

CHAPTER-IV
FOREST RESEARCH INSTITUTE
DEHRA DUN

Established in 1906, the Forest Research Institute, Dehra Dun is one of the oldest institutions of its kind, acclaimed the world over. Institute's history is a chronicle of evolution and development of scientific forestry not only in India, but over the entire Indian sub-continent. 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 U.P. Himalayas.

PROJECTS COMPLETED DURING 1997-98

Project 1: Design and development of accelerated and simulated performance tests and basic properties and evaluation of wood products and materials received from out side organisations.

Objectives: To develop accelerated and simulated performance tests for door/window shutters and fix the criteria of acceptance keeping in view the actual requirements and standardise the test method and procedures.

Results

Studies have helped in the design and development of door shutters from timbers hitherto made from only conventional timbers and also in the quality control. Several Govt. Deptts. and industries have benefited as door shutters from species like Eucalyptus and Rubber wood are now being used in large numbers. The studies have also helped in the revision/formulation of Indian Standards. Some methods have also been developed for packing cases, tool handles etc. for performance evaluation of these items.

Project 2: Evaluation of suitability of LVL from Poplar for door/window shutters.

Objectives: To determine the technical feasibility of producing laminated veneer LVL from plantation grown *Populus deltoides*.

Results

LVL (Laminated Veneer Lumber) boards were prepared using PF adhesive at 14 kg/cm² pressure for 30 minutes 14 kg/cm² for 25 minutes and 17.5 kg/cm² for 25 minutes and tested for physical and mechanical properties. Door shutters from LVL were made and subjected to functional tests for their performance which showed satisfactory results.

Project 3: Evaluation of suitability of *Paulownia* for wood composite.

Objectives: To evaluate its suitability for making wood composite.

Results

Peeling behaviour of wood has been studied. Gluing behaviour of wood is excellent. However, being weak wood, glue shear values do not meet IS requirements and as such is suitable only for making light, work plywood. It being light, is very good material for making block boards for light furniture. This wood is an excellent raw material for making fibre insulation board.

Project 4: Evolving gluing techniques for high glue bond strength in *Eucalyptus* hybrid plywood.

Objectives: To study the gluing behaviour of *Eucalyptus* using UF and PF glue for MR and BWR grade plywood.

Results

Gluing behaviour of *Eucalyptus* hybrid for making moisture resistant grade (MR) of plywood has been studied. UF glue at 17.5 kg/cm² pressure in all *Eucalyptus* veneer construction and UF glue with 10% Carbohydrate derivative at 14 kg/cm² and 17.5 kg/cm² pressure in all *Eucalyptus* veneer construction and about 14 kg/cm² in construction having *Eucalyptus* and poplar veneer gave satisfactory glue bond and the plywood so prepared meets the requirement of general purpose plywood as per Indian Standard.

Project 5: Studies on the effect of lindane and chlorpyrifos on the glue bond strength of interior grade *Populus deltoides* plywood.

Objectives: To develop methods for improving durability of plywood made from non-durable species by the method of imparting glue line poison treatment.

Results

The preliminary observation on the glue shear strength data shows no adverse effect of chlorpyrifos on it. But no definite trend was observed in case of lindane treatment on glue shear strength. The results of termite resistance test are awaited and yet to be received from Entomology Division.

Project 6: Studies on partial replacement of phenol with CNSL for preparation of phenolic adhesive for plywood.

Objectives: To develop cheaper adhesives from naturally occurring material like CNSL oil for plywood industry.

Results

CNSL oil was procured for preparation of phenolic adhesives. Prepared CNSL oil based phenolic adhesives by replacing 10, 20, 30, 40 and 50% phenol using alkali (NaOH) as catalyst and trichloro ethylene as solvent. These adhesives were used for making plywood. The plywood were tested for glue adhesion strength in dry, wet and mycological state. Upto 50% replacement of phenol with CNSL oil, the adhesives meet the requirements of IS specification for BWR grade.

Project 7: Studies on the suitability of bark from *Eucalyptus* species as filler/extender for plywood adhesives.

Objectives: To reduce the cost of resin.

Results

Upto 15% *Eucalyptus* hybrid bark powder as filler in PF resin, the plywood meet the requirements of IS specification.

Project 8: Evaluating the suitability of *Melia azedarach*, *Pinus roxburghii*, *Ailanthus excelsa* and *Prosopis juliflora* for particle board.

Objectives: To utilize various lingocellulosic residues for manufacture of building board like particle board which can substitute solid wood for various purposes.

Results

Flat pressed single layer particle boards were prepared from *Melia azedarach* using 6, 8, 10, 12 and 14% of PF resin and 1% wax emulsion as a sizing agent. With 10 percent resin content and 1% wax emulsion as sizing agent, the particle boards meet the requirements of IS specification.

Project 9: Ecological monitoring of biological diversity and the strategy of conserving thereof in the region of U.P.

Objectives: (a) Identification and demarcation of the areas that need biodiversity conservation. (b) Functioning and structure of dominated vegetation communities. (c) Population dynamics of rare and threatened species. (d) *In situ* conservation and maintenance of biological diversity.

Results

Nine types in eight hill districts of U.P. having 'Hot Spot' diversity areas were marked for periodical ecological monitoring. The species diversity of trees was observed with the increasing altitude while that of herbs opposite trend was observed. Lack of silvicultural operations above 1000 meters is posing problem of regeneration of important species. Due to the over exploitation and change in resource availability some of the species are being eliminated from the system, these are *Cinnamomum tamala*, *Carpinus viminea*, *Hovenia dulcis*, *Taxus baccata* and *Acer caesium*.

Project 10: Identification of provenances of Teak based on leaf morphology.

Objectives: Provenance identification of Teak by use of leaf morphological traits.

Results

On the basis of certain foliage morphological genetic markers a simple key has been prepared to identify different sources provenances of Teak.

Project 11: Analysis of geographic variation in *Acacia nilotica* and *Tectona grandis* from previously collected data.

Objectives: To find out high yielding types which may be propagated vegetatively or otherwise for plantation purposes to increase the yield.

Results

In case of *Acacia nilotica* identified high yielding types at seedling stage through discriminate function analysis while in case of *Tectona grandis* attempt was made through discriminate function analysis with an aim to arrest the identified increased gain through clonal propagation.

Project 12: Estimation of biomass, productivity and nutrient cycling in age series plantation ecosystem of teak.

Objectives: (a) To estimate the biomass of age series of plantations. (b) To develop regression equations for predicting biomass of age series plantations. (c) To estimate the nutrient cycling of teak plantations.

Results

Growth parameters of age series teak plantations raised in Tarai region of Uttar Pradesh were studied and regression were worked out. In all there were 11 plantations of 10, 11, 13, 19, 20, 23, 28, 29, 30, 32 and 39 years. In these plantations the annual uptake (Kg/ha) of various nutrients varies as N- 40 to 59; P- 7 to 9, K- 27 to 43; Ca- 85 to 125 and Mg- 12 to 21.

Project 13: Economics of *Tectona grandis* plantation in Tarai region of U.P.

Objectives: To study the economics of teak plantations raised by the Forest Department in the Tarai Region of UP.

Results

Five teak plantations of between the ages 15 and 41 years, for which the data was available from the Forest Departs of Tarai region were selected. The important financial indicators NPV and IRR were worked out.

Project 14: Preparation of Volume and yield Tables of Chir Pine of different seed origins, situated at the Demonstration Area sample plots in FRI.

Objectives : (a) Preparation of volume tables of *Pinus roxburghii* of different seed origins. (b) Preparation of yield tables of *Pinus roxburghii* of different seed origins.

Results

Regression equations for the total volume as well as stem timber volume were developed for individual trees covering the entire range of diameter classes. The regression equation for calculating the total yield of an individual tree covering the entire range of diameter classes at different ages have also been developed.

Project 15: Development of Forestry tools and equipment.

Objectives: To develop a pruning tool.

Results

The tool has been successfully tried for pruning operations in the field and it has been found that the tool gives a smooth cut during pruning, avoiding any fungal attack to the cut surface. In addition, the tool is more efficient productive than the conventional pruning tools.

Project 16: Revision of the book "Indian Woods - their identification, properties and uses", Vol.I.

Objectives: To revise and update earlier version.

Results

The revised manuscript has been submitted for publication. It includes additional information including microscopic features of wood of different species.

Project 17: Survey, Cultivation and Extension of some rare medicinal plants of North-Western Himalayas (Sponsored by IDRC).

Objectives: Development of cultivation practices of some rare and endangered medicinal plants of the North-Western Himalayan region for their conservation and extension to the hill communities for their socio-economic development.

Results

Surveys for the natural distribution and occurrence of *Taxus baccata*, *Nardostachys jatamansi*, *Picrorrhiza kurroa* and *Colchicum luteum* were undertaken in UP hills (Garhwal region), parts of HP and J&K hills. The germplasm of these species was collected from different locations and established at Chakrata nursery. Rooting was successfully induced on the stem/shoot cuttings of *Taxus baccata* using a combination of phytohormones. The other species were multiplied by vegetative means and provenance trails were initiated which are being continued. Chemical analysis of the species was undertaken to select the best chemotypes of the species for cultivation purposes.

Project 18: Improved utilisation of fibrous raw materials for pulp and paper making. Chemical composition and optimisation of the conventional pulping process through kinetic studies of non-woods.

Objectives: Studies on upgradation of wheat straw and rice straw pulps.

Results

Upgradation of the raw material was done by removing nodes and leaves. Chemical composition of whole straw and upgraded straw shows that percentage of polysaccharide is more in upgraded straw as compared to whole straw.

Project 19: Technology for improvement of land based biomass productivity under different social forestry plantations.

Objectives: (a) To determine the biomass productivity potential of land under different use. (b) To assess the soil fertility in terms of physico-chemical attributes and its relationship to biomass yield.

Results

Different land uses such as farming, agroforestry, fruit tree farming and natural fallow were studied for soil nutrient changes at different stages. There was a general depression in available nutrient store of N, P & K due to raising of wheat crop in farming and agroforestry and because of fruit harvest in fruit tree farming land use. The available nutrient store under natural fallow was quite comparable with other land uses though there was no cropping on this land. Collar dia and height of poplar trees under agroforestry was more than Mango trees under fruit tree farming land use.

Project 20: Selection of suitable provenance of tree species for sodic soils.

Objectives: To select the site-matched provenances for higher production in sodic lands.

Results

A provenance trial consisting of 20 provenances of *Dalbergia sissoo*, 10 provenances of *Acacia nilotica*, 6 provenances of *Azadirachta indica* and 5 provenances of *Prosopis cineraria* was conducted in sodic lands of Sultanpur district in U.P. The provenances of the above said species which had higher survival and produced higher biomass were identified.

Project 21: Geological, geomorphological and micromorphological studies of skeletal and sodic soils.

Objectives: To determine the nature and degree of correlation between geology, mineralogy and geomorphology with soil and vegetation.

Results

The studies were carried out in skeletal soils of Mussoorie forest division and sodic soils of Haryana and Uttar Pradesh. Geological and geomorphological studies in the skeletal soils revealed presence of low to moderate amount of weatherable minerals indicating their podzolic nature. Micromorphological studies revealed that platy epipedon, dominance of ultra micro and micro voids, plugging of meso and macro voids at surface restrict infiltration of water and arrangement, size and shape of these particles revealed sepic plasmic fabric. The findings have been compiled, tabulated and presented in the form of research papers and project reports.

OLD PROJECTS CONTINUED DURING 1997-98

Project 22: Control of growth stress induced sawing and seasoning degrade in plantation wood.

Objectives: To identify and develop pre-treatment and storage/sawing/stacking procedures for alleviating growth stresses induced warp and splitting in plantation grown juvenile wood.

Achievements

With the vacuum press drying kiln, it was possible to season *Eucalyptus* wood without any warp. This method is on an average, 6-7 times faster than normal drying method.

Project 23: Chemical plasticization of wood for solid bent wood furniture.

Objectives: To design and develop a pilot plant for the vapour phase ammonia treatment of wood in thick section.

Achievements

Work on bending of 12.5 mm and 25 mm thick strips of *Michelia champaca*, *Terminalia myriocarpa* and *Paulownia fortunei* was completed. A research paper is under publication. On the basis of data already collected a bent wood chair of Poplar wood was designed and developed.

Project 24: Studies on reducing drying time in Solar kiln.

Objectives: (a) To develop appropriate low cost kilns for small users and rural applications. (b) To design energy conserving process and improvements in conventional systems to improve timber seasoning technology.

Achievements

With a view to measure drying time vis-a-vis energy consumed, four charge of sissoo wood planks were dried in solar kiln using solar energy during day time and electrical energy during night time. One charge of Eucalyptus and one charge of sissoo wood planks were dried using solar energy during day time and dehumidifier during night time. Data are being analyzed.

Project 25: Development of appropriate technology for utilization of bamboo and Eucalyptus poles and poplar planks for cost effective housing and other structural components.

Objectives: To utilise Bamboo and plantation timber (Eucalyptus poles and poplar planks) for low-cost house construction suiting rural and urban poor.

Achievements

The test results of bamboo bundle columns have been analysed for application in mines. One-cross columns pole truss in Eucalyptus has been tested to destruction with 720 kgs of loading at failure. A few door shutters have been developed from poplar as ledged and braced, cross-laminated and with finger jointed stiles to counter the effect of inherent warping. Further experiments are on.

Project 26: Studies on wood working, carving and wood finishing on plantation timbers, development work on utility process and performance.

Objectives: Developmental work on machinability, other related properties and their optimization for plantation grown timbers.

Achievements

The treatments using ammonia fuming, bark extracts and linseed oil have been tried on plain looking timbers like poplar for achieving twin benefits of surface improvement and water repellency. The results indicate that such treatments are expected to be of great value to the wood finisher. Further efforts to perfect these treatments on statistical replicates are underway with objective of evolving patentable package.

Project 27: Evaluation of physical and mechanical properties of plantation timbers including studies on variation of properties of timber, grading and development of a CD for physical and mechanical properties of Indian timbers.

Objectives: To conduct species wise evaluation of properties including development of non destructive tests methods for quicker evaluation, study the effect of age of trees, between and within trees variation of properties, effect of defects etc. to classify and grade the timber for different end uses.

Achievements

The physical and mechanical properties of 20 clones of *Populus deltoides* were evaluated. It was observed that while clones St-63 and S7-C3 gave highest sp. gravity and strength properties, their rate of growth was somewhat lower than G-3 and G-48 clones. It was also observed that sp. gravity and maximum crushing strength of central portion of log were significantly lower than outer portion in all the clones. Software was developed for computerisation of physical and mechanical properties data of Indian timbers and data entry work has been completed.

Project 28: Studies on durability/treatability and efficacy of preservative treated wood spp. including plantation wood spp.

Objectives: (a) To evaluate treatability of plantation grown spp. (b) To evaluate durability of plantation grown species (bakain and poplar).

Achievements

Bakain and poplar wood were procured and samples were treated with CCA and creosote: fuel oil at 3 levels of absorption and installed at Dehra Dun and Jodhpur test yards. Microscopic studies were carried out on *Paulownia* sp. after treatment with creosote, wax dye and silver nitrate. Samples of *Eucalyptus* hybrid, chir and bakain were prepared and are being treated with ACA and CCA for testing their performance in cooling tower.

Project 29: Pressure treatment of refractory wood species/green wood.

Objectives: (a) To formulate treatment schedules to treat green timbers. (b) To develop mechanical pre-treatments to improve penetration and distribution.

Achievements

Flow path studies of *Eucalyptus* with ammonical silver nitrate solution were carried out. It was observed that ammonia penetrated deep into the cell wall. Experiments were carried out on the removal of residual ammonia from ACA treated wood. Partial removal of ammonia was achieved by subjecting to post treatment vacuum.

Samples of *Eucalyptus* were treated with two ACA formulations and ACZA formulation. Treatment was carried out at ambient room temperature as well as at elevated temperatures. It was observed that adequate penetration and loading could be obtained in 4 hours at elevated temperature. Modified ACA formulation gave better results than normal AWPA formulation of ACA and ACZA.

Project 30: Regeneration, Mortality and species diversity in Sal forests of U.P.

Objectives: (a) To find out the indicative values of mortality and poor regeneration. (b) To find out the change in resource availability and its impact on nutrient cycling. (c) To find out the role of secondary successional species synchronising with the disturbed nutrient cycling.

Achievements

Sites for mortality due to abiotic and biotic factors and poor and good regenerating areas have been selected in Dehra Dun for studying the structure and functioning of the ecosystem.

Project 31: Ecological Monitoring of Biological diversity and the Strategy of Conserving thereof in the region of U.P.

Objectives: (a) To find out the present ecological status of the ecosystem of 'Hot Spot' diversity areas. (b) To estimate the energy budget of the 'Hot Spot' diversity areas to evaluate the carrying capacity. (c) *In situ* conservation measures for Rare and Threatened species.

Achievements

Moist temperate forests of Kedarnath Forest Division and 'Hot Spot' diversity areas were selected for finding the Structure and Functioning of these forests to understand the mechanism for '*In situ*' conservation and carrying capacity.

Project 32: Genetic improvement of *Pinus roxburghii* (chir pine) including provenance research.

Objectives: To delineate the provenance(s) suitable and specific to site.

Achievements

Most promising provenances were identified at age six years which are still maintaining their superiority and ranking positions at age 16 years.

Project 33: Tree Improvement (World Bank Project).

Objectives: (a) To understand breeding system of *Dalbergia sissoo*, *Eucalyptus tereticornis* and *Populus deltoides* and to develop hybrids specific site. (b) To develop macro and micro propagation techniques after rejuvenation of the above mentioned species.

Achievements

Developed new F1 hybrid by crossing *E. tereticornis* (Mysore gum) with *E. camaldulensis* (Southern form). Developed protocol for mass clonal multiplication of superior phenotypes of *E. tereticornis* via micropropagation. Standardized macropropagation technique for mass multiplication of *D. sissoo* through bi-nodal cuttings. Rejuvenation of *Eucalyptus* through serial grafting, hedging, micropropagation rejuvenation has been achieved. In case of *Populus* 51 combinations have been tried through control crossing and seed harvested.

Project 34: Planting Stock Improvement Programme (World Bank Project).

Objectives: To produce quality planting material through the establishment of SPA's, SSPA's, CSO & hedge garden.

Achievements

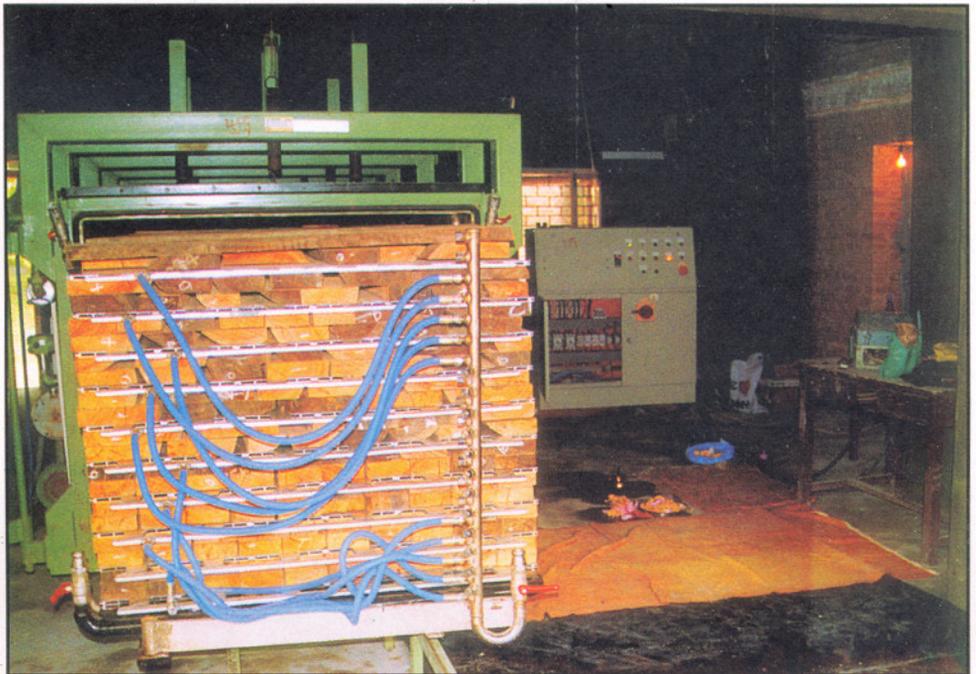
These are summarized in the following table :

Species	Area in ha.			
	SPA	CSO	SSPA	VMG (Hedge garden)
ET.	21.80	15.10	7.00	1.20
DS	50.00	10.50	9.40	0.75
PR	110.00	NIL	3.50	0.50
Total	181.80	25.60	19.90	2.45

ET=*Eucalyptus tereticornis*, DS= *Dalbergia sissoo*, PR= *Pinus roxburghii*



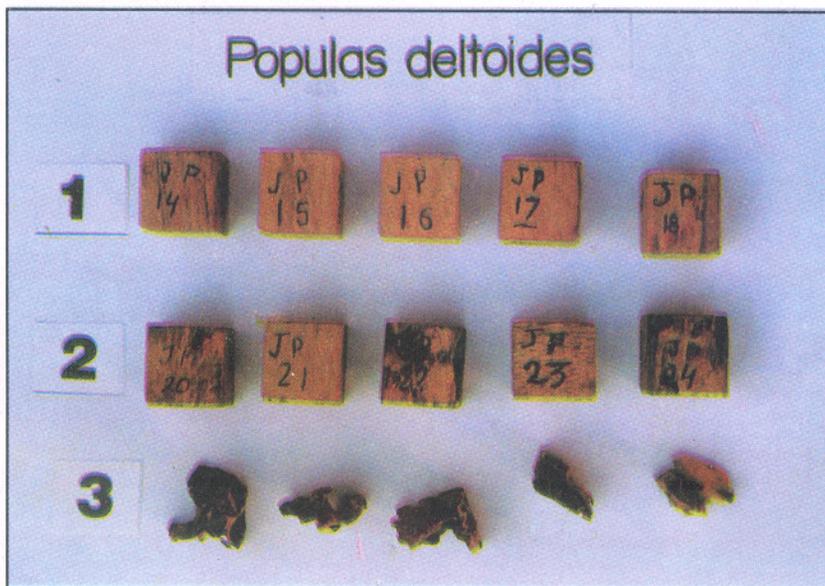
Sal top drying in Laldang Range (Lansdown Forest Division)



Vacuum based timber drying kiln



Jewel Beetles : Showing insect biodiversity
 aesthetic ,ornamental value also injurious
 to forest (wood borer)



Termite resistance obtained by Zinc borate treatment,
 (1) and (2) treated, (3) is control

Project 35: Preparation of Volume and Yield Tables of promising clones of *Populus* spp. in North zone of India.

Objectives: (a) To prepare the volume table of promising clones of *Populus* spp in North zone of India. (b) To prepare yield table of promising clones of *Populus* spp. in North zone of India.

Achievements

Literature review has been done with selection of sites in Tarai Region of UP. Some available promising clones and their plantations sites have been identified. Measurements of about 180 felled trees of G-48 clones and 175 felled trees of D-121 clones have been recorded. Two temporary sample plots of G-48 and D-121 have been laid out.

Project 36: Improvement of nursery techniques of commercially important tree species.

Objectives: To study the germination behaviour of various seeded pods and naked seeds of *Dalbergia sissoo*.

Achievements

Investigations were carried out to standardize the covering method of *Dalbergia sissoo* i.e. requirement of shade, mulch and open bed for better germination. The results indicate that to reduce the period of seedling in nursery and cost of raising seedlings, the seeds should be sown in nursery providing mulch with dry leaves or dry grass for early and maximum germination as compared to shaded or open bed. After the germination starts, mulch should be removed.

Project 37: Investigation into viability, germination and longevity of some important species of upper Gangetic plain.

Objectives: (a) Studies on germination, the effect of seed moisture content, and storage temperature on the longevity of *Ailanthus excelsa* seeds. (b) To determine optimum conditions for the germination of *Syzygium cumini* seed.

Achievements

The storage studies on *Ailanthus excelsa* are continuing, while work on *Syzygium cumini* will be repeated next year. Preliminary work on the screening of recalcitrant seeds was initiated.

Project 38: Storage of forest tree seeds (World Bank Project).

Objectives: Research and devise an appropriate cost effective technology for short to medium term storage of seeds to maintain viability and vigour.

Achievements

The storage trial on 8 species was continued with periodical germination test. A Common Action Programme in Seed Technology for ICFRE institute has been prepared.

Project 39: Clonal propagation of *Dalbergia sissoo*, *Tectona grandis*, *Eucalyptus* hybrid and Bamboo.

Objectives: To optimise the clonal propagation procedure by developing an understanding of the effect of growth regulatory substances, fertilizers, maturity of the mother plant and other physiological factors affecting rooting of cuttings.

Achievements

Initial observations have indicated important intraclonal variation in the clonal propagules of several clones of *Dalbergia sissoo*. Differences were apparent in the suckering ability, coppicing ability, rooting of binodal cuttings, and growth of rooted cuttings.

Project 40: Identification and screening of suitable nitrogen fixing species of trees, shrubs, and herbs for agroforestry plantations and wasteland afforestation programmes.

Objectives: (a) Survey, identification and distribution of leguminous and non-leguminous nitrogen fixing herb, shrub, climber and tree species already existing in the Himalayan region and alluvial plains. (b) Evaluation of suitable, fast growing nitrogen fixing tree species which can be recommended for agro-social forestry plantation and wasteland afforestation programmes.

Achievements

Survey and identification of leguminous and non-leguminous nitrogen fixing plants was done during this period. Out of eight species selected, four species viz., *Caesalpinia pulcherrima*, *Delonix regia*, *Gleditsia macrantha* and *Adenanthera microsperma* were observed as non-nodulating and *Callindra calothyrsus*, *Abrus precatorius*, *Dalbergia sericea* and *Erythrina blakei* were identified as nodulating.

Dalbergia sissoo seeds were collected from six different sources i.e., Jammu, Chiryapur, Hissar, Gonda, Assam and Nepal and sown under pot culture conditions to study their performance in relation to nitrogen fixation, assimilation and growth behaviour.

Project 41: Physiological effects of water stress on some forestry tree species.

Objectives: (a) To identify the suitable clones and provenances for plantation in dry regions i.e., arid and semi-arid zones of India. (b) To study the moisture stress tolerance of individual clone/provenance and find out critical soil moisture condition required by a clone/provenance to stay alive. (c) To find out suitable treatments to combat the ill effects of water stress.

Achievements

Plus tree was selected for the collection of seed for provenance and progeny trials. Planting was done for the provenance and progeny trials at different experimental sites. Experiments were executed in water stress physiology with antitranspirant treatments. Results are awaited.

Project 42: Studies on rare and endangered plants.

Objectives: (a) To prepare an enumerative account of rare and endangered species. (b) To study the causes of their rarity. (c) To ascertain conservation value of species and standardize their *in situ* and *ex situ* conservatory measures.

Achievements

Enumerative treatise on 100 species of rare and threatened status was completed with emphasis on their distribution, threatened habitat, phenology and measures for conservation. Ethnobotanically and medicinally important threatened plants of Kumaon and Garhwal Himalaya were enumerated. Checklist of threatened species of medicinal importance was compiled.

Field surveys were undertaken in Siwalik and sub-Himalayan tracts for studying the threatened flora of the region. Studies on *ex situ* conservation of 10 species of plants were made. Key areas of conservation/preservation were identified for the critically endangered taxa.

Project 43: Computerisation of Herbarium of Forest Research Institute, Dehra Dun.

Objectives: The Dehra Dun Herbarium has about 3,30,000 specimens. It is proposed to computerise around 40 characters of the species present in the Herbarium for easy identification of specimens.

Achievements

Parameters for automated information mechanism were finalised. Species and generic diversity with regards to five families were assembled through authentic specimens housed in the herbarium. One hundred type specimens were studied and catalogued with a view to developing a database.

Project 44: Publication of the book "Indian Woods - their identification, properties and uses", Vol. VI.

Objectives: It was planned to publish a comprehensive book "Indian Woods - their identification, properties and uses" in Six volumes covering 1600 woody species. Five volumes have already been published and this project is on the sixth and final volume of the book.

Achievements

Drafts of six families out of 15 families included in the book have been finalized and manuscript is expected to be submitted for publication soon.

Project 45: Studies on isolation and characterisation of polysaccharides of abundantly available seeds trees/shrubs, leaves, bark and exudate gum.

Objectives: (a) Substituting over exploited non-wood forest products with readily available non-forest based material. (b) Optimum utilisation of abundantly non-wood forest products, and (c) Development of products required for forest based industries.

Achievements

Water soluble polysaccharide was isolated, purified (yield ~14%) and sent to pharmaceutical Division, CDRI, Lucknow for testing in tablet dosage forms and syrups. *Cassia tora* endosperm was taken with water (1:7, m/v), autoclaved at 115-120°C (25-30 psi) for 60, 90 and 120 minutes respectively. It was drum dried and powdered.

Anionic polysaccharide reaction of galactomannans derived from *Cyamopsis tetragonolobus*, *C. tora* and *Sesbania bispinosa* was carried out. Three samples viz. Guar gum acrylamide (code A), CTG-acrylamide (code B), CTG-acrylo-nitrile (code C) and given to Daurala Sugar Works for testing its efficacy in sulphited sugar cane juice.

Project 46: Development of adhesives from renewable sources (starch/bark etc.).

Objectives: Utilisation of Non-wood forest products.

Achievements

Grafting of formaldehyde into Starch was done and samples IS-7, IS-9 and IS-12 were prepared (300g each). One hundred gram of each sample was given to UDCT, Bombay for Brabender studies and to Aromor Plast Ltd., Bangalore for making biodegradable plastic articles. One kg of adhesive was prepared for making corrugation boxes and handed over to Poddar Pharmaceuticals, Hardwar. One kg of biopolymer for agarbathi making was prepared and sent to N. Rangsons Mysore. This know-how is likely to be sold shortly.

Project 47: Phytochemical examination for utilisation of leaves, bark, fruits and roots of Indian Forest trees.

Objectives: Studies of vegetable dye from forest biomass.

Achievements

Methods were standardized to obtain black colour on different fabric from Eucalyptus, *Grewia* and *Terminalia* species. Very few plants give black dye. Pilot plant experiments were done to isolate dye from Eucalyptus saw dust and bark. Dyeing trials using different mordants were also conducted using manjitha lac, indigo dyes and banana leaves. Optimum conditions were determined to isolate dye from *Populus deltoides* bark from Bareilly and Yamuna Nagar samples.

Project 48: Studies on tree bearing oil seeds.

Objectives: Studies on *Jatropha curcas* seed.

Achievements

Jatropha curcas seed oil was refined by giving alkali treatment. In order to reduce the cost of refining, extraction of the oil with aq. methanol was carried out in place of partitioning the oil between pet. ether and methanol. The refined oil sample has been sent for its toxicity evaluation. Ethanol is cheaper than methanol and is also less toxic. Hence, refining of the oil was carried out using ethanol in place of methanol. The refined oil sample has been sent for toxicity evaluation.

Project 49: Recycling of waste paper.

Objectives: Utilisation of waste paper as a raw material.

Achievements

Literature was surveyed and the project was formulated as per research priority setting exercise. Preliminary investigations of recycling/deinking of old news papers was carried out in the laboratory hydropulper using different chemical combinations, viz alkali, silicate and hydrogen peroxide etc. Varying the time and temperature of treatment have shown improvement in brightness and strength properties.

Project 50: Research methods for reducing environmental pollution resulting from processing (Multistage bleaching sequence).

Objectives: To reduce the environmental pollution.

Achievements

Kraft pulps from *E. tereticornis* and *Dendrocalamus strictus* were delignified under optimised conditions.

The results reveal that by oxygen delignification there is about 50% reduction in BOD and 60% reduction in COD and pulps exhibits almost same physical strength properties except for marginal drop in brightness as compared to conventional CEHH sequence.

Project 51: Reclamation and Ecological Monitoring of Iron Ore mines in Saranda - Bonai range (SAIL - ICFRE Project).

Objectives: To develop appropriate Reclamation technologies for Iron Ore mine areas of the country and to monitor the restoration of Ecosystem, structure and function of the ecologically rejuvenated mine areas.

Achievements

The project was taken up as a part of MOU signed between Steel Authority of India Ltd., and ICFRE. Phase-1 of the project has been completed and data collected have been compiled in the form of a report. Rapid ecological appraisal of eastern sector iron ore mines of SAIL has been done. Phase-II of the project is in progress.

Project 52: Seed pathology of bamboo species; *Dalbergia sissoo*, *Eucalyptus*, *Anthocephalus chinensis*, *Acacia nilotica*, *Albizia lebbek*, *Grewia optiva* and *Acer caesium*.

Objectives: To identify seed mycoflora including seed borne pathogenic fungi and check seed deterioration in storage, and nurseries diseases by seed borne pathogens.

Achievements

Studies carried out on seed mycoflora of *Anthocephalus chinensis*, *Grewia optiva* and *Eucalyptus* revealed presence of 22 fungi belonging to 18 genera. Seed treatment which is easy to apply and economical, effectively controlled seed mycoflora. Emisan was found most effective to control seed mycoflora of *Eucalyptus* and *G. optiva* followed by Bavistin whereas in case of *A. chinensis* Emisan was most effective followed by Thiram. However, in *A. caesium* a mixture of Emisan and Bavistin checked growth of seed mycoflora more effectively.

Project 53: Studies on nursery and plantation diseases of *Eucalyptus*, *Acacia*, *Azadirachta indica* and *Paulownia* spp.

Objectives: To monitor disease situation in nurseries, detect new disease outbreaks and work out suitable control measures.

Achievements

Seedlings of *Bauhinia purpurea* raised in the nursery at New Forest were found attacked by *Rhizoctonia solani* which blighted the leaves resulting in premature defoliation. The disease incidence was 10%. *Dalbergia sissoo* seedlings were found in the grip of a serious foliar disease caused by *Colletotrichum dematium* and *C. gloeosporioides* which resulted in 30-40% defoliation. *Culvularia lunata* causing sheath and leaf blight caused 20-30% defoliation. Two new *Phytophthora* diseases were recorded on *Chukrasia velutina* and *Paulownia fortunei*.

A nursery experiment conducted to study the impact of deoiled neem cake on the growth of *Acacia catechu* and nematode population revealed that the biopesticide reduced nematode

population in the soil by 75.5% and enhanced shoot height and plant biomass by 30 and 50% respectively. Seedlings of *Paulownia fortunei* were found heavily galled by *Meloidogyne javanica* and *M. incognita*. In case of root knot nematode inoculated plants, application of Furadan, deoiled neem cak (5g) and deoiled neem cake (10g) enhanced plant growth by 61.8, 105.3 and 174.5% and reduced gall formation by 57, 73 and 94.6% respectively.

Project 54: Studies on nursery and plantation diseases of *Albizia* spp. and their management.

Objectives: To evaluate the status of existing diseases, detect new disease outbreaks and evolve suitable control measures.

Achievements

Regular monitoring of diseases in nurseries and plantations was carried out. The fungi found associated with diseased plants were identified. High incidence of *Ravenelia sessilis*, leaf and stem rust of *A. stipulata* was recorded in Chakrata Forest Division nurseries causing premature defoliation. *Ravenelia clemensae*, leaf rust of *A. procera*, was severe on five year old plants in Chakrata Forest Division and *A. lebbek* seedlings in Dehra Dun and Chakrata Forest Division resulting in premature defoliation. Occurrence of yellow mosaic disease was observed on *A. lebbek* in Chakrata and Dehra Dun Forest Division nurseries. Rhizoctonia web blight of *A. lebbek* continues to be a serious problem in Dehra Dun and Kalsi nurseries. Among other diseases, *Cercospora* leaf spot was recorded on *A. lebbek* and *A. procera*. The biology of *Cladosporium* sp., a new leaf spot and die-back disease recorded on *A. lebbek* and *A. procera* was studied.

Project 55: Studies of diseases of poplar and their management.

Objectives : To evaluate the status of existing diseases, detect new disease outbreaks, identify the associated organisms and to evolve control measures.

Achievements

Monitoring of several Chinese and Korean clones raised at FRI revealed that only two Chinese clones namely 91-02-23 and 91-92-27 were resistant to *Phyllosticta adjuncta* leaf spot under field conditions. Laboratory bioassay of four fungicides against *Phyllosticta adjuncta* showed Dithane M-45 and Radomil to be effective in inhibiting the growth of the fungus. Their application in the field increased plant biomass.

Project 56: Surveillance and monitoring of insect pest, their seasonal abundance and control by light trap techniques. Management of sal heart-wood borer in natural forests.

Objectives : (a) To study and monitor the insect pest situation, distribution of insect fauna and population dynamics. (b) Constant monitoring of the sal borer and trap tree operations for control.

Achievements

Conducted insect pest surveys and recorded damage due to insect in forest nurseries, plantations in various forest divisions in U.P., Haryana, Punjab and Himachal Pradesh. Damage in poplar, due to *Clostera* spp; in shisham due to *Plecoptera reflexa* and *Dichomeris eridentis*; and in sal forest (Thano, Dehra Dun Div.) due to sal heartwood borer *Hoplocerambyx spinicornis* was studied in detail. The seasonal life cycle and population dynamics, incidence (%), the natural enemies complex were studied. The incidence of borer attack in sal forest

declined from 23% to 4% at Thano Range (Dehra Dun For. Div.) and 30% to 8.5% at Phanduwala, Rajaji National Park (D. Dun) due to trap tree operation carried out. Under light trapping, screening and sampling of insects was done regularly. Local abundance and distribution of insect fauna, population dynamics for various category of insects species (target pests) of agroforestry/social forestry importance was studied. The relative abundance of target insect pest species was recorded under changing climatic conditions during different months of the year.

Project 57: Laboratory evaluation of natural termite resistance in timbers of Eucalyptus, poplar and bamboo.

Objectives: To study the inherent properties of Eucalyptus, Poplar and Bamboos to resist termite attack.

Achievements

Studies on natural termite resistance was conducted and evaluated. Among eighteen (18) species of bamboos tested against *Microcerotermes besoni* and *Bambusa nutans* (22.1), *B. balcoa* (27.4), *Dendrocalamus strictus* (25.6), *D. giganteus* (29.9) and *Ochlandra travancorica* (29.8) were found more resistant compared to others. The figures shown in bracket represent weight loss.

Project 58: Identification of forest insect, augmentation and maintenance of entomological reference collection and museum.

Objectives : To maintain the FRI collection (wet and dry insect collection), museum specimens, and exhibits properly.

Achievements

Maintenance of the National Insect Collection representing 330 families and 28 insect orders, curation, and fumigation work of insect collection, museum specimens, exhibit etc. was undertaken. Insect specimens, damage material and samples received from different services were identified.

Project 59: Biological control of important forest insect pests and screening of forest seed for insect infestation (WB : ICFRE-6).

Objectives : The use of parasites, predators (natural enemies) to control the undesirable insect pest population.

Achievements

Bio-control studies on key defoliator of poplar-*Clostera* spp. (*C. cupreata* and *C. fulgurita*) and that of shisham-*Plecoptera reflexa* and *Dichomeris eridentis* were carried out. Efficient and promising parasitoids of poplar defoliators, which includes 4 egg parasite, 3-larval and 2 pupal parasites and a predator *Canthecona* spp. were identified. In shisham, 6 parasite and (2) predators were found effective as bio-control agents.

Sub Project 59(1): Seed Entomology : Seed pests and their management.

Objectives : To survey and assess the damage due to insect attack on seeds of important tree species in seed orchards, seed production areas (standing trees) as well as in storage condition.

Achievements

Survey of damage caused due to various insect pest species infesting seeds of coniferous and broad leaved species was carried out in U.P., Haryana and Himachal Pradesh. The incidence was recorded in field as well as under storage conditions.

Chemical control experiments were laid out to test the efficacy of various insecticides selected against seed insect infesting cone and seed in SPA and seed orchards in Acacia, Albizia, Prosopis, Cassia, Deodar, Pines (kail), Spruce and fir etc. The treatment of Monocrotophos (0.0125%) with 40 PPM, NAA (Alpha Nephthyl Acetic Acid) was found most effective among all other insecticides treated in different concentration.

Project 60: Effect of trees on agricultural crops.

Objectives: (a) To study the effect of leaf litter and bark/sawdust compost of poplar and *Eucalyptus* on growth and yield of agricultural crops. (b) To study the effect of spacing of poplar on agricultural crops. (c) To study the performance of shade-tolerant agricultural crops under the shade of poplar in block plantation.

Achievements

Laid out a trial to study the effect of removal of leaf litter of poplar in block plantation on the yield of intercropped wheat. Leaf litter was removed during December '97 - January '98 at four frequencies. Poplar was planted during February 1998 at the three spacings (i) 5m x 4m, (ii) 5m x 3.5m and (iii) 6m x 3.5m.

Studied the variation in yield of wheat as a function of distance from *Eucalyptus* row. Wheat fields were located to the east, west, north or south of *Eucalyptus* row. The greatest reduction (41 percent) upto 17.5 m distance plot was observed when wheat plot was located to the north of east-west oriented *Eucalyptus* row. Reduction was minimum (14 percent) when wheat plot was located to the south of east-west oriented *Eucalyptus* row.

Project 61: Strengthening and developing of ICFRE: Socio-economic advancement of villagers by increasing productivity through agroforestry (UNDP Project).

Objectives: (a) To raise demonstration plantations of tree species on farmers' private land. (b) To train the farmers in raising nursery stock of their preferred species. (c) To supply quality germplasm of poplar species to the farmers for its further dissemination in other areas.

Achievements

The existing germplasm bank of poplar clones was augmented by 20 additional clones, making the total number of clones equal to 361. After screening of the various clones of poplar at nursery level, those promising better performance were put to field test in different trials in the selected villages of Yamuna Nagar district of Haryana. The trials are being carried out in the fields of farmers with 20 clones in line and 10 clones in block plantation. The trials were laid down in 1994 and 1995. The performance of the clones so far suggests that G-3, G-48, S7C15, S7C20, L-87, L-88, L-89, L-90, L-200-84, St/-74, Udai, Kranti, Bahar and St-67 are good clones. G-3 and G-48, in a few cases, have started exhibiting susceptibility to attack by pathogens.

Project 62: Productivity enhancement: Management for people's participation (Ford Foundation Project).

Objectives: (a) To conduct socio-economic studies for documentation of short term and long term needs and expectations of participating societies and individuals therein from the forest lands.

(b) To develop site-specific models of rehabilitation/forest generation for maximising the production of goods and services needed in combining a variety of wood and non-wood forest products for meeting local demands and attracting forest community participation.

Achievements

The project is being implemented in Yamuna Nagar, Haryana as a representative of "dry deciduous mixed forest of low hills in North India". The study area under the project is the forest under Chhichhrauli and Sidhaura Ranges of Yamuna Nagar Forest Division and five villages near it. Socio-economic survey through participatory rural appraisal, social mapping and other related techniques has been carried out. Survey and identification of timber and non-timber forest products including grasses and medicinal plants have been carried out. Experiments on the yield enhancement of bhabar (*Eulaliopsis binata*) and growth of bamboo (*Dendrocalamus strictus* and *D. membranaceus*) in the forest, and performance of six improved grasses in the villages are underway. The improved grasses have now been introduced in the field bunds of the farmers.

Project 63: Planting Stock Improvement : Poplar breeding (FREEP).

Objectives: The objectives are : a). To develop clones of selected hybrids. b). To introduce new germplasm of *Populus deltoides* from southeastern states of the USA into India for developing new clones of wider genetic base. c). To introduce new species of poplar into India from tropical countries.

Achievements

Carried out hybridisation among 5 female and 17 male clones of *P. deltoides* during 1997. Flowering shoots of 24 male and 12 female clones of *P. deltoides* have already been planted at Haldwani for carrying out hybridisation during 1998. Raised 2200 seedlings from seeds collected from 104 candidate plus trees of *P. deltoides* from 44 stands in 10 states in the U.S.A. during 1997. The seedlings have now been planted in the nursery at 80cm x 60 cm spacing for screening individuals with superior growth. Planted 30 cuttings each of 40 promising clones of *P. deltoides* for undertaking field trial at multiple sites.

NEW PROJECTS TAKEN UP IN HAND DURING 1997-98

Project 64: Development and evaluation of eco-friendly wood preservatives.

Objectives: (a) Extraction of neem leaves, twigs etc. with different solvents and testing their toxicity against fungus. (b) Preparation of copper lignin complex and estimation of toxic ion in the product.

Progress made

Neem leaves/twigs were treated with petroleum, ether, benzene, chloroform and alcohol and concentrated extract in each case is being tested against fungus by soil block method against 4 fungi. *Ipomea cornea* leaves were treated with hot water. Water extract of 30% was tested against termites in laboratory. Copper lignin complex was prepared by reaction of copper and ligno sulfonate to yield a product with 11.88% copper content. Experiments are being repeated to optimise reaction variables.

Project 65: Studies on thermal conductivity, dielectric constant and creep behaviour of timber.

Objectives: To develop non destructive methods of timber testing.

Progress made

Thermal conductivity of six Indian timbers and dielectric constant of 5 coniferous species was studied and a relationship between these properties has also been established. Creep behaviour of MDF and particle board under long time loading at different stress levels has been studied.

Project 66: Development of packing boxes from plantation grown timbers for horticultural produce.

Objectives: To design and develop more economical packing cases from plantation grown species with the aim to reduce the usage of solid wood for packaging purposes.

Progress made

Material of *Eucalyptus* spp. was collected and converted into planks, battens etc. A new design of box has been developed. The newly designed boxes are under laboratory tests.

Project 67: Biogeochemical cycling in temperate forest ecosystem in Chakrata and Mussoorie Forest Divisions.

Objectives: (a) To find out the impact of disturbances on Biogeochemical cycling of Forest Ecosystem. (b) To find out the Regeneration potential of important tree species. (c) To find out the changes in species diversity with the changes in resource availability.

Progress made

Initial studies on vegetation analysis and resource availability have been initiated.

Project 68: *In vitro* rejuvenation of *Eucalyptus* hybrid, chir pine, Teak, Shisham, Neem and Bamboo.

Sub-Project 68(1): *In vitro* multiplication of chir pine and Bamboo.

Objectives: *In vitro* multiplication of above tree species using different explant sources.

Progress made

Technique for the explant surface sterilization has been standardized. Media was formulated for axillary bud proliferation in Bamboo. Procedure for surface sterilization and its culture in different types of media was done. Cultures were examined for somatic embryogenesis.

Sub-Project 68(2): *In vitro* multiplication of *Eucalyptus* and Shisham.

Objectives: *In vitro* multiplication of above tree species using different explant source.

Progress made

Technique was standardized for explant sterilization of *Eucalyptus*, its culture and *in vitro* shoot multiplication and rooting. For Shisham, technique of explant sterilization has been standardized.

Sub-Project 68(3): *In vitro* multiplication of Teak and Neem.

Objectives: Mass multiplication of frost hardy Teak and high oil yielding Neem.

Progress made

Technique for explant sterilization, culture establishment and multiplication has been standardized. In case of Teak preliminary experiments have been initiated.

Project 69: Identification of superior planting material through standardization of Isoenzyme analysis technique and establishing procedure for clonal identification.

Objectives: To standardize the isoenzyme technique for Eucalyptus and Identification of Eucalyptus clone using isoenzyme markers.

Progress made

Isoenzyme pattern provides a clue for estimation of population structure and phylogenetic relationship because the zymographic pattern directly relates to gene system. The pattern is specific to species/variety/strain or clone. To establish the clonal identity preliminary experiments have been initiated.

Project 70: Studies on Forestry Operations and development of Forestry Tools and Equipments.

Objectives: (a) A comparative study of transportation of seedlings in hill for planting by conventional method v/s plant carriers developed by FRI. (b) A scientific study on forestry tools. (c) Development of Log Jack. (d) Development of weed clearing tool.

Progress made

Methodology for data collection on transportation of seedlings in hills by conventional method v/s plant carrier developed by FRI is being prepared with the help of statistics branch. A format has been developed which will be used in the field for data collection.

The design and drawings of Log Jack and forest weed clearing tools have been prepared. The development of prototypes is under progress.

Project 71: Poplar Improvement in India.

- **Objectives:** (a) Survey and selection work in Poplar (*Populus deltoides*). (b) To establish germplasm bank of Poplar at FRI, Dehra Dun. (c) To establish poplar breeding orchard. (d) Multilocational trial of promising clones of *P. deltoides*.

Progress made

Survey and selection of 39 clones of *P. deltoides* has been conducted in 3 areas of Haldwani Forest Division.

A study has been initiated on the establishment of germplasm bank of Poplar in FRI. Under this study, 285 different clones were transplanted in the field. The ETPs were collected from Social Forestry Nursery, FRI, Dehra Dun. The seeds of *P. deltoides* from USA were imported and their germination study was tested in the laboratory. The germination study shows poor germination percent (about 10-15%) of few trees and seed of more than 50 plus trees having germination about 72 and 75%. The germinated seedlings were transplanted in root trainers as well as in poly bags. For multi-locational trial in 10 states of the country, 40

promising clones were selected. First instalment of cutting of 21 clones were supplied in January, February, 1997 and second instalment of 20 clones were distributed in January, 98 to all the coordinating centres of the country.

Project 72: Productivity study of Teak plantation with high inputs.

Objectives: (a) To study the effect of organic and inorganic fertilizers on teak plantations in different age group. (b) To study the irrigational requirement of teak plantations. (c) To compare the growth performance of teak under different climatic zones of the country.

Progress made

Productivity studies on high input teak plantations have been initiated in different sites of the country in collaboration with private plantations companies. The studies include, the effect of organic and inorganic fertilizers and irrigation's schedules on Teak plantations. In Central India, the experiments were conducted in October, 1997 in the plantations at Budni site of Enbee Plantations Ltd, Bhopal. In South India, the experiments were conducted during March, 98 in collaboration with M/S Anubhav Plantations Ltd, Chennai and in Gujarat, the experiments were conducted with M/S Jivdiv Plantation Ltd, Bhavnagar during the month of February, 98. The data are being collected analysed at different stages.

Project 73: Flora of stress sites of Sultanpur and Raibareilly.

Objectives: To survey the saline sodic, ravinous and waterlogged areas of Sultanpur and Raibareilly, collection of plant specimens, their identification and preparation of flora.

Progress made

Reconnaissance survey was carried out in Raibareilly and Sultanpur areas. Literature scrutiny for plants found in stress sites like acidic soil, sodic soils, ravines etc. was made.

Project 74: Selection, identification, and evaluation of wild plant species for urban planting.

Objectives: A large number of spectacular and useful plant species are found in the wild. Such species will be selected and identified for urban planting.

Progress made

Review of literature for the selection of about 150 spp. of wild origin was made for introduction in urban landscapes and for propagation purpose.

Project 75: Survey, selection, *ex situ* conservation and propagation of Himalayan bamboos.

Objectives: Different species of the Himalayan Bamboo, *Arundinaria* will be collected, introduced and propagated in the Botanical Garden.

Progress made

Literature scrutiny on 6 species of bamboos distributed in Garhwal Himalaya was made. Herbarium specimens deposited in the Herbarium of FRI were studied. Data of flowering cycle were collected.

Project 76: Computerisation of anatomical database of Indian hardwoods for the purpose of their identification.

Objectives: To develop a computerised database for the identification of hardwood tree species. It will include digitised photographs of wood structure, description of anatomical features, habit, local and trade names and notes on properties and uses of about 1600 species which in turn would be helpful in wood identification.

Progress made

Modalities have been discussed with collaborative agency NIC for the preparation of master file.

Project 77: Wood anatomy of Indian Terminalias.

Objectives: To carry out detailed anatomical studies on various species of *Terminalia* for the purpose of identification and preparation of identification key.

Progress made

Literature has been consulted further work is going on.

Project 78: Anatomical variation vis-a-vis wood quality in different clones of *Populus deltoides*.

Objectives: To study the variation of various anatomical parameters for the selection of superior/better clones for the purpose of utilisation as wood anatomical variations are known to influence the properties of timber.

Progress made

Literature has been consulted further work is in progress.

Project 79: Studies on the cultivation and optimum time of harvesting of Tropical and Subtropical medicinal plants.

Objectives : To develop suitable package for large scale plantation of *Spilanthes oleracea* for farmers and pharmaceutical companies.

Progress made

Fresh and dry weights of *Spilanthes oleracea* harvested in different media viz., sand, soil, and FYM and their interaction was completed. Data so collected is under further analysis.

Project 80: Studies on the cultivation and optimum time of harvesting of temperate and alpine medicinal plants of high market value.

Objectives : To survey the natural distribution and occurrence of rare and endangered high altitude medicinal plants of high market value and demand and develop suitable schedules for their cultivation on commercial scale for the benefit of hill communities. The project further envisage to find out the phytoassociates, climate and soil factors that govern their growth in nature besides studying their chemical constituents to select the best chemotypes for multiplication.

Progress made

Survey of natural distribution in UP hills has been undertaken. Phytoassociates of *Taxus baccata*, *Nardostachys jatamansi* and *Picrorrhiza kurroa* have been analysed. Soil samples collected from different sites have been analysed for various physico-chemical properties. Provenance trials on *N. jatamansi* and *P. kurroa* have been continued. Studies on the survival and growth of *Taxus baccata* shoot cuttings (rooting induced) are being conducted. The germplasm collected previously has been multiplied.

Project 81: Identification of high gum yielding varieties of *Acacia nilotica* for future regeneration for socio-economic development.

Objectives: Augmenting production of gum without causing damage to the trees and suggesting high yielders for future plantations.

Progress made

Literature survey on *Acacia* gum has been undertaken. Sixty trees of *Acacia nilotica* have been selected at Saraswati Pranivihar in Kurukshetra, Haryana and gum tapping has been initiated.

Project 82: Studies on cultivation and optimum time of harvesting of medicinal plant, *Tylophora indica*.

Objectives: To develop package of practices for commercial plantations for farmers and industry.

Progress made

Literature survey has been completed.

Project 83: Studies on isolation and characterisation of polysaccharides of abundantly available seeds trees/shrubs, leaves, bark and exudate gum.

Objectives: (a) Substituting over exploited non-wood forest products with readily available non-forest based material. (b) Optimum utilisation of abundantly available non-wood forest products. (c) Development of products required for forest based industries.

Progress made

Polysaccharide was isolated from the bark of *Kydia calycina* and purified by cation and anion exchange.

Project 84: Phyto-chemical examination for utilisation of leaves, barks, fruits and roots of Indian Forest trees.

Objectives: Development of pest control agents and other bioactive principles from *Vitex negundo*.

Progress made

Essential oil was isolated from the leaves by hydrodistillation method at monthly intervals to determine the correct time for harvesting of the leaves for essential oil isolation. Physico-chemical properties of the oil were also determined. Extract of the flowering twigs

was prepared using petroleum ether, acetone and methanol and the yield were found to be 4.3, 4 and 7% respectively.

Project 85: Studies on Tree bearing oil seeds.

Objectives: To study oil seeds of forest origin to ascertain sources of oil and prepare wetting agents from oils containing hydroxyl acids.

Progress made

Oil was extracted from seeds of *Prunus padus* and *Holarrhena antidysenterica*. Yield of oil was found to be 25% and 13.4% respectively. Physico-chemical constants of the oil samples were determined. Methyl esters of the oils were prepared to determine their fatty acid composition.

Project 86: Standardisation of process for extraction of taxol from the needles of *Taxus baccata*.

Objectives: Standardisation of the process.

Progress made

Extraction of *Taxus baccata* needles by different routes viz. (a) Petroleum ether, acetone, and methanol and (b) petroleum ether and methanol was carried out.

Project 87: Sustainable management of sodic soil.

Objectives: To find out a suitable and cost effective substitute of gypsum and organic residue and study the impact of fly ash application on tree growth and soil improvements.

Progress made

Suitable site was selected after survey of the area. Experiment was laid as per statistical design after the earth work, treatment application and refilling of the pits. Seedlings of *Albizia procera* were transplanted. Survival status of plants and other growth observations have been completed.

Project 88: Bio-geochemistry of the forest ecosystem of Mussoorie Forest Division.

Objectives: To determine effect of geomorphology and topographic positions on properties and nutrient status of the soils, to determine the relationship between forest site quality and species diversity and regeneration of important tree species.

Progress made

Review of the literature, survey of the sites for field work, preliminary field data collection have been done. A few soil profiles were exposed and samples collected for further laboratory estimations which are in progress.

Project 89: Ecological impact assessment of bio-reclamation project in Raibareilly and Sultanpur.

Objectives: To assess the impact of biological reclamation on the development of plant communities in relation to successional improvement of soil.

Progress made

The afforested sites in Sultanpur and Raibareilly district have been surveyed. Experimental sites will be selected soon.

Project 90: Soil geological studies in the degraded land and problem soils for sustainable afforestation.

Objectives: To determine inter-relationship between geology, soil and vegetation.

Progress made

Literature on research project has been reviewed. Sodic sites of Sultanpur and Raibareilly districts of U.P. have been surveyed and suitable sites for collection of soil samples have been selected. Disturbed and Undisturbed soil samples were collected from different sites supporting tree species of different age groups. Soil samples are being processed for different analyses.

Project 91: Efficiency of organic vis-a-vis chemical fertilizer in improving productivity of sodic soils.

Objectives: To evaluate the most effective organic fertilizer and response of leguminous and nonleguminous tree species to application of organic fertilizers in sodic soils and to find out efficient, cost effective and ecofriendly substitute of chemical fertilizers.

Progress made

The experiment was laid out as per statistical design. Earthwork (1600 pits of 60cm x 60cm x 60cm size), treatment application, mixing and refilling the pits with treated soil have been completed. Seedlings of *Albizia procera* and *Eucalyptus* hybrid were transplanted. Observations on survival and growth have been recorded. Soil samples from selected spots in the experimental area from 4 predetermined depths were collected to study the benchmark informations on soil characteristics. Soil analysis is in progress.

Project 92: Studies on biofertilizers.

Sub-Project 92(1): *Arbuscular mycorrhizae* in relation to exotic and indigenous bamboo species.

Objectives: To increase efficiency of the macropropagation technique of bamboo and produce quality seedlings for better survival and productivity.

Progress made

Ecological studies on *D. strictus* were initiated. Experiment on mycorrhizal dependence of bamboo was laid out. Role of mycorrhiza in vegetative propagation of *Paulownia* through petiole cutting is being examined.

Sub-Project 92(2): Management of soil borne plant pathogens by VA Mycorrhiza in economically important plant species.

Objectives: To develop management model based on principle of biological control.

Progress made

Genetic materials of *Paulownia* have been screened for root-knot nematodes indexing.

Project 93: Forest Pathology.

Sub-Project 93(1): To develop protective measures against diseases of economically important tree species i.e. *Eucalyptus*, *Dalbergia sissoo*, *Acacia catechu*, *Populus deltoides* and *Pinus roxburghii*.

Objectives: To assess the disease situation in nurseries and work out suitable control for destructive diseases.

Progress made

Thirty clones of *E. tereticornis* raised in New Forest were evaluated for their relative resistance against *Cylindrocladium* leaf blight. An assessment of *Ganoderma* root rot carried out in a 17 year old khair plantation at Kishanpura in Haryana showed mortality to the extent of 56.4%.

Study on relative resistance of *D. sissoo* seedlings against Maravalia leaf and twig rust was carried out in clonal plantations at three different localities namely New Forest, Lacchiwala and Ponta Sahib. At New Forest, the disease index was above 50% in all the 56 clones except clone no. 41 in which the disease index was 35%. Out of 36 clones at Lacchiwala, 8 clones i.e. 18,42,67,83,88,904,20,193 exhibited disease index below 5% whereas 12 clones, i.e. 10,19,80,83,84,85,90,93, 103,137,175 and 189 showed 6-10% disease index. On the other hand, eleven clones i.e. 59, 192,235,60,194,34,148, 92,196, 123 and 06 showed disease index above 10%. At Ponta Sahib, assessment of 16 clones showed very rare occurrence of the rust. Successive monitoring of the leaf and twig rust of sissoo in Clonal plantation revealed appearance of the rust on the same clones as recorded earlier. However, the infection was very poor due to unusual weather conditions. Monitoring of *Bipolaris* leaf blight in poplar clones raised at New Forest was carried out. Out of 150 clones examined the incidence of blight varied from 1-6% in S7C20 clone, 2% in D-121 clone and was highest in G-3 clone i.e. 10-48%.

• **Sub-Project 93(2): To determine biofertilizers beneficial to economically important tree species (Bamboo, Sissoo and Babool) and develop practical methods for field application.**

Objectives: To isolate and culture VAM fungi and *Rhizobium* associated with tree species and study their effect on plant growth.

Progress made

VAM fungi associated with bamboo were isolated and identified to the generic level. The genus *Glomus* was represented by *G. etunicatum*, *G. deserticola*, *G. multicaulis* *G. geosporum*, *G. fulvum* and *G. microcarpum*. Besides, *Acaulospora* and *Sclerocystis* were also found associated. Cultures of VAM fungi from bamboo were maintained and further multiplied in the glasshouse. Pot culture experiments to study the impact of VAM alone and in combination with fertilizers on *D. strictus* seedlings showed that the seedlings inoculated with VAM and applied with half dose of fertilizer put on better growth. *Rhizobium* from *A. nilotica* was isolated, characterised and multiplied. The results of pot culture experiments to study the

impact of VAM and *Rhizobium* on *A. nilotica* showed that seedlings inoculated with VAM-1 and *Rhizobium* put on better growth than control seedlings. *A. nilotica* seedlings fortified with VAM and *Rhizobium* were outplanted. *Rhizobium* was isolated from *Prosopis juliflora* and cultured.

Project 94: Evaluation of natural resistance in 300 different clones/ hybrids of *Populus deltoides* against important defoliators.

Objectives: To determine and screen the various clones of poplar for natural insect resistance.

Progress made

Out of 300 selected clones, 80 clones of poplar (clones and hybrids) of *Populus deltoides* were evaluated for natural insect resistance against foliage feeders (defoliators). Observations on leaf consumption at different larval stages were recorded. The work is in progress.

Project 95: *Paulownia* propagation and introduction (Normal project: FRI-73/SF-2N).

Objectives: (a) To study field performance of *Paulownia* in different areas of Uttar Pradesh, Haryana and Punjab. (b) To develop nursery and planting technology of *Paulownia*.

Progress made

Root cuttings of 5 cm and 10 cm length sprouted well but the growth of the developing plants was poor. Mortality of such plants was high. There was no significant difference in the growth of plants developed from 15, 20 or 25 cm long root cuttings. 15 cm proved to be the most economical length of root cuttings. Root cuttings of 25-30 cm diameter proved to be the best for raising plants. Planting of thinner cuttings led to production of thinner ETPs. Greatest number (73 percent) of root cuttings sprouted when planted in nursery bed during the first week of January.

The average height and diameter of four month old ETPs produced by using black plastic sheet mulch were 2.47m and 4.30cm respectively. The corresponding figures for control were 1.18m and 2.95cm respectively. Black plastic sheet mulch also prevented growth of weeds in the nursery bed. Vegetative propagation of *P. tomentosa*, *P. fargesii*, *P. fortunei* (Guangzhou provenance) and *P. fortunei* (clone C020) was carried out to conserve their germplasm.

EXTENSION

Consultancies were given to various organisations in the form of advice on timber, substitute products, processes and testing of material. As a result a revenue to the tune of Rs. 5.33 lakhs was generated.

Script notes, theme stories have been prepared for making films on storage, sawing, seasoning and preservative treatment of Eucalyptus wood.

Industrial training on sawing and seasoning of Poplar, pencil making of Poplars with hand tools; Pencil slats treatments, Ammonia fumigation of timbers and wood plasticization and bending, were given to the farmers of Hardwar and officials of Punjab State Forest Department. Training to farmers NGOs, sent by Director of Extension, FRI, was rendered on wood treatment processes, ACA technology etc. One day seminar on "Industrial technology demonstration for plywood Industries". on 27th March, 1998 was organised at F.R.I. Dehra Dun in which about 40 industries participated.

The following pamphlets were published.

1. Forest Products Division in the service of Wood Based Industries.
2. Structural timber from lops and tops of Eucalyptus and poplar.

Under training programme of forestry personnel, a team from forest operations unit, silviculture Division, visited IFFDC, Sultanpur, to impart training in timber harvesting to the workers/supervisors. Special training programmes in the use and maintenance of power chains saws was organised at Chanda and Dhinduri, Jabalpur, M.P. The forest tree seed laboratory conducted training programme on seed technology and management for scientists and officials of state forest departments. During 1997- 1998, 151 trainees have participated in the training programme, out of which 51 were from international organisations.

A pamphlet "Bamboo Seed Storage Technology" was published.

Paper samples from various small paper mills and paper merchants were tested on payment basis. To Transfer the technology and knowledge from lab to mill, Industrial Technology Demonstration for Pulp and Paper industry was held. The top personnel from 12 pulp and paper mills were invited to take part in the demonstration programme. The scientists from Cellulose and Paper Division presented their recent work on various aspects of pulp and paper technology in order to transfer the know-how developed.

A pamphlet on " Facilities for research and training in pulp and paper science and technology at Cellulose and Paper Division, Forest Research Institute, Dehra Dun" was brought out.

Scientific help was extended to researchers and others consulting the herbarium for identification of various species. Technical enquiries received from various agencies were addressed. Training in Forest Botany was imparted to the trainees and probationers of Forest Service College, Forest Academy and the students of Post Graduate and Diploma Courses of FRI, Deemed University.

About 1200 wood samples were received from various Govt. Deptts., Public undertakings, CBI/Police Deptts. These were examined, identified and necessary advise was rendered to respective agencies.

Two weeks regular course on "Field Identification of Timbers" was conducted for trainees from various Govt. Deptts. Practical training was imparted to IFS Probationers, SFS Trainees and students of M.Sc. Wood Technology, Deemed University, F.R.I. One week Training on Fibre morphology and identification was conducted for the trainees from National Institute of Forensic Science and Criminology, New Delhi.

Monthly price bulletin "Market prices of Forest Products" was published.

Soil testing for farmers, forest departments private bodies etc. was carried out.

Seven training programmes for Environmental conservation in Mine areas (of six days duration each) for senior level executives of Steel Authority of India Ltd., have been organised during the year. More than 120 executives have so far been trained. Steel Authority has paid Rs. 1.00 lakh towards each training programme to Director, FRI, Dehra Dun.

Field training was imparted to officials of to SFD's of Haryana, Punjab, and U.P. pertaining on production of quality seeds/ planting material.

A three day training camp was organised by Extension Division under UNDP Project for the teachers of primary and secondary level, and the agriculture extension workers, totalling 19, of district Yamuna Nagar where five adopted villages are situated. A group of 24 farmers

from district Chamoli in the hills of Uttar Pradesh also participated in a one week training camp organised by Extension Division. Half of the participants in this camp were women.

Technical services and guidance was provided to the governmental and non-governmental organisations (NGO's), SFD's, educational and research organisations in entomological matters.

Technical consultancy has been rendered to Govt., Semi-Govt., Autonomous agencies, NGO's and private farmers on the cultivation of medicinal plants and establishment of herbal farms/gardens. Script for the ICFRE/FRI film on Non-Wood Forest Products has been written and shooting of the film has begun.

Staff of State Forest Department of UP state have been trained in Rill Method of resin tapping. The technique has also been demonstrated to IFS & SFS probationers. Teaching support has been extended to IGNFA and SFS college for their course curriculum pertaining to NWFP. Faculty support has also been rendered to FRI Deemed University for its M. Sc. Forestry course.

Germplasm collections and nursery trials on medicinal plants cultivation at Dehra Dun and Chakrata have been demonstrated to local people.

Training has been imparted to farmers from Garhwal hills, NGOs, SFDs, Institutes etc., on raising healthy seedlings free from diseases. Field demonstration was given to the farmers for cultivation of edible mushrooms.

FINANCIAL STATEMENT

HEAD/PROJECT	AMOUNT (Rs. in Lakh)
Salaries	179.36
Office Expenses	168.00
Travelling Expenses	11.22
Miscellaneous	160.44
Loans and Advances	5.15
Capital Expenditure	174.82
Externally aided Projects	182.78
Total (Plan)	881.77
Non-Plan Expenditure	874.59
Grand Total	1756.36