification of flora and tree density of one site has been completed.

**Project 9: Studies on nursery and cultivation techniques of important medicinal plants for socio-economic development. [FRI-146/NWFP-7]**

**Objectives:** To develop suitable package for large-scale cultivation.

**Progress made:** Seeds and Seedlings of *Andrographis peniculata* and *Asparagus racemosus* were procured. Germination survival trials were conducted and data was recorded. Spacing trial was conducted for *Andrographis* spp. An experiment has been conducted for *Asparagus racemosus* under different soil types to optimise maximum tuber yield.

**Project 10: Develop simple technology for treatment of joinery timbers. [FRI-149/FPD(WP)-32]**

**Objectives:** To develop simple technique for treatment and study various parameters of dip treatment to impregnate required chemical in wood.

**Progress made:** Five hardwood species namely, *Acacia nilotica*, *Hevea braziliensis*, *Syzygium cumini*, *Terminalia arjuna* and *Toona ciliata* (Toon) were studied for sp. gravity, moisture content and samples treated with Light Organic Solvent type Preservative (LOSP), solution of copper resinate, trichlorophenol and ammoniacal copper borate by different dip treatment times and calculated average retention of each species.

**Project 11: Evaluation of physical and mechanical properties of *Albizia chinensis*, *Cupressus cashmeriana*, *Chukrasia* spp. and classification and grading of timber for different end uses. [FRI-152/FPD(TM)-34]**

**Objectives:** (a) To test and evaluate physical and mechanical properties of *Albizia chinensis*, *Cupressus cashmeriana* and *Chukrasia* spp. (b) To study between and within trees variation of properties.

**Progress made:** Five logs each of the three timber species viz. *Albizia chinensis*, *Cupressus cashmeriana* and *Chukrasia* spp. were procured and test specimens for carrying out different physical and mechanical tests were prepared as per standard practice. Testing of *Albizia chinensis* and *Chukrasia* spp. for evaluation of physical and mechanical properties were completed in green condition and continued in air-dry condition for *Cupressus cashmeriana*. Studies on within tree strength variation from pith to periphery and bottom to top were also continued to study radial and axial variation of strength properties. Computational works of test data collected so far were continued.

**Project 12: Evaluation of properties of timber by non-destructive testing techniques. [FRI-151/FPD(TM)-33]**

**Objectives:** (a) To study the effect of wood parameters on ultrasonic velocity of timbers and to establish relationship of ultrasonic velocity with different strength properties of the timber. (b) To study thermal conductivity and sound absorption coefficient of timbers.

**Progress made:** The *Shorea robusta* species was converted into specimens of required dimensions to study the effect of wood parameters on ultrasonic velocity and testing is in progress. Thermal conductivity of *Pinus roxburghii* at mean temperature of 28°C has been determined. Results indicate that grain direction of wood affects the thermal conductivity and its values are found more along longitudinal direction than transverse direction.

**Project 13: Development of packing boxes. [FRI-111/FPD(TM)-24(ii)]**

**Objectives:** (a) To find a suitable alternate materials for packing boxes to reduce the use of wood. (b) To design and develop more economical packing boxes from plantation grown timber including Bamboo species.

**Progress made:** Testing material i.e. *Bambusa polymorpha* and *Bambusa nutans* was procured and packing boxes for holding 20 kg weight, new design using Bamboo strips, Bamboo battens and iron binding straps were prepared. The boxes were subjected to laboratory tests to study their performance and were compared with conventional boxes.

**EXTERNALLY AIDED PROJECTS**

**Project 14: Establishment of Bambusetum in Delhi. [FRI-163/BOT-24]**

**Objectives:** (a) To develop Bambusetum at two sites in Delhi for educational / recreational purposes and for future planting city forests of Delhi with suitable Bamboo species. (b) To train the officials of Department of Forests and Wildlife, NCT of Delhi in establishment and maintenance of Bambusetum.

**Progress made:** Prepared layouts for establishment at two sites. Provided planting material of about 20 species of Bamboo to Delhi Forest and Wildlife Department. Guided for proper planting of the material. Imparted training to the staff of Department of Forests and Wildlife, Delhi on the various aspects of establishment and management of Bambusetum.

**Project 15: Vegetational survey and inventorisation of species in the Ridge Forests of Delhi. [FRI-165/BOT-26]**

**Objectives:** (a) To survey and analyse the vegetation of the Ridge. (b) Inventorisation of plant species. (c) To suggest the measures for conservation of plant diversity in the Ridge Forest.

**Progress made:** Relevant technical information for field work has been collected. Steps for recruitment of Project staff have been initiated.

**Project 16: Optimization of Reconstituted Wood from Bamboo / Lantana. [FRI-167/FPD (CW)-35; INBAR funded]**

**Objectives:** (a) To test different mixture ratio of the raw materials (Bamboo and Lantana fibre) for production of Optimized Reconstituted Wood. (b) To modify the adhesive for production of Optimized Reconstituted Wood through mixing lignin liquor with phenolic resin. (c) To develop package and technologies for production of Optimized Reconstituted Wood from Bamboo.

**Progress made:** Reconstituted Wood boards were prepared with Bamboo / Lantana in different combinations using pure Phenol Formaldehyde (PF) resin as well as 30% and 50% black liquor substituted

PF resins. With 30% substitutions of phenol with black liquor and 50:50 combinations of Bamboo and Lantana, the properties of RCW boards were found comparable with solid Teak wood.

**Project 17: Selected options for stabilizing Green House Gas (GHG) emission for sustainable development. [FRI-176/FSLR-12; Consultancy under UNDP-GEF]**

**Objectives:** (a) To act as sectorial focal Institute for formulation of Forestry Projects under UNDP-GEF at national level. (b) To create awareness in State Forest Departments for encouraging such initiatives.

**Progress made:** Initially, FRI contacted all the State Forest Departments, many Agriculture Universities and Institutions and provided all the necessary information for concept building etc.

**Project 18: Genetic Improvement and production of nursery planting stock of Khair, Shisham and Kikar. [FRI-170/G&TP-7; PFD funded]**

**Objectives:** (a) To identify and test superior phenotypes. (b) To establish SPAs, CSOs. and SSPAs of the targeted species. (c) To produce improved nursery-planting stock.

**Progress made:** One Seed Production Area of *A. catechu* has been identified at Mirthal, Pathankot. 40 CPT each for *A. nilotica* and *A. catechu* has been selected. Progenies of *A. nilotica* and *A. catechu* has been raised. Site for the establishment of CSO and Progeny trials has been identified at Bir Sanur in Patiala Forest Division.

**Project 19: Studies on interrelationship between production levels and marketing of important forestry species in Punjab. [FRI-174/RSM-9; PFD funded]**

**Objectives:** (a) To study the production of important forestry species, both in forestry and agroforestry sectors for the next 10 years. (b) To study the present market mechanism of tree products relating to its pricing, availability and demand. (c) To study the important market channels and inter-market comparison of producers share in the consumer rupee and contractors margin of agroforestry species. (d) To study the present forest based industries in relation to their demands and future prospects. (e) To suggest policy measures to improve the interrelationship between production and marketing of important forestry species.

**Progress made:** The lists of tree species which are traded in different timber markets of Punjab have been collected and updated. The timber markets have been arranged according to the agro-climatic zones of Punjab. Survey of 25 timber markets was conducted. The markets have also been classified into large, medium and small depending on the quantum of the timber traded in them. The details of the timber which is being brought into the State were collected.



Collection of Seed from CPT of *A. catechu* at Garh Shanker Forest area.

### **National Forest Library and Information Centre**

The National Forest Library and Information Centre (NFLIC) is the heart of all academic activities of the Forest Research Institute having a document collection of 1,53,306 and providing all types of library information services to its users.

During the year 844 books were purchased at a cost of Rs. 7.67 lakhs and received additional 576 books on gratis. The NFLIC subscribed 114 foreign and 71 Indian periodicals. Besides, it also receives 350 periodical titles gratis.

NFLIC subscribed **CAB-CD, Tree-CD, Biological Abstracts, AGRIS and ECO Disc on CD-ROM** format at a total cost of Rs. 12.70 lakhs. During the year, 51,045 documents were bar-coded for efficient circulation; and 5,578 periodicals and books were bound at a total cost of Rs.2.08 lakhs for increasing their shelf life.

Under the Documentation Section a total of 600 records were classified for ledgering. 2881 references and 4,484 author, species and subject cards were filed. 114 plant species and 24 new subject files were opened. Besides, 105 queries of readers were attended.

A monthly Forestry News Digest under ENVIS Project was published by scanning 14 daily newspapers received in the NFLIC. A Special issue on Joint Forest Management (JFM) was also published in the month of August, 2000.

A total of 1,960 Grey Literature documents were received from the State Consultants, out of which 1,383 documents were accepted. These accepted documents were accessioned and classified using ODC System of classification. Besides 800 abstracts were also prepared for **Grey Literature in Forestry under FREEP**.

The bibliographical details of all the accepted documents numbering 5,783 were entered into a database for accessing them expeditiously.

The NFLIC sold 1,522 books and 47 VHS cassettes and earned revenue of Rs. 2.15 lakhs from this Sale.

### **F.R.I. Deemed University**

Forest Research Institute, Dehra Dun was conferred the status of 'Deemed University' by the Ministry of Human Resource Development, Government of India, New Delhi vide notification No. F-9-25/89 U-3 dated 6.12.1991. After the conferment of Deemed University status academic activities of the Institute have increased tremendously and it has been fostering research and education in Forestry, Environment and other allied disciplines in a more meaningful and productive way.

#### **Academic Courses and admissions:**

The FRI (Deemed University) has been offering the following academic courses on a regular basis:

- M.Sc. Forestry (Economics and Management)
- M.Sc. Wood Science and Technology
- M.Sc. Environment Management
- Post Graduate Diploma in Plantation Technology
- Post Graduate Diploma in Pulp & Paper Technology
- Post Graduate Diploma in Biodiversity Conservation

The M.Sc. courses are of two years duration whereas Post Graduate Diploma Courses are of one year duration. The intake capacity of each course is 15 except PGD in Pulp & Paper Technology where intake capacity is 10 students.

During the year 82 students were admitted in all to the above six courses. At present the total strength of the students in all courses is 111.

#### **Special Lectures:**

- Special lecture was delivered by Dr. R.V. Rao, Head, Wood Project Division, IWST, Bangalore on Wood Science & Technology.
- 31 guest lecturers arranged for PG Diploma Pulp & Paper Technology / M.Sc. Forestry students.

#### **Ph.D. Programme:**

With the support of the World Bank, ICFRE, UGC and CSIR, etc. coupled with the guidance of talented researchers, which the Institutes and established Research Centres have, the research activities under Ph.D. Programmes have increased manifolds. At present 343 Research Scholars have been registered including registration of 84 Research Scholars in the current year working on different research Projects. During the year, 37 Research Scholars have been awarded Ph.D. Degree.

#### **Training and placement:**

Besides practical training in the laboratories, Pilot Plants Nurseries and Reserved Forests FRI, compulsory practical field training visits to important industrial establishments and one-month Industry Project placement were arranged for the students to various places in Malaysia. Collaboration with SFD and Wood Based Industry was made.

The Deemed University has a well-equipped Computer Center where compulsory training to Research Scholars and Students belonging to all the six courses are provided regularly.

The Students are helped to secure suitable employment, for which campus interviews are arranged from time to time.

#### **Student's welfare activities:**

- F.R.I. (Deemed University) provides medical facilities to its students.
- Hostel accommodation is available in F.R.I. Campus.
- The facilities for indoor games and common room are provided to the hostlers.
- Library and Computer facilities are available to the students.

### **EXTENSION**

#### **Facilities generated and services rendered**

- Technical assistance and services were provided to organisations and approximately Rs.49, 000 was earned for testing of paper, catechin content in wood samples, etc.

- Consultancy service on various aspects of timber utilisation were provided to different Govt. Deptt. /user agencies etc. for improving the quality of wood Products by testing of wood and wood products / adhesives / chemical preservatives etc. Rs.21.08 lakhs revenue was generated.
- Remedial measures were suggested for referred insect pest problems. Insect identification service provided to various Institutes, Govt., Semi-Government and other organizations, Universities etc.
- ✓ **Other Extension Activities are reported in the Introduction - Forestry Extension, ICFRE.**

## FINANCIAL STATEMENT DURING 2000-2001

<b>I. PLAN</b>		<b>EXPENDITURE (RS. IN LAKH)</b>
A.	REVENUE EXPENDITURE	
	(a) Research	402.84
	(b) Administrative Support	321.02
	(c) Others specify	- -
B.	LOAN AND ADVANCES	
	(a) Loan Advances (Conveyance)	0.22
	(b) House Building Advance	1.20
C.	CAPITAL EXPENDITURE	
	(a) Building & Roads	- -
	(b) Equipments, Library Books	- -
	(c) Vehicles	- -
	(d) Others specify	- -
<b>TOTAL FOR PLAN (A+B+C)</b>		<b>725.28</b>
<b>II. NON-PLAN</b>		
A.	REVENUE EXPENDITURE	
	(a) Research	309.28
	(b) Administrative Support (Salary)	400.00
<b>TOTAL FOR NON-PLAN</b>		<b>709.28</b>
<b>III. FUNDED PROJECT</b>		
A.	World Bank Project	202.97
	UNDP Project	24.67
	NABARD Project	8.65
	FORTIP	16.60
	Others specify	44.26
<b>TOTAL FOR FUNDED PROJECT</b>		<b>297.15</b>