FOREST RESEARCH INSTITUTE DEHRADUN

Forest Research Institute (ISO 9001 : 2000), having history of over a century (established in 1906) of forestry research, is an ideal institution for learning forestry. Forest Research Institute (FRI) enjoys the reputation of leading Institute at global level in the field of forestry sciences. Under the umbrella of Indian Council of Forestry Research and Education, FRI is mainly focussing its activities in Uttarakhand, Uttar Pradesh, Haryana, Punjab, Chandigarh and Delhi. Institute is conducting researches on every aspect of forests like Silviculture, Ecology, Pathology, Entomology, Chemistry, Non-wood Forest Product, Genetics and Tree Breeding and Forest Soil and Land Reclamation. More than 125 projects of regional, national and international importance are ongoing in the Institute. Various projects funded by Department of Science and Technology, Department of Biotechnology, National Medicinal Plants Board, National Bamboo Mission, Council of Scientific and Industrial Research, Indian Space Research Organisation, Ministry of Environment and Forests, Punjab Forest Department, Uttar Pradesh Forest Corporation, Indian Farmers Fertilizers Cooperative, Haryana Forest Department, Chandigarh Forest Department, Dadra and Nagar Haveli Forest Department and Himachal Forest Department etc. are in progress in the Institute. The Institute has excellent laboratory facilities and sophisticated and modern equipments to support its research. National Forest Library Information Centre of the Institute is the biggest forestry library of the country having around two lakhs books and subscribes to 147 foreign and 83 Indian periodicals of forestry and related subjects.

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

		No. of projects completed in 2007-08	**No. of ongoing projects in 2007-08**	**No. of projects initiated in 2007-08**
FRI, Dehradun	Plan Projects	30	47	39
	Externally Aided Projects	18	21	15
CSFER, Allahabad	Plan Projects	1	1	3
	Externally Aided Projects	—	1	—
	Total	**49**	**70**	**57**

PROJECTS COMPLETED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Inventorization and monitoring of biodiversity of threatened wetland sites of Doon Valley and surroundings, Uttarakhand [FRI-250/Bot-33/2003-08]

Findings: Monitoring the floral diversity of threatened wetland sites of Doon Valley was conducted. Threatened habitat characterization and species categorization criteria using well defined indicators were developed. Activities responsible for depletion of wetland sites of Doon Valley and adjoining areas were identified. Systematic account on rare and threatened and wetland specific species was completed with emphasis on diagnostic feature, pictorial support, threatened and conservation aspects and uses. Nine publications were made and papers presented in National Seminar/ Conference.

Project 2: Assessment of wood quality parameter in seed raised plantations of different age series of *Dalbergia sissoo* Roxb. [FRI-299/Bot-44/2005-08]

Findings: Variations due to height, location and direction were found significant. Direction, location and height showed impact on wood element variations. Wood element dimensions were found to have increased with the age except fibre wall thickness. Presence of morphologically distinguishable heart and tension wood was found varying significantly in the trees of different diameters and also at different heights. It showed the impact of growth on the heartwood and tension wood formation. Inter and intra-tree radial and vertical variations in the dimensions of wood anatomical parameters were significant. It showed that homogenous wood properties from the seedling seed raised trees of *Dalbergia sissoo* even at the age of 33 years are not noticeable till the trees are over 35 years. In general, growth parameters showed increasing trend with fibre length. R^2 values indicated that NEP (Net Ecosystem Productivity), NPP (Net Primary Productivity), tree volume and diameter were the growth parameters. Lower rainfall coupled with higher temperature appears to affect the wood anatomical dimensions. Eight years old clonal plantation shows similar anatomical properties while seedling raised plantation showed variability in wood traits within the population at the same site.

Project 3: Regeneration study on *Quercus semecarpifolia* and *Carpinus viminea* [FRI- 324/ Silva- 26/ 2005-08]

Findings: Seeds of *Carpinus viminea* were collected from Mandal forest and Nainital Forest Division (Uttarakhand). TTZ test was conducted to check the viability of seeds. Seed parameters, such as seed length, breadth, 1000 seeds wt, moisture %, number of seeds in 1 kg were recorded. Seeds were then stored at different temperature i.e. 15°C, 5°C and room temperature. Seeds were kept for stratification treatment. Soil study was carried out to see the impact of soil on regeneration of *Carpinus viminea* and *Quercus semecarpifolia*. Survival, height and collar diameter of the transplanted seedlings were recorded quarterly.

Seeds of *Carpinus viminea* collected from Mandal possessed 45 to 70% emptiness and 13% moisture while the seeds collected from Nainital exhibited 40 to 60 % emptiness and 15 % moisture content. Germination of seeds stored at 5°C increased to 43% after 4 months of storage and seed stored at room temperature lost viability completely after six months. Stratified seeds retained 32% viability after a month of stratification after which it declined gradually and was 6% after 10 months of storage.

All the transplanted seedlings are surviving and their average height was 40 to 45 cms after 10 months.

Project 4: Studies on soil geological and geo-morphological linkages with different forest communities for sustainable management of Uttaranchal Forests [FRI-314 / FSLR-19 /2005-08]

Findings: The study was carried out in Kempty range of Mussoorie forest division, Uttarakhand. Soils of the area belong to Mollisols and Ultisols order and are members of fine loamy, mixed, messic family. It has been observed that Mollisols occur on limestone, dolomite, slate and quartzite parent material at higher altitudes (Kempty and Sainj blocks) having *Quercus leucotrichophora* and *Pinus roxburghii* vegetation. Barren land soils of Gandiyala block also occur on Mollisols order. Ultisols occur on phyllite, sandstone, shale and quartzite at lower altitude (Mailgarh and Kheragarh blocks) having *Dalbergia sissoo* and miscellaneous forests. Statistical analysis of soil showed that source of variation in different soil characteristics are significant for clay, pH, CEC, exchangeable Na, available N and water holding capacity for replications. Higher Ca: Mg ratio in upper horizons as compared to lower ones indicates the role of vegetation on pedogenesis. Geology, soil, vegetation and drainage maps of the study area have been prepared. There is mutual relationship between vegetation and soil which is governed by climate and aspect. The study further indicated that relief and age acting on geology govern the existing soil whereas effect of altitude and climate on geology gives rise to natural vegetation. Climate and aspect on a particular site has given rise to existing floristic composition and also different pedogenic processes active at any site.

Project 5: Soil and vegetation survey and preparation of Pedonarium in New Forest Estate [FRI-316/FSLR-21/2005-08]

Findings: The soils of New Forest Estate are near neutral in reaction, loamy in texture, deep with gravels and stones in deeper layers and are very fertile. Their physical and chemical conditions are suitable for the plant growth and the organic carbon, major nutrients and micro nutrients are available in adequate quantities. The soils do not suffer from any serious constraint. The soils supporting tree cover are richer in organic carbon and nutrients and have better physical attributes in comparison to the soils under other land uses. The soils were classified in 3 classes at order level and in 5 classes at family level. The pedonarium of soils representing tree cover, grass land, agricultural land and river bed has been prepared and displayed for the benefit of students, scientists and academicians.

Project 6: Effect of different plantations on soil properties and carbon store [FRI-315/FSLR-20 /2005 -08]

Findings: This study was carried out in the soils under poplar, eucalypts, shisham and teak plantation grown at different sites in Haryana and Uttaranchal to evaluate the fertility status of soil and its comparison to barren land and to estimate soil organic carbon pool. The study leads to infer that the soils supporting teak, eucalyptus and shisham were more fertile in Uttarakhand as compared to Haryana. These soils contained higher amount of nutrients and better physical properties. Organic carbon, available nitrogen, available phosphorous, porosity and maximum water holding capacity were higher i.e. 17.82, 3.14, 49.31, 4.17 and 3.55 % respectively, in the soils under poplar in Haryana as compared to Uttarakhand, while bulk density was lesser (1.64%), indicating better soil health in Haryana compared to Uttarakhand. The soils under eucalyptus in Uttarakhand have relatively higher organic matter (42.44 %), available nitrogen (57.28 %), available phosphorus (14.04 %), available potassium (15.68 %), porosity (3.28 %) and maximum water holding capacity (6.42 %) as compared to the soils of Haryana. Soils having higher amount of nutrients under plantations were more fertile as compared to barren land. The inference was further strengthened by productivity indices of soils of Uttarakhand and Haryana under plantations. Soil productivity index was higher under eucalyptus, shisham and teak plantations in Uttarakhand while in poplar it was higher in Haryana. Soil organic carbon pool was higher in the soils under eucalyptus, shisham and teak in Uttarakhand while it was higher in the soils under poplar in Haryana. Soils under plantations were better enriched in the nutrients and have higher soil organic carbon pool, as compared to barren land in both the states. Soils under plantations in Uttarakhand have 27.83 t/ha SOC pool as compared to 24.66 t/ha in Haryana. There was an increase of 10.29 t/ha in SOC pool in Uttarakhand in comparison to 9.30 t/ha in Haryana under plantations over barren land.

Project 7: To study ecological succession in restored mined land

Findings: Ecological succession was studied in the rock phosphate mine Maldeota. The study site is divided into the five plantation types namely Khair plantation type, Shisham plantation type, mixed plantation type, natural plantation type and Pine plantation type.

The maximum amount of phosphorous was recorded in Shisham plantation type and lowest was recorded in Pine plantation type. The Magnesium content was highest in Pine plantation type and lowest in Shisham plantation type. Similarly, the amount of Potasium was hightest in natural plantation type and lowest in Shisham plantation type. The Calcium content was highest in mixed plantation type and lowest in Shisham plantation type. The dominant tree species in the Khair plantation type is *Acacia catechu* while in shrubs *Lantana camara* was the most dominant species. In case of herbs, the most dominant species was *Bidens biternata.*

In Shisham plantation type, the most dominant tree species was *Dalbergia sissoo* while in case of shrubs *Lantana camara* was the most dominant species. Similarly in case of herbs was *Bidens biternata* followed by *Murraya koenigii.*

In mixed plantation area the dominant tree species was *Adina cordifolia* followed by *Acacia catechu*. In shrubs the most dominant species was *Lantana camara* while in case of herbs, the dominant species was *Achyranthes aspera*.

In natural plantation type, the most dominant tree species was *Bauhinia variegata* while in shrubs, *Adhatoda vasica* domintes the plantation type. In herbs the most dominated species was *Bidens biternata*.

In Pine plantation area, the most dominant species was *Pinus roxburghii* while in shrubs, the most dominant species was *Lantana camara* and in herbs the most dominated species was *Muraya koenigii*.

Project 8: To study the undergrowth ecology of natural and manmade forests of Tarai belt of Uttaranchal

Findings: Study was carried out in tarai belt of Central Tarai Forest Division and Hardwar Forest Division under natural forests, teak plantations and miscellaneous plantations having different age and forest floor conditions. It was observed that *Mallotus philippensis* was invaded in teak plantation. Basal area and under growth biomass was much more under miscellaneous plantations than teak plantations. Biotic stresses invited invasion of *Parthenium* weeds and grasses. Natural regeneration of teak was observed in natural forest floors. Miscellaneous plantations are ecologically better than monoculture and therefore, suggested to adopt in mass.

Project 9: Evaluation of the principal chemical constituent of medicinal plants available with NWFP Division [FRI– 300/Chem-14]

Findings: Plant species under the project were propagated in the nursery of NWFP Division at FRI and Chakrata. Analysis of *Andrographis paniculata* (Andrographolide), *Bergenia ligulata* (Bergenin) and *Oroxylum indicum* (mixture of oroxylin – A and chrysin) was carried out for the harvested plant material at different times. Total ash, water soluble ash, acid insoluble ash, alcohol soluble extractives and water soluble extractives for the above plant species were also estimated. Thin layer chromatography, examination of all the above plant species were also carried out. No considerable variation in the above ingredients was observed for the above medicinal plants.

Project 10: Genetic evaluation of selected genotypes for exploring clonal forestry potential in *Dalbergia sissoo* [FRI/319/G&TP-16/2005-08]

Findings: The trial was maintained properly and gap filling was done wherever required. The wood samples have been collected and are being tested for anatomical and wood properties. The half yearly observations have been collected and being analyzed to understand early patterns and genetic relatedness. A clonal multiplication garden or the vegetative multiplication garden has been established at the Forest Research Institute, Dehradun.

Project 11: Follow up project on advance genetic improvement in seed production areas, seed orchards and progeny trials of different forest tree species in Punjab [FRI-339/ G&TP-17]

Findings: A seed production area of 5 ha of *Acacia catechu* has been measured and analyzed. The report has been prepared and submitted to the CF (R&T) for obtaining the necessary permission to carryout the culling operation.

The seedling seed orchard of *Dalbergia sissoo* at Mattiwara, Ludhiana has been assessed or measured, analyzed and upgraded by culling of inferior families. Similarly, a clonal seed orchard of *Dalbergia sissoo* at Pindori Mindo Mind, Hoshiarpur was measured and upgraded to the advanced generation seed orchards. The plants to be culled and retained were marked in the field and accordingly the culling was also completed.

The advance generation clonal seed orchard of *Dalbergia sissoo* has also been established at Pindori Mindo Mind, Hoshiarpur. The CSO has been planted adopting double row orchard design so that maximum cross breeding is encouraged and inbreeding is minimized. The orchard consists of 30 clones and 60 ramets of each clone.

Project 12: Studies on enhancement of natural durability of bamboo and plantation grown species with conventional/eco-friendly preservatives [FRI-236/FPD (WP)-43/2003-08]

Findings: PATENT for a "New eco-friendly economical and non-hazardous wood preservative ZiBOC- comparable to CCA" was applied in December 2007.

Thirty six months study of ZiBOC at 0.5, 1.0 and 2.0% conc. exhibited complete protection of chir veneer samples in field ground test where as control were badly damaged. Stake test at three agroclimatic zones exhibited complete protection of stake samples at three and four percent concentration. The findings are comparable with CCA. The shelf life of preservative ZiBOC was tested for two years at room temperature and 9°C. No precipitation of individual components and on visual observation no change in colour was observed. Borax: Boric acid, CCA and CCB treatment by different processes of five bamboo species exhibited good protection of bamboo in ground as compared to control. Results establish non durable nature of untreated bamboo.

Project 13: Exploration of copper lignin complexes for wood preservation and effect of post treatment processes on precipitation or fixation in wood [FRI-252/FPD (WP)-44/ 2003-08]

Findings: PATENT for a "New efficacious eco-friendly wood preservative lignin copper complex A and B" Patent applied PAT/4.19.14/03046/2003.

Studied the efficacy of prophylactic treatments of black liquor with and without copper sulphate, against sap stain fungus *Alternaria alternata* on *Populus deltoides* (Poplar). Study suggests that complete protection of Poplar can be achieved for a longer duration by prophylactic treatment of black liquor and copper sulphate at various dilutions as compared to all other known methods. Different treatment methods to treat Mango wood was followed with Copper Lignin complex A and B, only dip diffusion for one week and hot and cold method for 48 hours gave good retention.

Project 14: Development of eco-friendly water repellent preservative finishes for handicrafts items [FRI-307/FPD(WP)-52/2005-08]

Findings: Samples of mango wood were treated with copperised cashew nut shell liquid preservative by dip treatment method for 10 to 15 minutes. The samples were then finished with four polish treatments viz. sprit polish, linseed oil polish, Wax polish and clear varnish. The following results were obtained:

1. Gloss of the samples treated with preservative plus finishes increased up to 38% as compared to samples treated with finish alone.

   Percent increase in gloss is in the order:- Sprit polish > linseed oil polish > Wax polish > clear varnish.

2. Study on the performance of different finishes shows that gloss at different humidity conditions exhibited that loss in gloss of the samples that received double treatment i.e. preservative and polish was less as compared to the samples that received polish treatment.

   Percent loss in gloss is in the order- Clear varnish > Wax polish > sprit polish > linseed oil polish.

3. Fungus attack was observed on samples that received polish treatment only.

4. Study on the effect of UV radiation on the performance of different finishes shows that loss in gloss of the samples that received polish treatment was more as compared to the samples that receive polish and preservative treatment.

Project 15: Effect of Ammonia Fumigation on glue line strength of plywood from plantation species [FRI-312/FPD(CW)-57/2006-08]

Findings: The combi plywood boards were prepared using poplar and eucalyptus veneers and then fumigated with Ammonia for various duration of time. Veneers of poplar and eucalyptus for face and back were first fumigated with Ammonia for various duration of time and than combi plywood boards were prepared. It is observed that the glue line strength reduces when the veneer as well as combi plywood was fumigated with Ammonia. The duration for the fumigation of combi plywood with Ammonia was optimized.

Project 16: Velocity gradient induced single glass modified solar kiln for drying of timber and NWFPs [FRI-310/ FPD(WS)/55, (2005-08)]

Findings: A modified solar kiln has been installed. Its work efficiency has been studied throughly. Results are encouraging as the cost of the new kiln is about 25 to 30% less than the prevalent model, design is simpler so that specialist carpenter is not required and the modified kiln is equally efficient in seasoning of wood.

Project 17: Evaluation of physical and mechanical properties of *Leucaena leucocephala* (Subabul) and classification and grading of timber for different end uses [FRI-309/ FPD(TM) – 54]

Findings: Physical and mechanical properties of *Leucaena leucocephala* (Subabul) were determined on material obtained from Andhra Pradesh and Dehra Dun. For evolving a criterion for classification of the species for different end uses, strength coefficient was worked out. On the basis of strength,

the species is found suitable for structural use, door and window shutters / frames, furniture and cabinet making, flooring, tool handles, packing cases, dunnage pallets and expendable pallets etc.

Project 18: Bending and compression properties of small diameters round plantation timbers [FRI-311/ FPD(TM) – 56]

Findings: Plantation timbers of small diameter viz. *Eucalyptus* spp. (Eucalyptus), *Dalbergia sissoo* (Sissoo) and *Melia azedarach* (Persian lilac) were tested in round form for determination of its bending and compression properties. It was found that, Fibre Stress at Elastic Limit (FSEL) is higher in round form than the sawn values for all three species. Bending stiffness (MOE) of *Melia azedarach* (Bakain) and *Dalbergia sissoo* is also found higher in round form than in the sawn form. However, *Eucalyptus* spp. is found less stiff in round form.

Project 19: Evolving kiln schedules under vacuum drying for selected plantation species [FRI-308/FPD (WS)-53/2005-08]

Findings: A tentative schedule to dry *Populus deltoides* to less than 15 % MC levels from 90 % MC levels in two steps of vacuum level-temperature combinations has been developed. In the case of *Tectona grandis*, drying rates of 0.75 %/hour compared to the 0.18 %/hour that is usually observed in conventional methods could be achieved through vacuum press drying. The results are indicative of the possibility of this technique being effective in faster drying of this moderately refractory species.

Project 20: Assessment of shisham die back (decline) in Northern India and its remedial measures [FRI-245/Path-12/2003-08]

Findings: The main aim of the project was to assess the mortality of *Dalbergia sissoo* in India, find out the causes of mortality and suggest effective management strategies. In order to test the genetic resistance of trees against wilt, seeds were collected form all over the country from 107 healthy trees in 25 heavily infected localities. All the test provenances were inoculated with three strains of *Fusarium solani* f. sp. *dalbergiae* and on the basis of survival of seedlings the provenances were grouped in very resistant (91-100% survival), moderately resistant (51-80% survival), susceptible (31-50% survival) and very susceptible (< 30% survival). All very resistant and resistant provenances were further tested by stressing them by flooding the pots for 10 days and the resistance was found to persist in at least two seed sources of Rakh Bhuru, Amritsar and Thano Range, Dehradun.

Twenty strains of *Pseudomonas fluorescens* were collected from the rhizoplane of healthy trees growing in heavily infected localities in H.P., Uttarakhand, U.P., Haryana, Punjab and Delhi. Antagonistic interaction of *P. fluorescens* was tested against *F. solani.* Most effective strain was identified from Kankupur (Distt. Sultanpur, U.P.) and was brought in powder preparation. Improvement in survival of seedlings was recorded after the *F. solani* infected seedlings were treated with *P. fluorescens*.

Field trials were conducted in a 5 years old plantation of *D. sissoo* at Nihal Gate range under Tarai Central forest division, Haldwani. Out of eight combinations of biocontrol agents, systemic fungicides and insecticide, treatment T_3 (*Pseudomonas fluorescens* in FYM) gave the maximum survival.

Morphological characterization of the pathogen was done using four nutrient media viz. Potato Dextrose Agar (PDA) Czapk's Dox Yeast Extract Agar (CDYEA), Malt Extract Agar (MEA) and Joff's Medium (JM). PDA supported slow growth while the fastest growth was on Joff's medium. The pH requirement of the pathogen was tested at seven pH ranges from 4-10 with an interval of 1. The final pH of the medium was found to be altered in both the extremities (4 to 10 pH) to near neutral at 6.5 to 7.0.

The temperature requirement was studied between 10^0C to 35^0C at an interval of 5^0C. The isolates grew best on 20^0C and 25^0C. Least growth was observed in 10^0 and 15^0C.

Analysis of soil for its quality and org. C, org. M, Av. N, Av. K, Av. P, pH and electrical conductivity was tested in healthy and diseased sites. Heavy clay content in soil favoured the disease. Whereas availability of minerals was affected in the trees growing in diseased localities.

Effect of biofertilizers on the development of symptoms was studied after growing the seeds in 5 different biofertilizers and inoculating them with *F. solani* by root dip method. The biospirillum (*Azospirillum* spp.) was found the best followed by *P. fluorescens* in protecting the seedlings from fungal attack.

Project 21: Screening for disease resistance in genetic material raised under tree improvement programme [FRI-207/Path-13/2002-07]

Findings: The study has brought out useful information of practical application in field about the disease resistant and susceptible clones of *Dalbergia sissoo* and Eucalypts.

Screening was done against following major diseases, which were identified after initial surveys in Clonal Seed Orchards, Seedling Seed Production Areas and Seed Production Areas of *Dalbergia sissoo* raised at Paonta Sahib (Himachal Pradesh), Lachchiwala, Dehradun (Uttarakhand), Bhitmera, Hissar (Haryana), Mirpur, Chachrauli (Haryana), Chandigarh (UT), Pandori Mindomind, Hoshiyarpur (Punjab) under Planting Stock Improvement Programme of FREE Project of World Bank: *Ganoderma lucidum* root rot, *Maravalia* leaf and petiole rusts, *Colletotrichum* leaf blight, *Rhizoctonia* leaf blight, *Phoma nivea* cankers, *Helminthosporium* twig blight and *Colletotrichum* pod blight. The resistant and susceptible clones have been identified against different diseases after artificial inoculations as well as in field under natural conditions for five consecutive years, which can be safely considered that the clones found resistant over a five years duration have inherent resistance against the disease and there were no escapes from the diseases. Information about some disease resistant material has been given in following paragraphs.

Clone Nos. 219 (Compt. No. Birpur 4A, Bhabhar Beat, Tulsipur Range, Gonda Forest Division, U.P.), 194 (Compt. No. 2, Hasanpur Beat, Tulsipur Range, Gonda Forest Division, U.P.), 266 (Compt. No. 3, Lalpani Beat, Rishikesh Range, Dehradun Forest Division, Uttarakhand), 304 (Beat Uttrinala, Shyampur Range, Haridwar Forest Division, Uttarakhand) and 276 (Lalpani beat, Rishikesh Range, Dehradun Forest Division, Uttarakhand) were best performers for height growth, girth, clear bole and showed resistance against *Ganoderma lucidum* root rot disease. Clone No. S-167 (Rajaji National Park Chilla, Kunau range, Uttarakhand), S-57 (Khalawala Range, Ambala Division, Haryana), S-106 (Birdwal range, Hanumangarh Division) and S-124 (Kosi riverbank, Sunsaria Inerva, Nepal) were resistant to leaf and petiole rust disease whereas Clone

Nos. S-19 and S-89 were the susceptible clones. Three clones viz. 9 (Pathari Range, Haridwar Forest Division), 41 (Hasanpur Compt., Tulsipur Range, Gonda Division) and 66 (Chhachhrauli Range, Yamuna Nagar Division, Haryana) were found resistant to *Colletotrichum* leaf and twig bight disease. Clone Nos. 210 (Tulsipur, North Gonda Forest Division), 174 (Chilla, Rajaji N.P.), 239 (Benketwa, N. Gonda), 85 (Hanumangarh, Raj. 12 A Kola), 36 (Tulsipur, N. Gonda), 49 (Trilokpur, N. Gonda), 57 (Khalawa, Ambala), 236, 237 (Benketwa, N. Gonda) and 189 (Janakpur, Gonda) showed resistance against stem and twig canker disease.

In eucalypts out of 94 families, Nos. 2, 17, 20, 68, 72, 73, 76, 78, 85, 86, 88, 90, 91 and 93 showed resistance (disease incidence < 5%) against *Cylindrocladium* leaf and seedling blight disease in nursery whereas in plantation, only three families Nos. 20, 72 and 73 showed resistance (disease incidence < 10%) against this disease.

Project 22: Biological control of *Lantana camara* and *Parthenium hysterophorus* by fungal pathogens [FRI-206/Path-12/2002-07]

Findings: For managing *Lantana camara* spread through seeds, application of *Phomopsis archeri, F. moniliforme* and *C. gloeosporioides* was suitable for killing inflorescences in order to reduce the setting of seeds. However, the host specificity testing should precede their employment for weed control. None of the fungi could kill *L. camara* though *P. archeri* substantially damaged their stems. Herbicides viz. paraquat, glyphosate, 2,4 D, atrazine, pendimethalin and alachlor were toxic to *P. archeri, F. moniliforme, C. gloeosporioides*, *Curvularia lunata* and *F. solani*. They can be applied sequentially but not by combining in a tank mix. Adjuvants commonly available in the market for use with herbicides were toxic to fungal pathogens. They should not be mixed with fungal pathogens during their application to weeds. Sublethal doses of glyphosate or atrazine when applied with *P. archeri* sequentially controls *L. camara*. However, because of the environmental concerns, as sublethal dose for atrazine is high, sequential application of glyphosate and *P. archeri* should be preferred. The researches for integration of mycoherbicidal strategy with herbicides for *L. camara* management is at preliminary stage and extensive field trials are required to make it commercially viable. The present study suggests integration of glyphosate with *Phomopsis archeri* for field trials.

Project 23: Preparation of management plan of Sukhna Wildlife Sanctuary and Working Plan of Chandigarh Forest Division (2004-08) [FRI-273/RSM–15/Ext.]

Findings: The first ever Management Plan of Sukhna Wildlife Sanctuary for the period from 2007-08-07 to 2016-17 has been submitted after incorporation of comments of the funding agency. 3 Zone Plans and 7 Theme Plans have been proposed as management interventions for scientific management of the sanctuary.

The Final Working Plan for the period of 10 years from 2007-08 to 2016-17 has been submitted after incorporation of comments of the funding agency. Three Working Circles viz. Protection W.C., Urban Forestry W.C. and Rejuvenation of Lake and Water Bodies W.C. have been proposed for scientific management of forests.

Project 24: Preparation of local volume tables of Khair, Sal, Shisham and Teak for UP Forest Development Corporation, Lucknow (2003-08) [FRI-255/RSM–15/Ext.]

Findings: Local volume tables of Khair, Sal and Shisham have been prepared and submitted to the C.M.D., U.P. Forest Devlopment Corporation, Lucknow. Field data of Teak have been collected and analyzed for preparation of volume table and final report was completed.

Project 25: Study of current market prices of timber in the states of Jammu & Kashmir, Himachal Pradesh and Nagaland

Findings: The market rates of timber, auction prices, DGS&D rates during earlier years was collected. The data was tabulated to arrive at the present DGS&D rates which need to be applicable in each State in relation to the government auction price and escalation in market rates of timber. A price matrix was prepared and escalation in prices derived statistically. Final report was completed.

Project 26: Status of wood based industries in Kumaon, Uttaranchal (2006-08) [FRI-366/ RSM–17/Ext.]

Findings: Inventorization of wood-based industry in Udhamsingh Nagar and Nainital was carried out. Demand and supply status of raw material was studied and the data compiled. The final report was completed.

Project 27: Evaluation of natural termite resistance in timber species [FRI-303/FED-20]

Findings: Eight imported timber species were procured from the local timber market, got them identified from the Wood Anatomy Branch, FRI and were tested in the laboratory for their natural resistance against subterranean termites. Only two species, Ivory coast teak and *Cryptomeria japonica* proved very resistant to termites (Category I); three species, Malaysian Sal (Yellow meranti group and Red meranti group) and *Pinus sylvestris* belong to resistance class (Category II), one species each belongs to poorly resistance class (Category IV: *Pseudotsuga* sp.) and perishable class (Category V : *Betula* sp.). Among the Indian woods, *Grevillea robusta* and *Eucalyptus* hybrid belong to resistance class (Category II) and Poplar proved poorly resistant (Category IV). The final report was completed.

Project 28: Integrated Pest Management of major pests in nurseries and plantations with special emphasis on biopesticides and microbial pesticides [FRI –198/ENT.13]

Findings: Studied the seasonal life cycle of five new important pests on poplar and four new pests on shisham identified and isolated fourteen new entomopathogenic fungi from dead and diseased larvae of major pests of poplar and shisham. Screened out different parts of 50 plants and identified 35 plants having biopesticidal properties. Out of which 7 selected plants were further subjected to extraction in different solvents and their efficacy tested in the laboratory against the major pests. Also tried these and compared them with commercially available microbial pesticides and botanicals in the laboratory and in field experiments. The project has been completed.

Project 29: Studies on wooden pallets using jointed sections for industrial purposes from plantation timbers [FRI-380/FPD (TE)-66]

Findings:

1. Both jointed and unjointed pallets can safely hold load upto 2400 kg for both Poplar and Eucalypts, much higher than the normal load capacity of 1000 to 1200 kg.
2. Load-deflection behaviour of jointed and unjointed pallets made of Poplar and Eucalyptus are almost same.
3. Deflections at the middle is significantly lower than the edges and become almost constant after certain load.
4. At the middle point, the deflection of pallet starts decreasing or become constant while deflections at the edges continue to increase with load.
5. Pallet with jointed pieces of top deckboard uphold more load (shock) during rough handling. It may be due to the discontinuity offered by the jointed piece in spreading shock through out the pallet.
6. Poplar pallets perform better in corner drop test due its light weight. Disadvantage of Eucalypts pallet is its heavy weight that offers weighty handling and poor performance in drop test.

Project 30: To develop medicinal plant nursery for generating awareness amongst local people [FRI-254/CSFER-05]

Findings: Demonstration plots of medicinal plants of *Asparagus racemosus* (Satawar), *Catharanthus roseus* (Syn. *Vinca rosea*) (Sadabahar), *Tinospora cordifolia* (Giloe), *Chlorophytum arundinaceum* (Safed Musli), *Rauvolfia serpentina* (Sarpgandha), *Barleria prionitis* (Kalabansa), *Plantago ovata* (Isabgol), *Plumbago zeylanica* (Chitrak), *Aloe vera* (Gheequar), *Cassia aungustifolia* (Sanay), *Gymnema sylvestre* (Gudmar), *Acorus calamus* (Butch), *Abelmoschus moschatus* (Mushkdana), *Andrographis paniculata* (Kalmegh), *Psoralea cordifolia* (Bawachi), *Ocimum sanctum* (Tulsi), Mentha, *Cyperus rotundus* (Nagarmotha) and *Rauvolfia serpentina* (Sarpgandha) were established at Central Padilla Nursery. Planting stock of important species as *Asparagus racemosus, Andrographis paniculata* and *Barleria prionitis* has been raised for distribution to the local people in extension programmes. Training-cum-demonstration programme on cultivation of medicinal plants was organized at Central Research Nursery during the project period.

EXTERNALLY AIDED PROJECTS

Project 1: Maintenance of Chakrata NWFP Nursery (UFDC sponsored)

Findings: The maintenance and improvement works of the High Altitude Herbal Garden at Chakrata was done. Important medicinal plants like *Aconitum heterophyllum, Podophyllum hexandrum, Picrorhiza kurroa, Digitalis* spp., *Artemisia annua, Swertia chirata, Ephedra gerardiana, Microstylis wallichii* and *Habenaria intermediata*, etc. were conserved for research and further development in the well protected garden. The nursery is provided with extension boards for

education and awareness. The garden has been made fit for taking up research studies of high altitude plants.

Project 2: Development of Ecorestoration Model for Iron Ore Mines of Bihar and Orissa [Funded by MoEF, New Delhi]

Findings: The project is of immense practical utility for the mine areas of Bihar and Orissa, where out of 47,797.00 hectares of mine lease area, nearly 11,500 hectares of the land area is under leases for Iron Ore alone. The objective of this project is to develop ecologically and economically viable restoration model for Iron Ore Mines of Bihar and Orissa which are spread over an area of 11,500.00 hectares. Ecorestoration model has to be developed on the basis of detailed soil, vegetation and parent materials in relation to ecological and ethno- botanical information. The model developed can be replicated in all these areas for overburden dumps mined out benches and degraded areas in vicinity of mines. Project report has been submitted.

Project 3: Forest Fire Monitoring and Management

Findings: The quantity of pre fire fuel load, fuel moisture and soil temperature has been determined in all selected sites i.e., Pure Sal, Sal mixed, Pure Pine, Oak, Mixed Deciduous forests and degraded sites. Post fire estimations of all these parameters have also been made in different forest types to evaluate the impact of fire.

The amount of Gaseous emissions of as CO, CO_2 and Methane emitted from the different forest during/after fire have been estimated at different distance such as 10 m, 20 m, 40 m, 50 m, 60 m, 70 m, 80 m, 90 m and 100 m from the source of fire.

Post fire temperature variations along the vertical gradient in different forests have been recorded using Infra red thermometer to assess the impact of fire in the forest stand. Leaf Area Index and canopy gaps are being recorded using canopy analyzer in different forest types, the recording is in progress.

Project 4: Restoration of biodiversity in the hills of Kujapuri following Badriran restoration approach (Funded by G.B. Pant Institute of Himalayan, Environment and Development, Almora)

Findings: Sixteen native forestry species of multi uses i.e. fodder, commercial sacred and ornamental have successfully been introduced in the area during the process of restoration measures. Among them the most successful species in term of survival and growth were *Fraxinus micrantha, Quercus leucotrichophora, Aesculus indica, Celtis australis, Grewia optiva, Toona serrata* (Syn.*Cedrela serrata), Arundinaria falcata* and *Dendrocalamus strictus*. Species diversity index of shrub layer, which was 0.67 before restoration, has significantly increased to 2.40 after restoration. Similarly in the case of herbaceous layer, the diversity index value increased from 1.40 to 2.21 due to restoration activities. *Chrysopogon fulvus*, a native grass species, has registered a significant dominance in its presence in the area after restoration. A significant reduction in the diversity of *Eupatorium glandulosum*, an exotic under shrub and *Bidens beternata*, an annual weed, has been recorded after restoration.

Project 5: Identification, development and utilization of natural dyes from the forest plants of Uttaranchal (Funded by DSIR, MoEF and ICFRE) [FRI– 249/Chem-12/ Ext.]

Findings: Specifications for the fabrication of natural dye pilot plant were drawn, procured, installed and commissioned for the first time in Uttarakhand. Processes were developed for the isolation of natural dye from abundantly available *Eucalyptus* hybrid (leaves and bark), *Populus deltoides* (bark), *Pinus roxburghii* (needles) *Lantana camara* (leaves) and *Cassia tora* (seeds). Fifty two trials were carried out in pilot plant at 20 to 40 kg batch scale, depending upon the bulk density of the material. Methods were developed for dyeing of different fabrics using the dyes of aluminium, copper, chromium and tin salts as mordants. The blends prepared using the isolated dyes from five plant species did not show appreciable changes in the shades of dyed fabrics. The dyed fabrics having fascinating shades exhibited very good fastness properties. It was established that vacuum tray drying is better than the spray drying in the case of all five dyes. MoU was signed with Sikkim Khadi and Village Industries Board (SKVIB) for installation of pilot plant for isolation of natural dye from plant species occurring in Sikkim under the technical guidance of FRI. An agreement has been signed with Uttarakhand Khadi Village Industries Board for the supply of dye. A documentary on the isolation of natural dyes was prepared by Pulse Media Limited, New Delhi for telecast on Doordarshan. The different parts of these plant species which are not of much use can be used for the isolation of dye thereby finding their utilization. The technology is ready for its transfer to interested entrepreneurs.

Project 6: Utilization of economic potential of *Parthenium* [FRI-262/Chem-13/ Ext. 2004-07] (Department of Biotechnology, New Delhi, Funded)

Findings: Phenol formaldehyde resin was prepared and analysed using commercial grade phenol and formaldehyde. Particle boards were prepared at 17.5 kg/cm^2, 21 kg/cm^2 and 24 kg/cm^2 pressure levels using 10%, 12% and 14 % phenol formaldehyde resin with pressing temperature 150^{o}C. For reducing the water absorption of boards, 0.5 and 1.0 % wax emulsion was also used for making particle boards. Particle boards thus obtained were tested for various physical and mechanical properties such as density, moisture content, water absorption, swelling due to surface absorption, Modulus of Rupture (MoR), tensile strength perpendicular to surface etc. as per relevant IS specifications. It was observed that the particle boards prepared at 24 kg/cm^2 pressure level using 14 % resin meet the IS specifications.

Project 7: Development of improved chemical formulation and equipment for efficient treatment of bamboo for long term preservation and fire retardance

Activity 1: Modification of Boucherie equipment and its extension for the treatment of green bamboo – design etc.

Activity 2: To develop low cost chemical compositions of eco-friendly/conventional preservative and fire retardant for treatment of structural bamboo for rural application NMBA (TIFAC).

Findings:

1. Fabrication, Installation and testing of Automized Boucherie equipment for the treatment of 24 Bamboos at a time.
2. Ten fire retardant and preservative compositions were prepared and tested for performance against fire. Out of ten combinations of fire retardants and preservatives tested, five combinations i.e. I, II, III, IV and VII were passed as per BIS no. 5509: 2000 and 1734 (part III) 1972.
3. The old flame penetration test equipment is modified and upgraded with special attachments.

Project 8: Biotechnological approaches for improvement of plant species with special reference to pulp and paper [CSIR-NMITLI funded/2004 – 08]

Findings: This was a multi-disciplinary and multi-institutional project involving FRI, KFRI Peechi, NCL Pune, IHBT Palampur, NBRI Lucknow, CIMAP Lucknow, Lucknow University and Osmania University, who got together for a common goal of improving plant species for pulp and paper having low lignin and higher fibre length. Under its component, FRI achieved the following:

1. 1140 wood samples from different locations / collections of *Leucaena leucocephala* (Subabul) trees representing 14 States were received from the participating institutes including FRI for chemical, physical and anatomical characterization.
2. Large variation was observed in lignin, fibre length and other parameters.
3. Fifty two elites short listed based on higher fibre length and low lignin content.
4. FT-NIR protocols developed for specific gravity, lignin, holocellulose and extractives estimation.
5. List of elites further shortened to 18 and then to 8.
6. Lignin and extractive content variation in wood samples with and without bark and for bark only studied.
7. Ash content studied for all the wood samples.

Project 9: *Ex-situ* conservation of some critically endangered plants of Uttaranchal [FRI-277/Bot-42/Ext./2005-08]

Findings: The project was funded by National Botanical Research Institute under the Investing in Nature-India (IIN-India) scheme. *Ex-situ* conservation was the prime objective of the project. A list of 165 rare and endangered species of Uttarakhand was prepared based on published literature such as Red Data Books. An Assessment of Threatened Plants of India, The Indian Plant Red Data Book, etc. Nine endangered species were collected and introduced in the botanical garden of FRI. The monotypic species *Catamixis baccaroides* found only on the shiwaliks of Dehradun was successfully grown in the botanical garden. The species has hence been flowered and produced seeds. Five species have been propagated and grown in their original habitats. Awareness training programmes were organized for school children of Kendriya Vidyalaya of Dehradun. In all 52 childrens and 12 teachers attended the programme. The endangered palm *Trachycarpus takil* was provided to NBRI, Lucknow, WII, and Dehradun for planting in their conservation gardens.

Catamixis baccaroides in FRI Botanical Garden

Catamixis baccaroides in original habitat

Project 10: Creation of germplasm bank of medicinally important tree species of Punjab [FRI-336/Bot-50/Ext./2006-09]

Findings: Five medicinally important tree species were selected for establishment of their germplasm banks. The field survey was done for whole of the State of Punjab and two sites selected for establishment of germplasm bank of various species. The lands were developed by removing the existing trees, shrubs and herbs, digging out tube wells for irrigation and fenced the areas by barbed wire fencing. The site maps were prepared providing parks and blocks for each species to be accommodated. The irrigation channels and under ground pipefitting were carried out for proper irrigation. The seedlings of different plus trees were grown as a progenies. The data on seed and seedlings characteristics, nursery performance of planting material etc was recorded and analyzed. The planting material was properly tagged by aluminum foil before shifting it to the field. The germplasm bank map was prepared depending upon the availability of land and the number of plants to be accommodated in the field. Generally, the planting was done in RBD with row or block plantation. The out planting was done generally during rainy season. Proper weeding, watering and soil working is being done as and when required. The casualties' replacement was followed in next growing season by identified material. The display of sign boards for each species giving details of the field map and progenies with other details like date of planting, spacing, no. of plants and area etc was also carried out. The field performance of different species was assessed regularly.

Project 11: Development of suitable propagation technology of three *Terminalia* species [FRI-261/Bot-40/Ext./2003-06]

Findings: Survey for distribution and availability of species in Uttarakhand region has been completed.Vegetative propagation technology through juvenile shoot cuttings of *Terminalia arjuna, T. bellirica* and *T. chebula* is developed.

An attempt has been made to study the effect of season and growth hormones on branch cuttings of these three species. The experiment was conducted during February 2005, May 2005, July 2005, August 2005, November 2005, February 2006 and May 2006. Seasonal effect was found important factor in response of callus formation and root initiation. In case of *T. arjuna* and

T. chebula, maximum rooting response was observed in August planted cuttings. On the other hand in case of *T. bellirica*, maximum rooting response was observed in July 2005 while no rooting was initiated during February, May and November 2005 planted cuttings.

Collection of seed and other reproductive planting materials from plus trees from different areas of Uttarakhand has been completed. Seed dimension (seed length and seed width) and germination behaviour (germination percentage, germination speed, germination period, germination energy, germination value and seed viability) study is completed.

One year seedlings studied for various growth parameters like (height, collar diameter, number of leaves and root length) and biomass production (dry weight of leaf, stem and root) was carried out.

The other propagation methods like air layering and grafting were tried and found successful.

In rooting response of juvenile shoot cuttings (mononodal cutting) of *Terminalia arjuna, T. bellirica* and *T. chebula* for mass propagation, the maximum rooting response was observed in case of IBA 4000 (*Terminalia arjuna* and *T. chebula*) and IAA 4000 (*T. bellirica*) treated cuttings.

The branch cuttings collected from mature tree of *T. bellirica* failed to root whereas, the branch cuttings of *Terminalia arjuna* and *T. chebula* favourably responded to rooting.

Three papers were published and one communicated so far under this study.

Project 12: Evaluation and standardization of the methods employed in identity of the medicinal plants employing woods of Himalayan and Sub-Himalayan tract [FRI-276/ Bot-41/Ext./2004-07]

Findings: The project evaluated and enlisted the woods of Himalayan and Sub-Himalayan tract that are being used in the production of various medicines. Such woods were studied for standardizing their correct identity through wood micro-structure, wood ultrastructure and wood chemistry. Since adulteration in raw materials of medicines is a common problem, therefore, the present study is extremely useful for pharmaceutical companies to check the same.

Project 13: Micropropagation of promising interspecific F_1 hybrids of eucalypts and establishment of field trial [FRI-220/G&TP – 11/Ext.]

Findings: Tissue culture plants of *Eucalyptus* hybrids FRI – 5 and FRI – 14 were multiplied and field planted at seven agroclimatic regions. Field data were collected from all the seven sites of field trial with respect to plant height, collar diameter, clear bole length, no. of branches. Attempts were made for protocol development of *Eucalyptus* hybrids FRI – 6, 10, 13 and 15. Aseptic cultures were established in all the four hybrids and *in vitro* shoots were successfully multiplied on media formulated. As a result of large no. of experimentations, a suitable media was also formulated for *in vitro* rooting of FRI – 6, 10 and 15. Tissue culture plants were hardened and acclimatized in mist chamber and shade house.

Project 14: Network program for establishment of demonstrations of Bamboo plantations in Uttaranchal [FRI – 257/Bot. – 36- Ext.]

Findings: *In-vitro* shoots of *Dendrocalamus asper* were multiplied on large scale. 15 and 16 fold shoot multiplication was obtained on MS medium supplemented with 2.5 mg/1 BAP. *In-vitro*

rooting was standardized. 95% *in-vitro* rooting was standardized on MS supplemented with 10.0 mg/1 IBA and 3.0 mg/1 NAA.

Tissue culture raised plants were produced and these plants were hardened and acclimatized in mist chamber and shade house. 12,000 plants of *D. asper* were supplied to Uttarakhand Forest Department for field plantation.

Project 15: Development of tissue culture technique for protocol development of *Bambusa balcooa* and *Melocanna bambusoides* [FRI – 258/Bot. – 37- Ext.]

Findings: *In-vitro* shoots of *Bambusa balcooa* were multiplied on MS medium supplemented with 10ìM BAP + 2.5 µM Kn, which gave a 3 and 4 multiplication folds. In *Melocanna baccifera (*Syn. *Melocanna bambusoides)* best *in- vitro* multiplication of 3-4 folds were obtained on MS medium supplemented with 10 µM BAP.

In *M. bambusoides in vitro* rooting was obtained on MS medium supplemented with 25 µM IBA, while in *B. balcooa* scanty roots were obtained by pulse treatment of IBA. A complete tissue culture protocol has been developed.

Project 16: Study on pathogenic and molecular variability in *Fusarium solani* causing shisham (*Dalbergia sissoo*) wilt. [BT/BR/4273/AGR/16/356/ 2003; 2004-07] Funded by DBT

Findings: Out of 129 isolates of *Fusarium solani* collected from the high infection zones, a total of 53 isolates were selected for various studies. Nutritional studies using four nutrient media viz. Potato Dextrose Agar, Czapek Dox Yeast Extract Agar, Malt Extract Agar and Joff's medium were conducted for variation in growth, sporulation and development of pigmentation. Bavistin and Propiconazole were most effective while Bayleton and Topsin-M were least effective in all concentrations.

Molecular characterization of *Fusarium* isolates
RAPD

Forty five primers showed a total of 659 reproducible bands. Each of these primers varied greatly in their ability to resolve variability among the genotypes. The individual primer produced bands in a range of nine (LC94 and 1319) to 22 (LC-102) with an average of 14.64 bands per primer. Out of the 659 bands, 15 bands were monomorphic *i.e.* they were present in all the 38 isolates. The values of the coefficients were estimated on the basis of 45 primers which ranged between 22% (between F1 and F37) to 94.5% between F29 and F30 isolates. The maximum similarity coefficient between F29 and F30 (0.945) indicated the closeness of these two genotypes.

Cluster analysis

Phylogenetic tree showed clear distinction among all the 38 isolates by dividing the isolates into two major groups. The first major group consisted of 24 isolates while the second major group included 13 isolates, which were isolated from ooze of the plant. Isolate F26 was separated from

these two groups. All *Fusarium* spp. except *F. solani* isolates were present in major cluster 2. Principal coordinate analysis was performed in order to highlight the resolving power of the ordination.

ISSR

A total of 206 bands were detected using 20 ISSR primers out of which 202 bands were polymorphic and only 4 were monomorphic. The number of amplified bands varied from 6 with primer LC-6 and LC-7 to a maximum of 14 with primer LC-64 and LC-65 with an average of 10.3 bands per primer while the amplified fragment ranged from 250 bp (primer LC-11 and LC-12) to 3250 bp (primer LC-59). Jaccard's similarity coefficients estimated using twenty ISSR primers ranged from 23 between F22 and F36 to the maximum of 97.3% between F1 and F2. Thus the result revealed closeness between F1 and F2 and high diversity between F22 and F36 isolates.

Cluster analysis

All the 38 isolates were clearly separated by dendrogram. Two major groups could be identified excluding F13 and F26. The first major group included all the *F. solani* isolates excluding F13 while second major group includes all other *Fusarium* spp. isolates obtained from ooze (F6, F7, F8, F9, F10, F11, F14, F15, F16, F18, F21, F22 and F37). Principal coordinate analysis was also performed in order to highlight the resolving power of the ordination.

SSR

Out of 62 tested, twenty five rice SSR markers revealed 294 bands in the 38 isolates. The number of bands per primer varied widely among these markers, ranging from 1 (LC-285 and LC-319) to 21 (primer LC-310). The average number of bands per primer was 11.76. The value of the coefficient varied from 16.5% between F22 and F36 to 97.1% between F29 and F30 followed by 88.4% between F8 and F9. The isolates F29 and F30 were found to be closely related.

Cluster analysis

All non *F. solani* isolates except F26 were present in two major clusters. The isolates F29 and F30 showing maximum similarity coefficient (>90%) were grouped in one cluster. There were two major clusters where the first major cluster includes 24 isolates and the second cluster includes thirteen isolates.

Project 17: Biotechnological approaches for improvement of plant species with special reference to pulp and paper [2004-06/ CSIR-NIMITLI Funded]

Findings: Chemical screening of subabul with respect to lignin content, holo-cellulose and pentosan was carried out. 1130 samples of subabul collected from different geographical region were analyzed for lignin content and holo-cellulose. The lignin content varied from 17% to 31% and holo-cellulose was in the range of 58-77%. Pentosan was also determined in 50 samples. The project completion report submitted to CSIR.

Project 18: Evaluation of appropriate technologies and its adoption as applicable in rural environment [FRI-321/PLO-3]

Findings: Bamboo seeds were sown in the mist chamber of Silviculture Division. But the germination percentage was low. Later on, fresh seeds were procured and were germinated in the seed lab as well as in the nursery of Shatabdi Van Vigyan Kendra. Germination was better and some of them were shifted to polybags. Observations in the nursery raised seeds are being taken. Bamboo cuttings were multiplied in the polybags in the nursery area. Training to 10 persons was conducted from the villages of Badonwala, Harbajwala and Umedhpur. During training, lectures were given regarding the macro-proliferation technique and also regarding the bamboo protection from fungus and insects. Practical work was done by the trainees in the field and the seedlings were separated and replanted in the field by the trainees to learn the technique. Cuttings were also raised in the bed by the trainees.

Bamboo seedlings/rhizomes of *Melocanna baccifera, D. memberaceous, D. strictus, Japanese Bamboo* and *D. asper* were brought from Shyampur Forest Nursery and were introduced in Shatabdi Van Vigyan Kendra. One sample each was given to Plant Physiology for further multiplication and as germplasm collection. Further multiplication of the seedlings was also done by separating the young seedlings of the species available in the nursery. Observations are being taken regularly.

Bamboo seedlings raised in Shatabdi Van Vigyan Kendra were maintained and routine watering and weeding was done in nursery. Protection from frost was also provided. The seedlings were kept in polybags, root trainers and in beds. Field observations regarding the bamboo seedlings raised by the villagers were also noted. Separation and further multiplication by adopting macroproliferation technique will be done and the seedlings will be given to the villagers.

PROJECTS ONGOING DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Impact of ban on green felling on the plant diversity of selected sites in Uttarakhand [FRI-357/Bot-52]

Status: Sites selection of unallotted, seeding and final felling in the Chir Pine and Deodar forest of Chakrata was completed. Vegetative analysis with respect to the regeneration of Chir Pine and Deodar forests of Chakrata have been carried out. Site for vegetative analysis of Chir Pine and Deodar forest of Nainital and Almora districts was in progress.

Regeneration of *Cedrus deodara* in Jageshwar

Regeneration of *Pinus roxburghii* in Paikham (Someshwar range)

Project 2: Exploration, ethnobotanical evaluation and preservation of rare and endangered flora of Jaunsar-Bawar [FRI-298/Bot-43/2005-08]

Status: Eight exploration-cum-collection tours were conducted. Four hundred plant specimens have been collected, of which two hundred specimens were taxonomically identified. Ethnobotanical information on 50 species was also collected.

Project 3: Planting stock improvement: Inter and intraclonal variations in relation to shoot production, rooting and subsequent growth in Vegetative multiplication garden of *Dalbergia sissoo* [FRI-358/Bot-53]

Status: Regular visit to all three VMGs. Maintenance of three VMGs. Hedging of all clones at 30 cm. height in root sucker garden in plant physiology premises. Antifungal treatment of all the clones in VMG. Thalla formation and fertilizer application in individual hedge of all three VMGs. Marking and selection of clones for various studies. Exposing of root suckers in all the three VMGs.

Project 4: Field evaluation of different clones of *Dalbergia sissoo* growing in Clonal Seed Orchard at Lachhiwala, Dehradun for their growth and physiological parameters [FRI-357/Bot.-52]

Status: Maintenance of 2 ha. area. Preparation of number plates and numbering of individual tree. Data collected on pod formation of individual trees. Data collected on bud initiation and leaf emergence of individual tree (543). Collection of pods from different clones.

Project 5: Extent and evaluation of dieback of Shisham (*Dalbergia sissoo*) and identification of disease resistance sources (One Component in Plant Physiology Discipline, Botany Division)

Status: The studies on following parameters are being carried out :

1. Physiological parameters viz., photosynthesis, transpiration, internal CO_2 and leaf temperature in field and laboratory conditions.
2. Biochemical estimation of chlorophyll, carotenoids, sugars, protein, starch, amino acids and phenols.

Project 6: Revision of Indian Woods – their identification, properties and uses, Vol.II. Wood Anatomy Discipline. Botany Division

Status: Microstructure studies of the family *Linaceae* and *Zygophyllaceae* were completed as per the feature list given by International Association of Wood Anatomists, 1989.

Project 7: Development of technology for cultivation of commercially Important under exploited Lesser Known Tree Species (LKTS) [FRI-322/Silva-26]

Status: Cuttings of (*Cordia dichotoma, Ficus auriculata, Ficus glomerata* and *Ficus palmata*) were planted in nursery with different concentrations. In *Ficus palmata* and *F. glomerata,* best rooting was observed with 2000 and 3000 ppm IBA concentration. The experiments were conducted in nursery on *Ficus glomerata* with different media. Sand, Soil and FYM (2:1:1), Sand, Soil and Coal

(2:1:1), Sand, Soil and Brick ash (2:1:1), Sand and Soil (1:1). In *Ficus* seedlings, 90 % mortality observed in FYM. The seed treatments were given to Cordia dichotoma seeds viz. sulphuric acid (5,10 and 15 mts), cold water (12 hrs and 24 hrs), boiling water, gentle burnt and scarification. The seeds treated in Sulphuric acid for 15 mts. gives best germination. It was observed that treatment of seeds in cold water for 12 hrs proved to be better than 24 hrs. Fruits of *Averrohoe carambola* were collected and length of ripe fruits was approx.7.5 cm and diameter approx 38.84 mm. While extracting seeds from pulp of *Averrohoe carambola* (commonly known as Amrakh), 1 to 8 seeds were found but commonly 3 and 4 seeds were found in one fruit, but according to literature in both stages of maturity the numbers varies from 2 (in small fruits) to 15 (in big fruits). Seeds in quartz sand shows better germination as compared to germination paper and germinator 25 to 30°C. Established VMG and comparison trial of seedlings and cuttings. Achieved early fruit production in *Ficus palmate* (Bedu) and *Ficus auriculata* (Timla).

Project 8: Multilocation trials of promising clones of *Gmelina arborea* Roxb. (FRI-326/ Silva- 30)

Status: Twenty seven clones were assembled from RFRI, Jorhat. The sprouting was observed in all the clones but after 4 months none of the clones (except RFRI/GA/027) survived in FRI. In February 2007, assemblage of 19 promising clones of *G. arborea* from RFRI, Jorhat were received and planted in the nursery for trials. Survival in nursery was poor. Established VMG of survival clones viz. RFRI/GA/008, RFRI/GA/037, RFRI/GA/038, RFRI/GA/79, RFRI/GA/099, RFRI/GA/106, RFRI/GA/004, RFRI/GA/007, RFRI/GA/027 and F.R.I Tree 1,2,3,4 and also Tree 1,2,3,4 of Barkot range (Hardwar).

Project 9: Enhancing the longevity of acorns of *Quercus dilatata* and *Quercus leucotrichophora* [FRI-354/Silva-33/ 2006-09]

Status: Acorns of *Quercus leucotricophora* were collected from Mussoorie and Chakrata Forest Divisions. Acorns of *Q. leucotrichophora*, were cleaned, desiccated to three moisture levels using Silica gel in 1:1 ratio according to IPGRI DFSC's desiccation protocol, to study their response to desiccation. Acorns were desiccated to 36, 32, 28 and 24% moisture content and their viability was assessed every two months. Acorns were stored in four containers (plastic box, cloth bags, polybags and steel containers) at –5°, +5°, 15° C and at ambient temperature. Acorns were subjected to bimonthly germination tests to assess their viability. Electrical conductivity of stored acorns was also measured to record the reduction in vigour, during storage.

Project 10: Evaluation of Seed Orchards of *Dalbergia sissoo* for Seed Quality [FRI- 355/ Silva-32/2006-09]

Status: Seeds have been collected from Clonal Seed Orchards and Seedling Seed Orchards of *Dalbergia sissoo* from Yamunanagar and Bithmara in Haryana and Hoshiarpur in Punjab along with general plantations. The seed and pod characteristics, seed germination and seed vigour have been measured and recorded in laboratory for all seed sources. The seed germination, viability and storage trials are in progress at specified intervals.

Project 11: Field Evaluation of New Clones of Poplar [FRI-323/Silva-27]

Status: Field trial of clones of *Populus deltoides* developed at FRI, Dehradun from seed introduced from natural stands in USA has been concluded in Punjab at the age of 6 years. Based on estimated volume, clone FRI-AM-58 has performed best giving 20.53 m height and 31.32 cm dbh. Control clone G-48 ranked 27th recording 21.47 m height and 25.01 cm dbh.

Project 12: Recommendation of Land use model for degraded forests of Nainital of Uttarakhand [FRI-383/FSLR-25/2007-10]

Status: The study is being carried out in Nainital Forest Division, Nainital Uttarakhand. After arranging maps and working plan of Nainital Forest Division, grid points were marked. Ground survey of the area was done and in part of the area soil pedones were exposed and their morphological properties were noted. Soil samples from each genetic horizon were collected and brought to the laboratory. Soil samples so far collected, have been prepared and analysed for their physico – chemical properties.

Project 13: Relative effect of geology, vegetation and climate on soil formation of Uttarakhand [FRI-381/FSLR-23/2007-12]

Status: Reconnaissance survey of the area for collection of soil and rock samples has been made. Soil samples are collected from Dehradun, Nainital, Uttarkashi and Tehri Garhwal districts of Uttarakhand on the basis of variations in geological formations, forest vegetation, altitude and climate. Soil samples are also collected from soil profiles under *Quercus leucotrichophora*, *Pinus roxburghii*, *Cedrus deodara*, Spruce/fir, *Shorea robusta* and miscellaneous forests with different geological formations and pre-determined depth i.e. 0-15, 15-30, 30-60, 60-90 and 90-120 cms with the help of auger. Geological formations of the surveyed area was recorded. Rock samples collected from different geological formations are being analysed for physico-chemical attributes.

Project 14: Soil organic carbon inventory of Uttarakhand [FRI-382/FSLR-24/2007-12]

Status: Soil samples from different land uses (natural forest, block plantations, horticulture crops, agroforestry and grass lands) were collected from Dehradun, Haridwar, Tehri Garhwal, Nainital and Uttarkashi districts of Uttarakhand. Soil samples were collected from 0-30 cm depth for estimation of soil organic carbon pool. Collected soil samples were processed and prepared for analysis and their organic carbon was estimated. Separate samples for bulk density estimation were also collected from each site under all land uses and bulk density was estimated.

Project 15: Development and multiplication of superior bioactive clones of *Stevia rebaudiana* [FRI-320/ NWFP-19/ 2005-09]

Status: Fifty three accessions of *Stevia rebaudiana* have been collected from Uttarakhand, Delhi, Himachal Pradesh, Haryana, UP, and J&K States and introduced under field conditions for assessing their performance. Of these, 22 accessions have been analyzed for their active constituents viz., stevioside and rebaudioside percentage using HPLC technique. These 22 accessions have also been

assessed for their biomass productivity. Breeding of nine physically and chemically characterized accessions has been undertaken and F1 seeds are under germination trials.

Project 16: Development of organic cultivation protocols for enhancing productivity of selected medicinal and aromatic plants in Uttarakhand [FRI-359/NWFP- 23 /2006-09]

Status: Research on developing organic cultivation protocol for 3 medicinal plants such as *Asparagus racemosus, Rauvolfia serpentina* and *Ocimum sanctum* have been undertaken. Experiments using different combination of FYM, and vermicomposts have been tried. Treatments containing 12.5 t FYM/ha and 6.25 tVermicomposts/ha showed highest biomass yield in case of *Ocimum sanctum*. Procedures for 4 times tulsi biomass harvesting, for use in Ayurvedic medicines, in a year have been developed. Reduction of farm input cost study and effective soil moisture conservation, soil nutrient replenishment and weed control using mulch are in progress.

Asparagus racemosus with beans

Ocimum sanctum

Rauvolfia serpentina

Project 17: Studies on nursery diseases of important medicinal plants of Uttaranchal [FRI-352/NWFP-22/2006-09]

Status: Studies to identify the causal organisms for various nursery diseases of Medicinal and Aromatic plants in the state of Uttarakhand are in progress. Many fungus related diseases are being identified in Dehradun area, Rishikesh, Haridwar and Chakrata area etc. in collaboration with Pathology Division. Diseases affecting over 20 important medicinal plants have been identified.

Project 18: Utilization of fungi for bio-fertilizer of industrial waste water [FRI-346/ Eco-20]

Status: Textile Mill effluent, distillery effluent and tannery effluents were collected from different industries and analysed for physico-chemical parameters like temperature, colour, odour, pH, turbidity, conductivity, total solids, Biological Oxygen Demand, Chloride, Nitrogen, hardness, Calcium, alkalinity, Phosphate, Potassium, Sodium and heavy metals. Different fungi were tested for their adaptive nature and their capability to decolorize and bioabsorption of heavy metals from the effluents.

Project 19: Studies on the development of biopesticides from *Eucalyptus* hybrid [FRI-344/ Chem-16]

Status: Three extractives (EA, EB and EC) and volatile oil (EE) isolated from the leaves were screened against the target pests (Fungi: *Aspergillus niger, Fusarium solani* and *Pycnoporous*

sanguineus and insects: *Plecoptera reflexa, Eupterote undata, Phalantha phalantha* and *Ascotis seleinaria imparata*). EE and EC exhibited 100% fungicidal activity. Two fractions- ECEA and ECNB of EC showed fungicidal activity at the concentration equal to EC. Therefore EE and EC were identified for their formulation development. All the three extractives and EE demonstrated varied insecticidal activity (50 to 100%). The UA rich fraction isolated from the active EB when screened against *Clostera cupreata, Plecoptera reflexa* and *Phalantha phalantha* was found to be active. Further bioassay guided chemical analysis is in progress.

Project 20: Production and value addition by chemical derivatization of alpha cellulose of *Lantana camara* for its useful applications [FRI 345/Chem.-17]

Status: Alpha cellulose isolated from stems of *Lantana camara* was subsequently modified to prepare industrially important cellulose derivatives as Cyano Ethyl Cellulose (CEC), Hydroxy Propyl Cellulose (HPC), Cellulose Suphate (CS). Preparation of Methyl Cellulose (MS) by using methyl chloride (in gaseous phase) is in progress. All the variables for preparing the cellulose derivatives such as concentration of the reactants, solid liquor ration, time and temperature were optimized for maximum DS and solubility. The optimized product was evaluated with IR, SEM, TGA/DTA and WAXDs studies.

Project 21: Evaluation of Australian seed sources and families of *Eucalyptus tereticornis* for productivity and genetic improvement. Phase II [FRI-358/G&TP-20]

Status: About forty seven promising phenotypes representing different sources and families of *E. tereticornis* were identified and marked based on index selection. The trees were coppiced and the wood discs and samples were sent for wood analysis work. The coppicing behaviour of various genotypes was recorded. The new coppice shoots were also put for their clonal propagation through shoot cuttings under the mist chamber conditions. The rooting response of the genotypes recorded. Clonal plantlets produced and kept for hardening. Insect and disease incidence was recorded. Intra species hybridization was carried out between the best sources. Experimental trials were maintained.

Project 22: DNA fingerprinting of Shisham (*Dalbergia sissoo*) clones planted in Punjab [FRI-338/G&TP-17]

Status: Sixty seven clones of Shisham (*Dalbergia sissoo*) obtained from State Forest Department, Punjab were characterized and fingerprinted using DNA markers. Twenty two most divergent and distant clones were identified and recommended to Punjab Forest Department for using those clones in their plantation and improvement programs.

Project 23: Genetic Improvement of *Asparagus racemosus* to enhance root production and saponin content [FRI/340/G&TP-19]

Status: A field trial of 20 different seed sources *Asparagus racemosus* has been laid out at FRI, campus in RBD design. Different growth parameters viz. number of shoots, shoot length, number of roots, tuber size and shape have been recorded. The work on the estimation of total saponin content has been started.

The floral biology of different sources has also been studied. The seeds of individual entities have been collected to test under progeny trial.

Project 24: Establishment of breeding arboretum of *Eucalyptus* and production of interspecies hybrids [FRI/319/G&TP-15/2005-10]

Status: Breeding arboretum of *Eucalyptus* consisting 10 species/clones was maintained. Infestation of *Eucalyptus* gall insect was recorded in some plants. Such seedlings were uprooted and burnt. The insecticide was applied to all the plants of arboretum as pre-cautionary measure. The arboretum has been enriched by planting divergent genotypes of *Eucalyptus* so that heterogeneous seed is produced. Different observation on flowering and fruiting was recorded. The floral biology of different species has also been studied. In some of the genotypes of *E. pellita* and *E. urophylla*, an early flowering has been reported. The cross fertilization in some of the combinations was attempted and F_1 hybrid seed harvested.

Project 25: Deployment of the promising F_1 hybrids of *Eucalyptus citriodora* and *Eucalyptus torelliana* for establishment of vegetative multiplication garden and their field trials [FRI/338/G & TP-17/Ext./2006-09]

Status: Natural hybrids of *Eucalyptus citriodora* and *E. torelliana* were identified using morphogenetic markers. Hybrids were raised in the nursery. Field trials of these *Eucalyptus* hybrids have been laid out in field at six locations viz. Hisar (Haryana), Yamunanagar (Haryana), FRI campus, Dehradun (Uttarakhand), Haldwani (Uttarakhand), Hoshiyarpur (Punjab) and Patiala (Punjab). Appropriate control / checks were also planted in the trials for comparing the performance of the different entries. Hybrid vigour has been calculated on the basis of early performance of different entries over the locations.

The vegetative multiplication garden of different genotypes has been established at FRI Campus for maintaining the juvenility for clonal propagation.

Project 26: Eco-friendly preservatives and fire retardants combinations for protection of structural Bamboos for low cost houses [FRI-350/FPD (WP)-60]

Status: Six combinations viz, Ammonium sulphate + Ammonium phosphate+ ZiBOC; Ammonium sulphate + ZiBOC; Ammonium phosphate + ZiBOC; Magnesium phosphate + Magnesium pyro phosphate+ ZiBOC; Magnesium phosphate + ZiBOC; Magnesium pyro phosphate + ZiBOC of fire retardant chemicals were tested at 15% concentration in three species of bamboo. Performance is given as below:

Performance of species: *Dendrocalamus strictus* > *Bambusa tulda* > *Bambusa arundinacea*.

Performance of composition: Comp. 4 > Comp. 2 > Comp. 1 > Comp. 5 > Comp.3 > Comp. 6.

A demonstration shed of treated bamboo, preservative and fire retardant treated thatch and pine poles treated with ZiBOC, CCA and CCB was made. Cost is Rs. 10,299/-.

Project 27: Studies on performance of plantation grown species in cooling towers [FRI-351/FPD (WP)-61]

Status: *Pinus radiata, Toona ciliata, Pinus roxburghii* and *Ailanthus excelsa* treated with ZiBOC, CCA and CCB tested in cooling tower. One year of installation gave eight fold protection in *Toona ciliata* as compared to control. Four fold protections in *Ailanthus excelsa* as compared to control 1.3 fold protection in *Pinus roxburghii* and *Pinus radiata.*

Project 28: Analytic studies on woody cell wall architecture

Status: Rosettes are created in a hexagonal arrangement that acts as a channel through which glucose from cell is drawn and is polymerized into cellulosic chains that are in turn packed into a micro fibril that is extruded on the outside of plasma membrane. Forces that are exerted by the growing micro fibril are responsible for the motion of rosettes in the plasma membrane. Role of microtubules as the system guiding the movement of rosettes in a fluid plasma membrane has been explored. The abundance of rosettes in regions of cellulose production is related to microtubules. Rate of deactivation of rosettes depends on the life time of rosettes. In the developing cell wall, rosettes are continuously produced on the plasma membrane. They have finite life time after which they get deactivated. Self assembly of cell wall was considered as an organization originating from cell wall internal resources and is likely due to crystalline nature of cellulose. Hemicelluloses due to their amorphous nature form bridges between cellulose and lignin through hydrogen bonds. Directed assembly of cell wall has been analyzed with respect to cytoskeleton viz. microtubules.

Project 29: Identification and evaluation of disease resistance in different genotypes of Poplar [FRI-353/Path-21]

Status: Growth and disease status of G-48, Udai, WSL-22 and 39 of Jawahar Nagar (Udham Singh Nagar) and Maheshwari (Haridwar) nurseries are recorded 3 times between July to October 2007. The clones exhibited differential scale of foliar diseases. Dieback of G- 48 plantations (3 to 5 years) were observed at Taharpur and Jandhary (Sharanpur). Colony character, pigmentation, rate of growth and sporulation of 10 isolates of *B. maydis* were studied. Isolate, BM-10 had higher rate of growth (10 d) and highest sporulation ($25.2x10^6$). Sixty isolates of Bipolaris were collected from G-3 population and individuals with G-3 parent. Twenty five isolates were brought to pure culture. Three generations of crosses (2005, 2006 and 2007) of common poplar genotypes are quantified for growth as well as diseases regularly. Disease status of more than 400 genotypes was also assessed.

Project 30: Effect of *Populus deltoides* on shade loving medicinal plants [FRI-305/SF-8]

Status: 3000 plants of Shataver (*Asparagus racemosus*), 2100 plants of Chitrak (*Plumbago indica*) and 2500 plants of *Aloe vera* were procured and planted at Demo Plot. Data on growth performance of poplar and medicinal plants is recorded. Extraction of *Asparagus racemosus* from 0.54 hectare and its marketing through Uttarakhand Forest Cooperation was done. Cost and benefit analysis of *Asparagus racemosus* was done. Observation on performance of other medicinal plants under poplar were taken. Effect of frost on medicinal plants under poplar shade was studeid. Soil analysis is in progress.

Project 31: Tree crop interactions: Effect of *Melia* species on crop [FRI-306/SF-9]

Status: 1600 plants of *Melia* sp. have been planted in block and boundary geometry at Hukran in Hoshiarpur district and at Handesra in Mohali district. Growth data of *Melia* plantation in research cum demonstration plot in Hoshiarpur and Mohali were recorded. Monitoring of Research cum demo plots of *Melia* in Hoshiarpur and Mohali district was done and study of agriculture crop rotation and yield under *Melia* sp. was done. A nursery of *Melia* sp. is being maintained in Central Nursery, FRI, Dehradun. Monitoring and maintenance with pruning operation is being done time to time during the year. Soil analysis of the same plots is in progress.

Project 32: Effect of pine and oak forests on agriculture crops

Status: Data collection on agricultural crops viz. Paddy and Jhingora in farmers' field at Khirsu (Pauri) and Purola has been done. Analysis of data on crop yield is in progress. Work on soil analysis is in progress.

Project 33: Econometric analysis of potential and constraints for farm forestry development in Eastern UP [FRI-356/Stat-2/2006-10]

Status: Questionnaire was prepared and tested. House hold data collection pertaining to the conditions of adaptation of tree farming at farm lands from villages of Eastern and Western UP is under way. Preliminary analysis has been done. The other structural intervention has been incorporated into the questionnaire. The modeling process is under way.

Project 34: Collection and dissemination of market information on commercially important medicinal plants of Uttaranchal [FRI-282/RSM-16/2005-08]

Status: Market prices of commercially important medicinal plants have been collected from Ramnagar, Tanakpur, Saharanpur and Delhi markets. Collected data were compiled, tabulated for publication of quarterly newsletters. Beside the price data, relevant information on medicinal plants and policy decisions of Uttarakhand government were also collected and incorporated in newsletters for the benefit of the growers. Quarterly newsletters were published and disseminated to various stakeholders throughout the country covering as many as about 50 commercially important medicinal plant species. Funding agency has extended the project upto March 2009 for the progress achieved.

Project 35: Preparation of Working Plan for Dadra & Nagar Haveli Forest Division [FRI-328/NWFP–20/Ext/2005-08]

Status: Field tours for enumeration and collection of data have already been completed and data compiled. The writing of Working Plan for the period from 2008-09 to 2017-18 is in progress and 8 chapters have been finalized as per Working Plan Code. Project has been extentended upto December 2008.

Project 36: Farm Forestry extension and its marketing and economic linkages [FRI-367/RSM–18/Ext/2005-08]

Status: Market Price data were collected in structured formats. Collected data compiled, tabulated and published in the form of Quarterly newsletter "Market Prices of farm-grown agroforestry wood in Punjab". 3 issues were published for dissemination of information to stakeholders.

Project 37: Inventorization and replacement plan for the trees planted by NDMC [FRI-405/RSM–19/Ext/2006-08]

Status: Inventorization of trees, diseased trees and replacement plan for trees at Central Vista, roadsides, Nehru Park, Lodhi Garden and Talkatora Garden has been done. Field demonstration of disease control techniques to NDMC officials at New Delhi was given. Lay-out Plan for the bio- aesthetic landscaping of Rajpath and C-Hexagon along the Central Vista, New Delhi had already been prepared and submitted. The presentation of final report to NDMC has been done and final report is ready for submission after receipt of final instalment of funding.

Project 38: Bio-ecology and nutritional behaviour of polyphagous insect pests with special reference to *Spilarctia obliqua* [FRI-304/FED-21]

Status: Studies on nutritional preference of polyphagous pest, *Spilarctia obliqua* Walk. (Lepidoptera: Arctiidae) were conducted taking five important host plants including *Brassica compestris, Paulownia fortunei, Populus deltoides*, *Tectona grandis* and *Toona ciliata*. *Paulownia fortunei* was found to be most preferred host among five plants tested. Biochemical analysis of all five host plants was conducted to ascertain the role of different chemical constituents present in different plants. It was found that total soluble sugar contents were maximum (88.54 mg/gdw) in the leaves of *Paulownia fortunei* followed by *B. compestris* (55.61 mg/gdw), *P. deltoides* (33.00 mg/gdw), *T. grandis* (31.87 mg/gdw) and *T. ciliata* (23.53 mg/gdw). Total soluble protein was also found maximum (18.10 mg/gdw) in *P. fortunei* followed by *B. compestris* (16.25 mg/gdw), *P. deltoides* (16.19 mg/gdw), *T. grandis* (15.05 mg/gdw) and *T. ciliata* (14.12 mg/gdw). Starch contents also followed same trend i.e. maximum (79.76 mg/gdw) in *P. fortunei* followed by *B. compestris* (43.10 mg/gdw), *P. deltoides* (29.27 mg/gdw), *T. grandis* (28.69 mg/gdw) and *T. ciliate* (21.12 mg/gdw).

Project 39: Endangered and rare entomogenous fungus *Cordyceps sinensis*, identification of its insect hosts and food plants of insect hosts in the Bugyals of Uttarakhand [FRI-347/FED-22]

Status: Ali, Auli, Brolini, Kuramtoli, Pattar Nachanni, Kevla Vinayak, Bhaguabasha and Badrinath Forest Divisions were visited for the study. The host insect could not be identified. Some of the food plants of the larvae is a polyphagous insect, feed on the roots of *Polygonum affinis, Geumelatum* and *Impatiens sulcata*. The abundance in above mentioned Bugyals was 0.02 larvae per sq. metre. Living larvae and pupae were collected from the field. Moth emerges in the laboratory at 15° C temperature.

Project 40: Biology and control of bamboo, *Phloeobius crassicollis* damaging green standing bamboo [FRI-374/FED-28]

Status: Biology of *Phloeobius crassicollis* in laboratory was studied. The beetle (female) lays 45 eggs at the node of the bamboo. Incubation period 17 to 19 days. Larvae enter into the node and feed on the inner surface of bamboo. Larval period is prolonged and lasts for 11 months. Mature larvae construct an oval pupal chamber on the edge of the larval gallery at internode. Pupal period 20 to 25 days. Life cycle is completed in one year. For control, two experiments were conducted in Shakumbhari Range using systemic and contact insecticides. Results are awaited. The incidence of this borer in *Bambusa bambos* (Syn. *B.arundinacea*) ranges from 5.2% to 18.9%.

Project 41: Studies on the termite diversity of northern India with special reference to species composition in relation to different tree species [FRI-275/FED-19]

Status: Termite collections made from four States have been identified: Punjab – 28 species with 12 genera belonging to two families include 14 new records; Haryana - 21 species with 11 genera belonging to 3 families include 9 new records; Himachal Pradesh - 19 species with 12 genera belonging two families include 9 new records and Delhi - 11 species with 6 genera belonging two families; include 7 new records. Inventory on the termites from Uttarakhand has been completed in April 2008. Presently termites from Uttar Pradesh are being identified.

Project 42: Control of shisham leaf miner *Leucoptera sphenograpta* using systemic insecticides [FRI-349/ FED-24]

Status: Survey of nurseries and plantations of *Dalbergia sissoo* was carried out in different parts of Uttarakhand, Uttar Pradesh and Haryana for studying the biology and intensity of infestation of shisham leaf miner, *Leucoptera sphenograpta*. Field photographs showing damage by the leaf miner were also taken. Suitable site for laying out control experiment on shisham leaf miner as per statistical design was selected in Thano forest range, Dehradun Forest Division, Uttarakhand.

Project 43: Upgradation and computerisation of National Insect Reference Collection (NIRC) [FRI-233/FED-16]

Status: Taxonomy of Parasitic Micro-Hymenoptera (Chalcidoidea) stored in the collection was taken up. Five new species belonging to genera *Neococcidencyrtus* (2 spp. nov.), *Epitertracnemus* (1 sp. nov.) and *Cerchysiella* (2 spp. Nov.) were described.

Database for proper management of National Insect Reference Collection (NIRC) is in the process of development. Seventeen thousand insect species, mainly of forestry importance, are represented in the collection. Database incorporates information on taxonomical classification of insect species, locality, date of collection, collector, identified by, host insect/plant, location in the collection, their number, etc.

In the year 2007-08, digital imaging work was taken up and about 12,000 species were digitally imaged with the aim that they will be linked with the database which will be made

available on net. Each insect was photographed from different postures to make identification of specimens easier. Male and female, variants were also photographed. In all about 50,000 pictures have been taken.

Editing of photographs was also done to improve the picture quality. Copyright symbol, scale, name of collection, division and institute was also incorporated in each picture. About 20,000 pictures have been edited.

Fifty insect species not represented in the NIRC were incorporated in the collection. (accession of the collection increased from 21717 to 21766).

Project 44: Studies on biodiversity of parasitic Chalcidoidea (Hymenoptera) of Uttarakhand [FRI-375/FED-29]

Status: Survey and collection of parasitic Chalcidoidea (Hymenoptera) was done in the Doon Valley (Barkot, Lachhiwala, Karvapani, Kalsi, etc.). and also in Ramnagar and Haldwani Forest Ranges (Sitavani, Barat Roo, Chuna Knan, Lalkuan areas). Three different collection methods viz. sweeping, yellow pan trap and malaise trap were used to collect the samples. From the preliminary observations, Family Eulophidae is the most abundant and species rich family in the area followed by Pteromalidae, Encyrtidae, Eucharitidae, Mymaridae, Eupelmidae, Aphilinidae and Trichogrammatidae.

Project 45: Taxonomic studies of parasitoids belonging to subfamily Microgastrinae (*Hymenoptera: Braconidae*) of Uttaranchal and Haryana [FRI-371/FED-25]

Status: Survey, collection and identification of *Apanteles cypris* Nixon on *Cnaphalocrocis medinalis* (Guenee 1854), 5 species of genus Apanteles, *Cotesia ruficrus* (Haliday 1835), *Cotesia taprovanae* (Cameron 1897) form old collection of NFIC, 2 species of genus *Cotesia, Microgaster plecloptera Microplitis ocellatae* Bouche 1834 have been done as *Agrothereuts abbreviatus* (Fabricius 1794) of subfamily *Microgastrinae*. Sorting and placing in different genera of the Microgastrinae parasitoids from the collection during the surveys of different forest ranger of Uttarakhand and Haryana.

Updating of authentically identified parasitoid sub-families- *Microgastrinae, Apanteles (Apanteles) dargeelingensis, Apanteles (Apanteles) chatterjeei, Apanteles (Apanteles) effrenus, Dolichogenidea hyblaeae* and *Dolichogenidea hypsiphylae.* Sorting and identification of parasitoids belonging to the subfamilies of family Braconidae; Microgastrinae, Braconinae, Aphaidinae, Rogadinae and Alysiinae has been done. Collection and identification of *Spathius* species has been done from unidentified coleopteran beetles.

Project 46: Butterfly diversity in moist temperate forests of Garhwal: Evaluating species of conservation priority and indicator taxa of habitat disturbance in ban oak forest ecosystem [FRI-348/FED-23 /2006-09]

Status: Monthly sampling surveys of butterflies carried out in Garhwal: Chamoli-Rudraprayag Districts (Kedarnath Musk Deer Reserve), Tehri Garhwal district (Budha Kedar-Pangarana and Ghoraghati in Lakha Mandal area); Uttarkashi district (Naitwar-Istragad in Govind Wildlife Sanctuary) along fixed transects in both undisturbed and degraded oak forest habitats, so far has

revealed more than 150 species, with one new range extension from North-east India, one species new to science that has been described and many rare species.

Brown Gorgon, *Meandrusa gyas gyas*, sampled in 'Kedarnath Musk Deer Reserve' is a new range extension from North-East India into the Western Himalayas

Project 47: Development of agroforestry models of *Bamboo* species in Eastern U.P. [360/ CSFER-7]

Status: Raising of Bamboo seedlings for *Dendrocalamus strictus* and *Bambusa bambos (*Syn. *B. arundinacea)* have been done in the nursery for development of agroforestry models and extension programmes. Agroforestry models have been developed on farmer's and community land with a view to study performance of two bamboo species and crops taken for the study. Study of the growth performance of bamboo species with respect to height, number of leaves and culms has been done. Yield of agriculture/other crops under different treatments has been recorded. Agroforestry model with wheat has been established in demonstration plot of *Bambusa bambos* (Syn. *B. arundinacea*). Farmer's feedback has been collected for seedlings of bamboos distributed under extension work.

EXTERNALLY AIDED PROJECTS

Project 1: Study on the impact of riverbed material collection on Silviculture, ecology and environment in Uttaranchal Himalayas (Funded by UFDC)

Status: Field studies were initiated in 7 rivers of Uttarakhand under three forest divisions for data collection. The rivers from where the data were collected are Yamuna and Amlawa of Chakrata Forest Division, Gola, Dabka, Nandaur and Nihal of Haldwani Forest Division and Kosi of Ramnagar Forest Division from where the building materials are extracted under Uttarakhand Forest Development Corporation. Data were collected with respect to the impact of material extraction on ecological successions, accumulation of debris, change of river course, soils, volumes of ditches and gradient of catchments as well as lower courses. The interim report of the project has been sent to UFDC. The data is being analyzed and interpreted for final report.

Project 2: Development of silvicultural practices for promoting cultivation of *Taxus baccata*, *Rhododendron arboreum* and *Phyllanthus amarus* (Funded by NMPB)

Status: Survey for natural distribution of *Taxus baccata*, *Rhododendron arboreum* and *Phyllanthus amarus* was conducted in Uttarakhand state. Cuttings of *Taxus baccata*, *R. arboreum* and wildlings of *Phyllanthus amarus* and *R. arboreum* were collected and planted for rooting and further studies. Wildings of *R. arboreum* were transplanted in polybags. After six months of transplantation, scion of *R. arboreum* were collected from forest and grafting was carried out on wildings (polybag and field). These grafted plants are under observation. Air layering in young trees of *Rhododendron* was also carried out.

Project 3: Development of technological package for the production and quality evaluation of seeds of important medicinal plant species under National Medicinal Plant Board [GO/UA-8/2005]

Status: Seeds of 22 species of medicinal plants were collected from Ranikhet (Almora), Mandal (Gopeshwar), Munsiyari (Pithoragarh) and Ramnagar. Seeds were extracted and cleaned with the help of dodder sieve and gravity separator. The viability of seeds was evaluated by TTZ test. Seed morphological parameters of collected species such as seed length, width, shape, colour, 1000 seed weight, number of seeds in a single fruit and number of seeds in 1 kg were recorded. Seeds were pretreated with different growth promoter such as GA_3 0.1%, KNO_3 2% and H_2O_2 0.1% were subjected to germination test monthly. Seeds of 10 medicinal plant species were stored in storage cabinet at 5°C and 15°C and room temperature. Germination experiments of these stored seeds were conducted quarterly. Storage study of 10 medicinal plant species is under process.

Of previously collected (2006-07) species of medicinal plants, one year germination study has been completed for 35 species. *Cymbopogon martini* showed average germination (20-35%) in the month of August and October in all pretreatments while no germination was observed in H_2O_2 pretreated seeds and seeds germinated in the germinator in August. Fresh seeds of *Asteracantha longifolia* gave good germination (30-55%) for initial 6 months, which reduced gradually thereafter. GA_3 pretreated seeds of *Anacyclus pyrethrum* performed best (100% germination) in GA_3 and KNO_3 in the month of March, while poor germination (9%) was recorded in control condition in December. *Abrus precatorious* gave good germination (60%) in control condition in the month of September while in the month of August of the same year no germination was recorded in GA_3 and H_2O_2 pretreated seeds. Seeds of *Bergenia ligulata* exhibited average germination (20-35%) for initial 7 months which reduced to 7%, afterwards. In case of *Cassia lavigata,* seed showed best germination (91%) in H_2O_2 in the month of August but in December no germination was observed in control GA_3 and KNO_3 pretreated seeds. *Chicorium intybus* gave good germination (50-70%) throughout the year except in the month of November where 17 % germination was recorded in control condition. In case of *Cuminum cyminum* rhythmic germination pattern was observed monthly. *Ficus roxburghii* has shown maximum (30%) germination in germinator in the month of January while no germination was observed after that. In case of *Hippophae salicifolia* best germination was recorded in H_2O_2 pretreated seeds (97.5%) and lowest (11%) germination was recorded in GA_3 pretreated seeds in the month of August.

Project 4: Development of genetically superior planting material and cultivation technology for increasing productivity of *Jatropha curcas* [Funded byDBT]

Status: Germplasm bank of the collected germplasm has been established. Seeds and cuttings of selected CPTs have been collected and plants have been raised from the material in the nursery. Seeds had been collected from 44 CPTs and 9 stands in third year. Seeds were collected during this year from accessions identified to have more than 35% oil content in the previous year and the seeds were sent to TERI for reconfirmation of oil content during this year. Data are being recorded of laid out field trials to standardize spacing, pruning, fertilizer, irrigation and type of planting stock for raising plantations of this species at three sites in Uttarakhand.

Germination studies on effect of storage conditions (i.e. temperature, moisture content) and storage duration were carried out. Sites are being selected for establishing demonstration plantation, CSO, SSO and Progeny trials. Seedlings and cuttings from the selected CPTs are being raised in the nursery for the proposed plantation during next year.

Project 5: Genetic improvement of *Jatropha curcas* for adaptability and oil yield [Funded by CSIR]

Status: Maintained the field trial of elite and native accessions of Jatropha at Etah, Uttar Pradesh. Multiplied more germplasm of FRI accessions to meet the requirement on account of mortality in plantations at multilocation trial sites. Laid out field trials at Dehradun to standardise spacing, irrigation, fertiliser and pollarding regimes for raising plantations of this species at Dehradun.

Project 6: Development of non-destructive harvesting methods for medicinal plants [GO/UA-07/2006-NMPB/2005-08]

Status: Development and maintenance works continued at nursery sites in Chakrata and FRI, Dehradun. Seeds and seedling of *Picrorhiza* sp. and *Rheum* sp. were collected from available sources and propagated in NWFP production nursery and Chakrata. Sites were selected for laying out the harvesting trials in natural condition and harvesting trials are in progress in nursery and selected natural patches. Yield data related to harvesting are collected from field and nursery trials.

Project 7: Exploration, conservation and propagation of important medicinal climbers of Garwhal Himalayas [GO/UA-15/2006-NMPB/2006-09]

Status: *Ex-situ* conservation site has been developed and maintained for propagation and conservation of medicinal climbers'. Twenty four climber species have been collected as germplasm so far from different altitudinal zone of Garhwal Himalayan region. Ten numbers sample of climber species have been given for disease identification from surveyed area and the conservation site. Demonstration hut has been constructed at conservation site under the objective of training and demonstration. Some of the important species have been preserved for herbarium for demonstration activity.


Demonstration hut


Abrus precatorius at conservation site


Nursery beds

Project 8: Ecorestoration studies in Uranium Mines

Status: Recovery of uranium from the ores mined at the three mines- Jaduguda, Bhatin and Narwapahar (Jharkhand) in the mill, the bulk of the material processed emerges as tailings. The tailings slurry along with liquid effluents is neutralized with limestone to remove the soluble daughter nuclides and heavy metals and the slurry containing fine particles is pumped to tailing ponds where the solids settle. The recorded radioactivity content of these tailings is very low. To avoid any long term affect of these radioactive tailings on the atmosphere, well being of human and cattle as well as native flora and fauna, the tailings have been covered with 30cms. layer of soil, to reduce gamma radiation levels and radon emission rates to levels. Further, to consolidate the radioactivity in the tailings, the area has been revegetated by selected plant species having shallow root systems, good conservation value as well as low canopy cover. Five native plant species that were forestry origin have been selected for trial. These are *Pogostemon bengalense*, *Colebrookea oppositifolia, Dodonaea viscosa, Furcaria foetida* and *Jatropha gossypifolia.* Distribution and concentration of radionuclide was evaluated in tailings pond areas at different depth in soil and tailings and uptake studies of radionuclides in different selected plant species have been evaluated. Uptake of radionuclide is very low in these selected plant species.

Project 9: Impact of tourism on Environment of Roopland and Pindari of Nanda Devi Biosphere Reserve of Uttranchal

Status: Soil samples were collected from all the study points and analysis done for their physico-chemical characteristics. Vegetation survey/analysis of both the study sites have been done along the trek routes. Information on number of tourists visiting the areas, village wise human population, literacy rate and livestock population etc. have been collected. For socio-economic studies survey of villages of both the areas (Wan, Loha Jung, Mundoli of Roopkund; Song / Lohakhet, Chaura, Dhakuri /Umla, Vachham, Khati of Pindari area) were carried out. For participation of stakeholders in tourism and environmental awareness among the local people etc. meetings were held at Khati, Vachham, Wan, Loha Jung villages of both the study sites.

Project 10: Income generation for women in rural areas of Uttaranchal through vermicomposting of organic solid waste into manure

Status: Organic solid wastes from the campus were vermicomposted using four pit unit and earthworm species *Eisenia foetida*. Women of different villages were motivated to adopt vermicomposting for additional income generation. This year, on-campus training was given to

150 ladies from different villages in F.R.I. campus and off-campus trainings were organized in Phoolsaini. Total 675 women were given on-campus and off-campus training. 23 vermicomposting units have been constructed on the lands of the women of Phoolsaini village. One vermi-mela was organized at Shatabdi Van Vigyan Kendra, Dehradun, in June 2007.

Project 11: Studies on population status and berberine content in different provenances of *Berberis aristata* DC in H.P. and standardization of its propagation techniques (Funded by DBT)

Status: HPLC method for quantification of berberine in the roots of *Berberis aristata* was standardized. Forty four samples of roots of different provenances of Himachal Pradesh received from HFRI, Shimla were analyzed for berberine using the standardized method. Maximum berberine concentration was found to be in Kharapathar (1.58%), Kinnaur (2.70%) and Shimla (2.81%) provenances. Seasonal variation of berberine in the roots was also studied. High berberine content (1.86%) was observed in winter season in Sarahan provenance. Further work is in progress.

Project 12: Development of Live Red Data Book [FRI-277/Bot-42/Ext./2006-09]

Status: Twelve species viz. *Bentinckia nicobarica, Pterygota alata* var. *irregularis, Hyphaene thebaica, Carpentaia acuminata* and *Gustavia angusta* were introduced in the Botanical Garden of FRI.

Five species namely *Trachycarpus takil, Sophora mollis, Eremostachys superba, Valeriana wallichii* and *Acorus calamus* have been reintroduced in their original habitats.

Eremostachys superba in flowering in FRI Botanical Garden

Project 13: Planting stock improvement of some indigenous fuelwood and fodder tree species for higher biomass production in relevance to the hilly regions of Garhwal Himalayas [FRI-337/Bot-51/Ext./2006-09]

Status: The seeds and cuttings of fuel wood and fodder tree species were collected from superior phenotypes from different altitudes (from 600 to 2000mts. a.s.l.) of Garhwal Himalaya. Study of seed characteristics (seed length, width, thickness, weight and germination percent) of collected seeds from different altitudes. The data of normal and elite trees i.e., height, girth, clear bole and crown area was recorded from various altitudes for analysis.

Project 14: Bamboo improvement for rural and tribal communities : integrating recent technologies (Funded by National Bamboo Mission)

Status: Hill Bamboosetum: The selection of site for establishment of hill bamboosetum has been inalized at Khirsu (Pauri Garhwal) at 1800m (6000 fts) elevation. The area has been demarcated and taken over the possession of land from Uttarakhand State Forest Department. The area is cleaned by removal of bushes and other weeds. Fencing of the area is in process.

Germplasm Bank of *Dendrocalamus strictus*: Two hectare lands is identified in the FRI campus in erstwhile old Pavilion ground behind the Scientist Hostel of Forest Research Institute for

establishment of *Dendrocalamus strictus* germplasm bank. The area was cleared, labelled and developed. The map of the germplasm bank is prepared and accordingly the other developmental activities like pitting, soil working etc. are being carried out. The collection of germplasm from Shyampur, Haridwar, Vyasi, Rishikesh of Uttarakhand, Hyderabad area of Andhra Pradesh, Punjab and Haryana is done and the planting material is planted in gunny bags and maintained in Plant Physiology glass house premises.

Planting material of six bamboo species viz., *Bambusa balccoa, B. tulda, B. nutans, B. pallida, B. bambos* and *Dendrocalamus hamiltonii* were collected from North-East region.

Establishment of Model Bamboo Nursery: The bamboo model nursery is under development at Shatabdi Van Vigyan Kendra, FRI City Campus, Dehradun. A layout design of model nursery was prepared and accordingly the area was demarcated, cleaned and fenced by bamboo sticks.

The construction of bamboo huts and nursery beds is under progress. For providing irrigation facility, two water tanks are under construction. The planting stock is being prepared in physiology glass house premises and will be transferred to nursery at City Campus as soon as the irrigation facility will be functional.

Project 15: Development of micropropagation protocol for clonal multiplication and germplasm conservation of *Swertia chirata* Buch-Ham. A medicinally important herb [FRI – 333/Bot. – 47- Ext.] (Funded by NMPB)

Status: *In vitro* shoot multiplication obtained in *Swertia chirata* through nodal explant. Maximum no. of shots developbed after sixty days on to MS medium supplemented with BAP 1.0 mg/l + 0.5 mg/l IAA and 50 mg/l Ads. The rate of shoot formation per culture increased 10-15 folds after 4th and 5th subculture.

In vitro rooting were standardized. 92.0% rooting was obtained on ½ strength MS medium supplemented with 1.0 mg/I IBA.

Project 16: Researches on natural decay resistance of juvenile timbers like poplars (Sponsored by DST) [FRI 283/Path-18/External]

Status: Eight samples (log size 0.5 – 0.7 m) from Uttar Pradesh (Bahraich, Hardoi, Sitapur and Aligarh), two from Punjab (Mohali) and four from Uttarakhand (Rudrapur) were collected of different clones from the field in fresh felling and put through standard soil block tests for testing natural decay resistance using two test fungi *Pycnoporus sanguineus* and *Gloeophyllum striatum*. Most of the tested poplar clones showed resistance against brown rot fungus. There was definite variation among the clones/source material for decay resistance; even same clones from different locations had exhibited different natural decay resistance. Variation in natural decay resistance was also estimated inside a tree from base to top. It was observed that the trait varies along the height. Maximum decay resistance was found at 2.5 m height, below and above it gradually reduced. Resistance was more at base than at the top.

Project 17: Biological control of root diseases of some medicinal plants using selected antagonistic fungi [FRI-411/Path-26/External] (Sponsored by NMPB)

Status: Disease severity in medicinal plants was recorded from medicinal plant nurseries of Rishikesh and Dehradun and biological control strategy was selected for the control of diseases in medicinal plants due to the realization of toxicity associated with the chemicals. Disease causing organisms were isolated and identified from the wilted and rotted plants of *Asparagus racemosus*, *Stevia rebaudiana*, *Wrightia tomentosa* and *Rheum austarlis* as *Fusarium* sp.; *Fusarium* sp. and *Sclerotium rolfsi*; *Fusarium* sp., and *Rhizoctonia solani*. Antagonistic fungi were isolated and identified for the control of pathogens. Eight antagonistic fungi screened against the target pathogens found effective in controlling the pathogens.

Project 18: Utilisation of economic potential of *Lantana camara* [Funded by DST Project]

Findings: *Lantana camara* was collected and analyzed for chemical composition. Handmade paper of different GSM was prepared. Alpha cellulose was prepared at 2 kg level under optical conditions and analyzed for its purity, DP, brightness and ash content.

Project 19: Study of current market prices of timber in the States of Jammu & Kashmir, Himachal Pradesh and Nagaland

Findings: The market rates of timber, auction prices, DGS&D rates during earlier years was collected. The data was tabulated to arrive at the present DGS&D rates which need to be applicable in each State in relation to the Government auction price and escalation in market rates of timber. A price matrix was prepared and escalation in prices derived statistically. Final report submitted to the funding agency in February 2008.

Project 20: Technology transfer and development of a model village by skill upgradation and capacity building of rural communities for socio-economic upliftment [FRI-287/PLO-1]

Status: Observations were taken on medico horticultural model in village Ambiwala and medicinal plant sps. *Aloe vera* and France bean, Asparagus and Spinach, Tulsi along with spinach, *Aloe vera* with Lahsun, Pipli and Dhania, etc and the performance of the species were good. Seeds of Stevia were raised in Polyhouse. The germination is about 70% at Shatabdi Van Vigyan Kendra. Observations are being recorded. Planting material of Aloe, Stevia, Satavar and Sarpgandha have also been procured from the State Forest Department Medicinal Plant Nursery at Rishikesh. Some of the seedlings of Aloe were planted in the field by the weaker section of the society. Training programme was organized to motivate the villagers. During training period in November 2007, villagers raised medicinal plants in the Shatabdi Van Vigyan Kendra, which is coming up well. 854 Stevia, 1021 Asparagus and 46 *Aloe vera* seedlings were multiplied in Shatabdi Van Vigyan Kendra. 20 Coleus, 40 *Aloe vera*, 108 Stevia seedlings were multiplied in the field located at village Badonwala.

Project 21: Research and development of Jatropha (*Jatropha curcas*) under National Network Programme (CSFER)

Status: As per technical programme, Progeny, zonal and Networking trials have been conducted in nursery as well as in the field. In field's trials, CSFER –1 showed the best performance in progeny

as well as zonal trials. Under National Networking Trial, Coimbatore – TNMC - 4 showed the best results. Maintenance and management of provenances of year 2005-06 and 2006-07 has been done. Observations on flowering, fruiting pattern and calculation of yield per hectare is being done. The seed sample better performing provnences of different Institutes and centres were exchanged for the provenance trial in second phase of the project. Seed sample from different trials were sent to the Head, Chemistry Division, FRI, Dehradun for oil content analysis. The average yield of 0.5 kg per plant has been estimated in the 3rd year of Jatropha from the fruiting in the month of November.

NEW PROJECTS INITIATED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Impact of major forest invasive plants on the biodiversity of Chakrata Forest Division [FRI-394/Silva-37]

Status: Selected three sites in different altitudinal zones i.e. tropical, sub-tropical and temperate in Chakrata for collection of field data. Field data were collected from the plots affected by the Forest Invasive Species (FIS) as well as from un-affected plots by laying out of nested quadrates in similar ecological conditions. The forest areas were included Sal forest in tropical zone, Banj and Chir forests in sub-tropical zone and Deodar and Kail in temperate zone. The species composition and regeneration status of desired species have been found out. The forest areas are affected by the FIS like *Eupatorium odoratum, Lantana camara, Ageratum conyzoides, Artemisia vulgaris* and *Sarcococca saligna* etc.

Project 2: Impact of ban on green felling in Deodar, Blue Pine, Fir and Spruce forests in Uttarakhand

Status: Surveyed and recorded data on the plots prescribed for felling in 1980s. The data was recorded from the compartments of Deodar, Spruce, Fir and Blue Pine forests, which were actually felled and unfelled coupes under Chakrata and Tons divisions of Yamuna circle. The project is modified keeping in view the requirement of additional field staff and inclusion of study from Himachal Pradesh also.

Project 3: Assessing biodiversity through maintenance of preservation plots of Uttarakhand [FRI-393/Silva-36l]

Status: Studies were carried out on forest composition, carbon estimation and enumeration in selected preservation plots situated in three forest types i.e. tropical, sub-tropical and temperate. Data was also recorded on elite trees situated in the preservation plots of Uttarakhand. Survey is being carried in all the preservation plots established in Uttarakhand to know the present status.

Project 4: Role of allelopathy on regeneration in Silver fir (*Abies pindrow*) and Spruce (*Picea smithiana*) forests – Effect of natural leachates on seed germination [FRI- 391/ Silva-34/2007-10]

Status: Cones/seeds of Silver fir, Spruce, Deodar and Kail have been collected from selected sites. Identification of under story species in Silver fir and Spruce forests has been completed. Leachates/ bioassay has also been prepared using specified techniques in laboratories for carrying out effect of leachates on germination of coniferous species.

Project 5: Studies on seasonal distribution of weeds in forest nursery and eco-friendly methods of their control [FRI-392/Silva-35]

Status: Collected relevant literature. Leaf leachates of different concentrations were prepared. Experiment to study effect of leachates on germination of two tree species were carried out. Study of effect of leachates on sprouting of cuttings of tree species is being carried out. Study of tolerance of crop plants to different leachate concentrations is in progress.

Project 6: Standardization of drying and storage protocol and quality assessment of selected commercially cultivated medicinal plants of Uttarakhand [GO/UA-08/2006-07-NMPB/2008–10]

Status: Appointment of a Junior Research Fellow as project staff has been made. Literature review including methods of estimations was made and work plan has been devised.

Project 7: Role of temple forests in rejuvenating microclimate of some villages of Uttranchal

Status: Two study sites were selected in Nagdev Forest Range of Pauri Forest Division and weather stations installed in both the sites. Daily data recording was started. Vegetation survey of sites were done by laying out quadrats of 10m ×10m size for trees, 3m ×3m for shrubs and 1m ×1m for herbs as per nested quadrat method. Soil samples were collected from both the sites at different altitude/slope/aspects for physicochemical analysis in the laboratory. Meteorological data compiled from both the weather stations for further data analysis in the office.

Project 8: Ecological impact of urbanization on floristic diversity in natural and manmade forests of Doon Valley

Status: Sites have been selected and phytosociological studies were carried out at different length gradients from urban area. Under growth biomass was also determined from selected sites along with microclimatic data recording.

Project 9: Ecological impact assessment of invasive *Lantana*, its removal and subsequent restoration of habitats in Rajaji National Park of tropical moist forests

Status: Vegetation analysis was done in *Lantana* removal sites under *Shorea robusta* mixed deciduous, *Acacia catechu* and *Dalbergia sissoo* dominated vegetation communities in Rajaji National Park. Biomass estimation of *Lantana* and native under storey vegetation was also done in *Lantana* invaded and one year old *Lantana* removal sites under above mentioned vegetation communities.

Project 10: Development of Air Pollution Biomonitoring Station for air quality assessment of Dehradun

Status: One Air Pollution Biomonitoring Station developed at City Centre (Shatabdi Van Vigyan Kendra, Dehradun). Total 9 species were exposed to vehicular pollution at the station for active biomonitoring of air pollution. After the completion of first active biomonitoring, plant samples were analyzed for different biochemical indicators and were correlated with Air Pollution Index. Air Pollution class was identified by studying the variation in biochemical indicators. Second biomonitoring study has been initiated.

Project 11: Studies on *Sapindus mukrossi* fruits for their utilization [FRI-362/Chem.-18]

Status: Fruit pericarp and seed kernels of *Sapindus mukorossi* were extracted using different solvents of increasing polarity. Different extracts and fatty oil (41% yield) were screened against common forest fungi of which two extracts showed good activity. Fruit pericarp yielded ~20% of saponins.

Project 12: Chemical marker of *Eucalyptus* hybrids for wood durability and foliar dense: Characterization, heritability and genetic correlation [FRI 363/ Chem-19]

Status: The foliage of *Eucalyptus torelliana* (ET) and *E. citriodora* (EC) (five replicates of each) were collected and hydrodistilled to yield respective essential oils. Three extractives from leaves of ET using hot petroleum ether, acetone and methanol were also isolated. These oils and extractives when bioassayed against *Cylindrocladium quinqueseptatum* showed bioactivity**.** Heart wood of the ET and EC was collected and sequentially extracted with hot petroleum ether, chloroform and methanol to yield their respective extracts. These were subjected to bioassay screening against brown rot and white rot fungi.

Project 13: Isolation and characterization of phytoecdysteroids from *Achyranthes aspera* and *A. bidentata* and their effect on the economic traits of *Bombyx mori* L. [FRI-364/Chem- 20]

Status: The leaves, stem, roots and seeds of *Achyranthes aspera* and *A. bidentata* were collected, processed and their extractives using petroleum ether, acetone and methanol were prepared. The extractives were fractionated using different solvents. Methanol extracts of seeds, stem and roots of *A. aspera* were tested on Silkworm, *Bombyx mori* at Sericulture Research Station, Sahaspur, Dehradun.

Project 14: Studies on the utilization of seed polysaccharide from *Strychnos potatorum* [FRI-365/Chem-21]

Status: The seeds of *Strychnos potatorum* were procured and powdered. The seed powder was extracted sequentially with petroleum ether, chloroform and methanol. Seed powder was extracted with water to isolate the polysaccharide. Water soluble extractives were tested against kaolin as flocculant.

Project 15: Screening and identification of the lower Asarone (β-Asarone) containing variety/populations of *Acorus calamus* L. and its multiplication to enhance its economical and medicinal value

Status: Germplasm of *Acorus calamus* collected from 25 different sources/populations from the natural range of its distribution covering the states of J&K, Uttarakhand and Himanchal Pradesh. The collected material has been established at FRI campus in the form of germplasm bank. Morphological parameters of the collected sources were recorded. Root sample of 15 sources prepared for oil extraction. The oil extracted from 10 sources has been estimated for β-Asarone content.

Project 16: Molecular analysis of high resin yielding genotypes of *Pinus roxburghii*

Status: Samples for DNA extraction and analysis collected from high and low resin yielding genotypes of *Pinus roxburghii* based on the resin collection data from region of Tuni (Uttarakhand)

and Solan (Himachal Pradesh). Total of 47 primers were screened for RAPD analysis out of which 44 primers responded for PCR amplification.

Project 17: Bioconversion of forest waste lingo-cellulosic biomass into ethanol [FRI-361/ C&P-18] (partly Funded by UCOST)

Status: *Lantana camara* and Pine needle was chemically analyzed for chemical composition. The hydrolysis was done by two different methods single and two stages (Aqueous and Dilute Acid) at different bath ratio, time, temperature and acid dilution. In single stage optimized condition at 120^0C for 90 min of reaction time, Total Reducing Sugar (TRS) achieved was 55.68% (34.32g/l) in case of Pine needle and 80.98% (49.92g/l) in case of *Lantana camara*. In two stage hydrolysis, the maximum TRS in Pine needle was 60.86% and it was 87.69% in case of Lantana. The samples are for fermentation. The standard graph of alcohol, phenolics, TRS and xylose prepared using UV spectrophotometer.

Project 18: Drying studies on timbers useful for handicraft [FRI-378/FPD(WS)/ 64]

Status: The wood of *Acacia nilotica* and *Mangifera indica* was procured. After conversion of both the woods in final sizes, the sample pieces of both the wood were air dried to slightly above FSP. Samples of *A. nilotica* were treated with chemicals for chemical seasoning. Data on drying degrades of *A. nilotica* is being collected.

Project 19: Studies on shrinkage, swelling behavior of edge bonded solid wood boards [FRI-379/FPD(WS)/65]

Status: Boards from two plantation species viz. Shisham and Teak of two thicknesses (12 mm and 19 mm) using three different types of glues have been prepared. Conditioning of boards continued.

Project 20: Quality assessment of timbers by using ultrasound and microwave techniques [FRI-377/FPD/(T M)–63]

Status: The logs of *Cedrus deodara, Shorea robusta, Tectona grandis* and *Dalbergia sissoo* were procured and converted into test specimens for different tests. Instruments were procured and testing of *Cedrus deodara* was initiated.

Project 21: Studies on the effect of design parameters and different adhesives on the performance of finger joints in commercial timbers [FRI-376/FPD (WS)-6]

Status: Static bending and compression tests on finger jointed sections of Mango and *Eucalyptus* hybrid using one cutter set and two adhesives are nearing completion. For comparison purpose, the tests were carried out on clear solid wood samples from the same lots from which the jointed samples were made. Encouraging results have been obtained.

Project 22: Impact of biotic factors on forest biodiversity with particular reference to specific threatened sites and species of Uttar Pradesh (UP), Uttarakhand and Delhi [FRI-359/Bot.-54]

Status: Selected the sites for vegetative analysis in the southern, northern and central Delhi ridge forest area. Candidate plus trees of species such as *Diospyros montana*, *Balanites aegyptica* and

Pongamia pinnata etc. were identified and their growth parameters were recorded for germplasm collection and *ex-situ* conservation.

View of South Delhi Ridge Forest

Biotic pressure on site

Project 23: Extent and evaluation of dieback of shisham (*Dalbergia sissoo*) and identification of disease resistance sources [FRI-385/Path-22]

Status: The field areas around Varanasi were visited to evaluate the disease status and samples were collected. The specifications of equipment required in the project were finalized and sent to Purchase Officer for further processing. The process for appointment of field associates in collaborative divisions was initiated.

Project 24: Mortality of Kikar (*Acacia nilotica*) in Punjab and Haryana and its management [FRI-386/Path-23]

Status: The mortality in Kikar is reported only from Haryana and Punjab. The sites were identified in all the three agroclimatic zones of Haryana i.e. North (Yamuna Nagar, Ambala), West (Sirsa, Bhiwani) and South (Faridabad, Gurgaon). The Yamuna Nagar site was visited and status of mortality was evaluated in Jagadhari Range (Gobindpuri Road and Sugh Reserve Forest).

Project 25: Screening and hybridizing Indian isolates of *Cordyceps sinensis* for enhanced production of bioactive principles [FRI-387/Path-24]

Status: The Himalayan glaciers at Bedini, Auli and Chipla Kedar were visited and *Cordyceps sinensis* was collected. Two insects from Bedini, 3 from Auli and 20 from Chipla Kedar in Pithoragarh forest division were collected and brought to the laboratory. The fungi were isolated on nutrient medium from all the insect larvae.

Project 26: Molecular variability in *Cylindrocladium quinqueseptatum* causing leaf and seedling blight in Eucalyptus [FRI-388/Path-25]

Status: Collection of 228 diseased samples of Eucalyptus from different locations e.g. from Uttarakhand, Punjab, Haryana and Uttar Pradesh was made. Isolation, purification and liquid culture of 60 *Cylindrocladium quinqueseptatum* isolates have been done and their lypholization is in progress. Modified CTAB version has been standardized for DNA isolation. Operon RAPD

primers (A, B, C, D and E series) have been screened for amplification of genome. Synthetic medium for conidia formation was developed. ITS region amplification with primer ITS 1 and 4 is in progress.

Project 27: Creation of Photo Gallery for FRI at Shatabdi Kendra, Dehradun [FRI-457/ Path-31]

Status: The project has its roots in the publication of 100 years of FRI brought out on the occasion of centenary celebrations of FRI in 2006. The ICFRE Society desired that a photo gallery of FRI be created depicting the creative history of the institute for last hundred years or so. In the first year, the photo collection of FRI was searched to knit a story spreading over a time line of 100 years. About 150 photographs related to different events, activities, personalities, structures, etc. have been scanned so far. Different divisions of FRI have been contacted to enrich the story in the form of scientific creativity in this pioneering institute of forestry.

Project 28: Studies on *Sapindus mukrossi* fruits for their utilization [FRI-362/Chem-18]

Status: Oil extract of kernel of Sapindus was prepared and tested (1,500 ppm) against six forest fungi namely, *Colletotrichum gloeosporioides, Phomopsis dalbergiae, Ganoderma lucidum, Fusarium oxysporum, Rhizoctonia solani* and *Trichoderma pilluliferum.* It failed to check the growth of any of the tested fungi. Petroleum Ether (PE), Chloroform (CHL) and Methanol (Me) extracts of pericarp were prepared and tested against these fungi. The activity of CHL and Me extracts was reasonably high at 2% concentration though lower concentrations of 0.5, 1.0 and 1.5 % were also tested. The Minimum Inhibitory Concentration (MIC) is also worked out for each extract concentration-fungus combination.

Project 29: Development of prediction models for resin production of *Pinus roxburghii* [FRI–395/Stat-4/ 2007-09]

Status: Experiments were laid at natural forest of Uttarakhand, Himanchal Pradesh and Jammu Kashmir. Data were collected for the first year.

Project 30: Fuel wood utilization and its impacts on women's health in Jaunsar (Uttarakhand) (Funded by U-COST) [FRI-441/Stat-5/Ext./2007-09]

Status: Questionnaire was prepared and tested. Household data collection pertaining to fuelwood utilization and its impact on health is under way. Preliminary analysis has been made. The pollutants data due to fuelwood burning of a few households has also been collected.

Project 31: Quantitative estimation of livestock feed from forest in Uttaranchal Himalayas (Funded by CSO) [FRI-442/Stat.-6/Ext./2007-09]

Status: Questionnaire was prepared and tested. Project launch workshop has been conducted. Household data collection pertaining to livestock feed and other related information is under way. Preliminary analysis has been made.

Project 32: Establishment of a network to facilitate collection, processing and dissemination of statistics pertaining to tropical timber and other forestry parameters of India (Funded by ITTO) [FRI-410/Stat.-7/Ext/2007-08]

Status: Data collection is under way. Data from UP Forest Department has been received. Regional workshop has been held with the stakeholders.

Project 33: Development of mechanism for computation and forecasting of growing stock in strip forests of haryana taking into account the year wise plantation and survival of relevant species (Haryana Forest Department Funded) [FRI-289/RCS-2/Ext/2006-09]

Status: The growth data revealed significant differences among agroclimatic zones in the state. Regression models were developed for volume estimation.

Project 34: Preparation of weight and volume tables for agroforestry species [FRI-389/RSM-17]

Status: Survey for sites selection and laying out the sample plots for collection of single tree data collection has been completed in the Hoshiarpur, Garh Shankar, Patiala, Fatehgarh Sahib, Ludhiana and Sangrur Forest Divisions. Correspondences had been initiated for getting the permission of department for felling of desired trees. Compilation and tabulation of single tree data of *Melia composita* is underway.

Project 35: Studies on wooden pallets using jointed sections for industrial purposes from plantation timber [FRI-380/FPD (TE)-66]

Status: Both jointed and unjointed pallets of poplar and eucalypts can safely hold load upto 2400 kg, which is much higher than the normal load capacity of 1000 – 1200 kg. Disadvantage of eucalypts palletes is its heavy weight that offers weighty handling and poor performance in drop test.

Project 36: Bioecology and control of oak stem borer, *Aphrodisium hardwickianum* (white) (Coleoptera : Cermbycidae) [FRI-348/FED-23/April 2007-March 2010]

Status: During the first year four sites were studied and four sampling surveys have been carried out in Kedarnath Wildlife Sanctuary, Chamoli district; Govind Wildlife Sanctuary, Uttarkashi; Budha Kedar and Kannatal in Tehri Garhwal district in Ban and Moru Oak Forest. Data has been collected on the incidence, extent of damage, life cycle and natural enemies of the borer, biotic interferences in the infested oak tree stands and infested logs brought from the field for experiments in the laboratory. Experiments were also conducted on the lifecycle of this borer, its natural enemies and other borers in infested logs.


Ejection holes


Frass


Pupa

Damage by oak borer on *Quercus dilatata*

Project 37: Assessment of suitable age of seedlings of forestry species for plantation in Uttar Pradesh [FRI-396/CSFER -7]

Status: Nursery raising of selected species viz. *Holoptelea integrifolia, Albizia* sp. *Terminalia arjuna, Gmelina arborea, Bombax ceiba, Madhuca indica, Aegle marmelos, Pongamia pinnata, Acacia catechu, Tamarindus indica, Azadirachta indica, Artocarpus heterophyllus, Prosopis juliflora, Acacia nilotica, Syzigium cumunii, Pithecellobium dulce, Haplophragma adenophyllum, Dalbergia sissoo* and *Tectona grandis.* Maintenance and growth data recording of seedlings of selected species in nursery is in progress. Plantation trials to study the comparative growth performance of Khair, Semal, Imli, Prosopis and Siris in field and nursery conditions have been done in CRPF campus (under rain fed conditions) and Central Padilla nursery (under irrigated conditions) in RBD design in three replications.

Maintenance, management and monthly growth data recording of experimental plantations at CRPF campus and Padilla nursery is in progress. Two years old seedlings have been procured from the forest department and site has been selected for the plantation.

Project 38: Development of agroforestry models for Eastern Uttar Pradesh [FRI-397/ CSFER–8]

Status: Field survey and selection of study sites was done to identify farmers practicing agroforestry in their fields in districts of Allahabad, Lucknow, Varansi, Mirzapur, Sonbhadra and Raebareli. Agroforestry plots with different tree crop combinations viz. Eucalyptus –Rice, Eucalyptus-Sugarcane, Poplar-Rice, Poplar-Sugarcane, Teak-Rice, Aonla-Rice were selected for further studies. Data of forestry species viz. age, height, girth etc were recorded of these selected Agroforestry plots. Collection of soil samples from the selected sites. Soil samples collected from selected sites of farmers fields are being analyzed for moisture content, electrical conductivity, pH, organic carbon, nitrogen and phosphorus. Questionnaire based survey was done for studying the perceptions of the farmers regarding the agroforestry and problems of farmers in adoption of agroforestry in their fields. Collection of data regarding agricultural crop production and collection of soil samples from selected agroforestry fields after harvesting of the paddy and wheat in Phulpur, Allahabad and Jagatpur, Raebareli has been done. Survey for studying the market availability for agroforestry products and problems of farmers in adoption of agroforestry in their fields. Analysis of soil samples for organic Carbon is in progress.

Project 39: Demand supply gap analysis of important tree species of selected districts of Uttar Pradesh for extension and afforestation purposes [FRI-397/CSFER–9]

Status: Preparation of questionnaire has been done for farmers regarding study of demand supply position of selected trees. Basic data about districts and villages had been collected from population census records. Random selection of Tahsil wise villages (2 %) has been done for Gorakhpur district for starting survey work from villages. Survey for demand-supply position of selected species has been done in four villages of Gorakhpur district under Campierganj Tahsil and five villages in Sahjanwa Tahsil.

EXTERNALLY AIDED PROJECTS

Project 1: Field evaluation of superior germplasm of *Jatropha curcas* in Uttarakhand as a part of multilocation trial [Funded by DBT]

Status: Cuttings of selected accessions with more than 35% oil content have been collected and multiplied by Garhwal University and the same was supplied to partner institutes. Multilocation trial has been established at Prem Nagar, Dehradun 30 20′ 15"N latitude, 77 57′ 40" longitude, 600 m altitude as per the guidelines issued by funding agency. Quarterly data are being taken. Weekly weather data is being recorded. Frost injury was observed in the month of December in Jatropha in nearby plantations, hence protective measures were taken for protection from frost.

Project 2: Raising of demonstration plantations for augmenting fuelwood and fodder resources and promoting income generation in two villages of Uttaranchal [Funded by Uttaranchal Council of Science and Technology]

Status: Microplans of two villages selected under the project was prepared and planting was carried out. Apart from fuelwood and fodder species, plants of walnut, aonla, kathal, jamun, chulu and mulberry have also been planted in selected villages. Maintenance and data collection is in progress. Nursery of *Robinia pseudocacia, Quercus* and *Morus alba*, etc. has also been established for planting in next season on further demand of farmers in the village in Chakrata.

Project 3: Status of soils and organic carbon store in Giri catchments of Himachal Pradesh

Status: Surveyed the catchments area of the Giri River, starting from Rajban to Nehripul, Himachal Pradesh. Dig out in the soil profile in different land uses viz. miscellaneous forests, agriculture, Eucalyptus and Khair at Satone, Sadiyar, Ranukajee and Chadni, H.P. in the catchments area and collected soil samples from different genetic horizons. Geological formations of theses areas were also studied and rock samples were also collected for mineralogical investigations. Soil samples for organic carbon estimation were collected by opening soil pit of 30 cm^3 from different land uses. Bulk density samples were collected from different sites. Soil samples collected so far were processed for various estimations and analysis are under process.

Project 4: Development of RS base bioclimatic index [Funded by Department of Space, Space Application Centre, Ahmedabad, ISRO]

Status: The project is sanctioned in the month of February 2008. Sites have been selected and some preliminary works are to be initiated.

Project 5: Hyper spectral Studies [Funded by Department of Space, Space Application Centre, Ahmedabad ISRO]

Status: The project is sanctioned in the month of February 2008. Sites have been selected and some preliminary works are to be initiated.

Project 6: Utilization of economic potential of *Lantana camara*

Status: α-Cellulose was isolated from *Lantana camara* using acid-alkali process. The conditions were optimized with respect to time, temperature and chemical concentration to obtain higher yield, high purity and maximum brightness. Chemical modification of a-cellulose to carboxy methyl cellulose (CMC) was done using different solvents. D.S. values ranging from 0.3 to 0.9 were obtained in different solvents using different reaction conditions viz temperature, material to liquor ratio, time etc. Reaction conditions were optimized to prepare CMC using cheaper routes. Hand made paper was prepared alone and blended with long fibre in different ratio. The hand made sheets of different gsm were prepared. Further studies are in progress.

Project 7: Prospecting for utilization of unexplored ethno-botanically important medicinal plants of Uttarakhand

Status: Tubers of *Dicentra paucinervia* (DP) and of *Pavetta indica* (PI) leaves and stem were collected and processed. Their respective extracts were prepared using different solvents. Chemical analysis of chloroform extract and total alkaloids isolated from methanol extract of DP, and methanol extract of leaves and petroleum ether extract of stem of PI was done using column chromatography. Three pure compounds were characterized in DP while two in the leaves and stem of PI. Further work is in progress.

Project 8: Phytochemical examination of bioactive agents from plants of therapeutic value

Status: The extracts of *Malaxis acuminata* pseudobulbs collected from Chakrata region were prepared by sequential extraction with different solvents. Column chromatography of the petroleum ether extract was done. Two pure compounds were isolated from the petroleum ether extract by column chromatography. *Drymaria cordata* collected from FRI campus, Dehradun and from Mao area of Seanpati Distt. Manipur were extracted with solvents of increasing polarity. A pure compound was extracted from petroleum ether extract using column chromatography. Structure elucidation of isolated compounds and further research work is in progress.

Project 9: Study of Floristic diversity of Shiwalik hills of Haryana

Status: Selected sites and vegetative analysis were carried out in different blocks of Haryana viz. Kalesar block (Berra, Kalesar , Gunja, Faizpur), Pinjore block (Bhogpur beat), Chiken block (Top Banaser-R.63) and Klaka block (Thadugarh R.60), Darpur block (Chieken ghata, Lamba bara, Chiken khol, Dharpur khol, Gojdwala Dang). Data analysis is in progress.

Project 10: Development of micropropagation protocol for the economically important bamboos: *Dendrocalamus hamiltonii* and *Gigantochloa atter* [Funded by UCOST]

Status: A general survey was conducted for healthy and fast growing clumps for the collection of explant material and explant of *Dendrocalamus hamiltonii* and *Gigantochloa atter* were inoculated on MS medium supplemented with cytokinin BAP and Kn. Bud break was achieved.

Project 11: Development of tree to tree prescription of species associated with Ta Prohm Temple (4th Enclosure), Siem Reap, Cambodia [Funded by Archaeological Survey of India, New Delhi]

Status: Technical Report of the project was submitted highlighting diversity, conservation and protective measures on the tree flora associated with archaeologically significant site of heritage value.

Project 12: Baseline study of the flora and fauna of the Chhatarpur area (M.P.) [Funded by RIO TINTO Exploration India Pvt. Ltd.]

Status: Survey and inventorization of flora and fauna of the project area was completed for the pre-monsoon period. Final technical report was submitted.

Project 13: Management of sacred "Bodhi Vrikhsa" at Gaya with special emphasis on its health status [Funded by Temple Committee, Bodh Gaya]

Status: Monitored health conditions of the tree and treated the wounded and decayed parts of the tree and sprayed with micronutrients.

Project 14: Management of fungal deterioration of medicinal plant produce in storage by the use of botanical fungi toxicants

Status: Samples (29) of medicinal plant produce were collected from Rishikesh, Kathgodam, Ramanagar and Saharanpur depots and associated fungi were isolated. On the basis of the frequencies of fungal colonies and economic importance of the products, four products viz. *Withania somnifera* (roots), *Stevia rebaudiana* (leaves), *Cinnamomum verum* (bark) and *Carum carvi* (seeds) were selected for further studies. In the preliminary screening, among the aromatic oils used, lemon grass oil was found to inhibit the growth of the fungi deteriorating the medicinal plant produce.

Project 15: Molecular variability in *Cordyceps sinensis* isolates of Uttarakhand (Funded by UCOST)

Status: Different isolates of *Cordyceps sinensis* have been isolated, purified and grown in solid media. The isolates were grown in liquid media and were sieved for experimentation. Isolates have been lyophilized and the DNA extraction protocol has been standardized.

NATIONAL FOREST LIBRARY AND INFORMATION CENTRE

The National Forest Library and Information Centre (NFLIC) is richest in document collection on forestry and allied sciences in South and South-east Asia. The NFLIC has been providing all types of library and information services viz. reference, referral, lending, reprography current awareness, inter-library loan, retrieval of information from machine readable database, etc. to its users.

During the year, a total of 32,347 books were loaned to the users for outside reading. Besides, 66,292 documents were consulted. The document collection of the NFLIC was enriched by the addition of 1,358.

The NFLIC subscribed to Indian and foreign periodical titles at a cost of about Rs.60 lakhs. It also received about 350 periodical titles gratis. The binding of loose periodicals is an essential library activity. During the year, 200 sets of periodicals were bound. The NFLIC has been selling ICFRE publications through its Book Depot. During the year 736 books and 30 VCDs were sold to the state forest departments, universities, etc.

The Ministry of Environment and Forests, Govt. of India established an ENVIS Centre on Forestry at the NFLIC. The Centre, during the year enriched the following database by the addition to new references: Indian Forestry Abstracts, Participatory Forest Management, *Prosopis juliflora*, Poplars, Forests and Environment in Press, Current Forestry Literature, which are accessible through the website of the Centre having URL: www.frienvis.nic.in Besides, the contents pages of journals, forest cover of India, state wise and then district wise, announcements of forthcoming national and international conferences, seminars, symposia, training courses were also put up on the website.

FOREST RESEARCH INSTITUTE UNIVERSITY

Forest Research Institute, Dehradun was conferred the status of 'University' by the Ministry of Human Resource Development, Government of India, New Delhi vide Notification No. F.9.25/ 89 U-3 dated 6th December1991. 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. The University has been fostering pioneering research in specialized areas under Ph.D. Programmes. In pursuance of the UGC Notification No. F.6-1 (II)/2006 (CPP-I) dated the 13th September 2006, the name of Forest Research Institute Deemed University is changed as Forest Research Institute University (Established under section 3 of the UGC act 1956 vide Notification No. F.9-25/89 U-3 dated 6th December 1991).

Academic Courses and Admission

The FRI University has been offering the following academic courses on a regular basis:-

The M.Sc. courses in Forestry, Environment Management and Wood Science and Technology are of two years duration whereas Post Graduation Diploma in Natural Resource Management, Non Wood Forest Products and Pulp and Paper Technology are of one year duration.

Admission to the above courses are made on the basis of a candidate's performance in All India Competitive Entrance Test.

During the year 2007-08, 103 students were admitted in all the above six courses for the academic session 2007-09 and 2007-08 respectively. The course wise strength is as follows:

1.	M.Sc. Forestry	-	28
2.	M.Sc. Environment Management	-	25

3.	M.Sc. Wood Science and Technology	-	23
4.	Post Master's Diploma in Natural Resource Management	-	12
5.	Post Master's Diploma in Non Wood Forest Products	-	08
6.	PGD in Pulp and Paper Technology	-	07
	Total	**-**	**103**

Study Tour / Excursion: During the academic session local excursion, short and long tours were organized. Following places were covered in the study tours.

1. Lecture and training programme attended by M.Sc. Wood Science and Technology IVth Semester students in IWST Bangalore from 09th to 22nd April 2008.
2. Local excursions were organized at different places on the subjects viz. Botany, Pathology, Entomology, Forest Ecology and Medicinal Plants for all the M.Sc. and PG Diploma courses.
3. M.Sc. Wood Science and Technology, IIIrd Semester also attended lecture programme in February 2008 at IWST Bangalore.
4. A long tour was organized to different wood based industries of Rajasthan in January 2008. M.Sc. Wood Science and Technology students learnt about the latest technology of wood industries.
5. M.Sc. Wood Science and Technology students had also visited to wood and panel Expo, New Delhi for their placement and training.
6. PG Diploma students had visited to Haryana, Punjab and Rajasthan on long tour in December 2007 and February 2008.
7. M.Sc. Forestry students had gone to Valley of Flower in July 2007 for excursion tour.
8. The students of M.Sc. Environment Management have conducted following tours to get exposure on various Environmental related problematic areas.

Industrial / Institutional Attachment and Dissertation work: All India based different industries and Institutes were approached for the Industrial Attachment in December and for Dissertation work / project work from 1st April to 31st May.

All the students of M.Sc. courses were sent to one month industrial attachment to different industries / organizations in December. M.Sc. and PG Diploma students completed their dissertation / project work on specific topic relevant to their subjects.

Examination: Examination schedules for theory and practical exam were prepared. Question paper was collected from paper setter and examination of I, II, III and IV Semester for all M.Sc. and PG Diploma courses were conducted two times in a year. Same exercise was repeated for conduction of supplementary examination.

Convocation of Forest Research Institute University:

Third convocation of FRI University was held on 27th December 2007. Thiru S. Reghupathy Hon'ble Union Minister of Environment and Forest, Govt. of India was the chief guest and delivered the convocation address. The function was presided over by the DG, ICFRE Shri Jagdish Kishwan, IFS. The Director FRI presented his report on the activities of the FRI University to the honorable guests in which he presented the progress of the University in detail.

Following number of degrees were awarded in the convocation.

1.	Ph.D.	-	51
2.	M.Sc. Forestry	-	25
3.	M.Sc. Environment Management	-	37
4.	M.Sc. Wood Science and Technology	-	30
5.	Post Graduate Diploma in Plantation Technology	-	05
6.	Post Graduate Diploma in Biodiversity Conservation	-	14
7.	Post Graduate Diploma in Non Wood Forest Products	-	13
8.	Post Graduate Diploma in Natural Resource Management	-	06

Apart from the above, 21 merit holders were also awarded gold medals by the chief guest. The convocation was attended by large number of Scientists, Foresters, teaching faculty, current students and alumini of FRI University.

Extra Curricular Activities:

1. Quiz competition were organized by students. Orientation meeting was organized for the newly admitted students to interact with faculties.
2. Five seminars were held in the month of June 2007 for the students of M.Sc. and PGD courses to present their dissertation/project work.
3. Cultural programme was organized by students club FRI University on 12th April 2008.
4. Cricket Match organized on 1st and 2nd March 2008.
5. Annual Sports Meet was organized from 7th to 10th March 2008.

Special lecture:

1. Sh. B.S. Corrie, Tribal Rehabilitation Commission, Kerala Govt., delivered a lecture on "S. Tribes and Other Traditional Forest Dwellers" on 21st March 2007.
2. Dr. Mehar Singh, CCF, Wildlife, Kerala delivered a lecture on "Ecotourism" for all the students of FRI University.
3. Dr. Mehar Singh, CCF, Wildlife, Kerala delivered a lecture on "Landscaping in relation with Wildlife Management" on 23rd March 2007.

4. Dr. Podwils, Director, DAAD International Funding Agency of Federal Republic of Germany, visited FRI University on 14th August 2007 and he was briefed to all students/Research Scholars on various schemes and opportunity available in Germany.

5. Dr. S.D. Singh, IFS delivered a lecture on "Forestry Research" to the FRI University students.

6. Special lecture was organized on "Personality Development" for all FRI University students on 4th March 2008.

7. Special lecture was attended by FRI University students on "Application of Nano Science in Forestry" on 27th March 2008.

CONSULTANCIES

1. Installation of a solar kiln at Pipli, Haryana for Haryana Forest Development Corporation Limited and at Jalandhar for M/s Process-cum-Product Development Centre (PPDC), Meerut. The kiln has been installed and handed over to the client after successful trial and training of their staff.

2. Identification of technological gaps and possible remedial measures in wood based sports goods cluster at Jalandhar for Dr. B.R. Ambedkar National Institute of Technology, Jalandhar

3. Consultancy was provided to M/s Indo-Gulf Fertilizer, Jagdishpur, Sultanpur; M/s Tata Chemicals, Babrala, Badaun; M/s Shriram Alkali and Chemicals, Bharuch, Gujarat and M/s Chambal Fertilizers and Chemicals Limited, Kota on Cooling Towers.

4. Forest Department of Uttarakhand for Biostablization of Varunavat landslide.

5. Tehri Hydro Development Corporation Ltd., Tehri for stablization of left and right bank slopes of Koteshwar Hydro Electric Project with the help of suitable vegetation.

6. Commonwealth Games, DDA, New Delhi.

7. M/S Faridabad Gurgaon Mineral, New Delhi.

8. Bodhgaya Temple Mangement Committee for management of heritage tree Bodhi Vriksha.

9. New Delhi Municipal Council, New Delhi for management of diseases in plantation trees.

10. Archaeological Survey of India for the management and conservation of trees at Ta Prohm Temple, Siem Reap, Cambodia.

11. RIO Tinto Exploration India for Baseline study on the flora and fauna of Chhatarpur forest area of Madhya Pradesh.

AWARDS

1. DAAD Reinvitation Fellowship for two months in Germany was awarded to Dr. Meena Bakshi, Scientist-C to work in Bayerische Forstamt fur Forstliche Saat und Pflanzenzucht from November-January 2008. Worked on isozymes, microsatellites of *Pinus wallichiana* and *Dalbergia sissoo* using advanced DNA Sequencer.

2. Sudhir Kumar Sharma was awarded "FELLOWSHIP AWARD" to attend the International Conference on Plant Tissue Culture and Agri biotechnology held at Kualalumpur (Malaysia) from 17th to 21st June 2007.

3. Best poster titled "Bioactive principles from *Achyranthes aspera"* awarded to Dr. Rashmi in 2nd Uttarakhand Science Congress, held at Nainital from 15th to 17th November 2007.

PATENTS

1. Patent applied on "New eco-friendly, economical and non-hazardous wood preservative ZIBOC- comparable to CCA"

2. Black hair dye composition and a process for preparation thereof.

   (Application no. 1910/ DEL 207 dated 10th September 2007).

DISTINGUISHED VISITORS

1. Sh. Syed Mahmood Nasir, Conservator of Forests, Director of Biodiversity, Ministry of Environment, Govt. of Pakistan, Islamabad visited FRI on 3rd April 2007.
2. Mr. David Hu Loncl, High Commissioner of Canada visited FRI on 9th April 2007.
3. Mr. Hillary Thompson, Temple Quay House, Bristol visited FRI on 11th April 2007.
4. Sh. M.M. Pallam Raju, Hon'ble Minister of State for Defence, Govt. of India, Delhi visited FRI on 22nd April 2007.
5. Shri Binoy Viswan, Hon,ble Minister for Forest and Housing, Govt. of Kerala, Thiruvananthapuram visited FRI on 2nd May 2007.
6. Laffitte Dierre Senat, 15 R.K. Vargirant 25006, Paris visited FRI on 9th May 2007.
7. Thiru S. Regupathy, Hon'ble Minister of State for Forest and Wildlife, Govt. of India. Delhi visited FRI on 12th July 2007.
8. Ms. Meena Gupta, Secretary, Ministry of Environment and Forests, Govt. of India paid a visit to NFLIC and Bambusetum of the Institute on 1st August 2007.
9. Dr. Podewils, Director, Daad India office paid a visit to FRI on 14th August 2007.
10. 28 Afganistan Nationals visited FRI Dehradun on 17th August 2007.
11. Prof. N.S. Shekhawat, J.N.V. University, Jodhpur visited FRI in 2007.
12. Prof. H.S. Gehlot, J.N.V. University, Jodhpur visited FRI in 2008.
13. Shri G.S. Rajagopal, Director, SVP National Police Academy, Hyderabad visited the NFLIC of the Institute on 13th December 2007.
14. Mr. Sato Takashi, Director, International Cooperation Department and Dr. Kato Kazutaka, Tree Breeding Officer, Tree Breeding Centre, Japan visited the Division of Genetics and Tree Propagation and other Divisions of FRI, Dehradun from 20th to 29th February 2008 to get acquainted with tree improvement programme on short rotation forest tree species.
15. Dr. Vera Thoss, Ecological Chemist and Industrial Liaison Manager, University of Bangor, UK from 4th to 22nd February 2008.
16. The Parliamentary Committee and Hon'ble Minister of Environment and Forest visited the Germplasm Conservatory cum Herbal garden on 15th June 2007.

CENTRE FOR SOCIAL FORESTRY AND ECO-REHABILITATION ALLAHABAD

Centre for Social Forestry and Eco-Rehabilitation (CSFER), Allahabad was established in October 1992 as an advanced Centre under the umbrella of ICFRE, Dehradun. Presently, it is a Centre of Forest Research Institute (FRI), Dehradun. The Centre aims to nurture and cultivate professional excellence in the field of Social Forestry and Eco-Rehabilitation in the state of Uttar Pradesh.

The important research activities of this Centre are in the field of Planting Stock Improvement Programme (PSIP); Wasteland reclamation; Development of Agroforestry Models; Reclamation of mined areas through afforestation; Productivity of Ecosystem; Studies on Shisham mortality; medicinal plants etc. A number of research projects, funded by different agencies viz. UNDP, NABARD, World Bank, etc., have been carried out at this Centre. This Centre has also taken up a project on Research and Development of Jatropha sponsored by NOVOD Board.

PROJECTS COMPLETED DURING THE YEAR 2007-2008

PLAN PROJECT

Project 1: To develop medicinal plant nursery for generating awareness amongst local people [FRI-254/CSFER-05]

Findings: Demonstration plots of medicinal plants of *Asparagus racemosus* (Satawar), *Vinca rosea* (Sadabahar), *Tinospora cordifolia* (Giloy), *Chlorophytum arundinaceum* (Safed Musli), *Rauvolfia serpentina* (Sarpgandha), *Barleria prionites* (Kalabansa), *Plantago ovata* (Isabgol), *Plumbago zeylanica* (Chitrak), *Aloe vera* (Gheequar), *Cassia angustifolia* (Sanay), *Gymnema sylvestre* (Gudmar), *Acorus calamus* (Butch), *Abelmoschus moschatus* (Mushkdana), *Andrographis paniculata* (Kalmegh), *Psoralea cordifolia* (Bawachi), *Ocimum sanctum* (Tulsi), Mentha, *Cyperus rotundus* (Nagarmotha) and *Rauvolfia serpentina* (Sarpgandha) was established at central Padilla nursery. Planting stock of important species as *Asparagus racemosus, Andrographis paniculata* and *Barleria prionites* has been raised for distribution to the local people in extension programmes. Training-cum-demonstration programme on cultivation of Medicinal Plants have been organized in Central Research Nursery during the project period.

PROJECTS ONGOING DURING THE YEAR 2007-2008

PLAN PROJECT

Project 1: Development of agroforestry models of *Bamboo* species in Eastern U.P. [360/CSFER-7]

Status: Raising of Bamboo seedlings for *Dendrocalamus strictus* and *Bambusa arundinacea* have been done in the nursery for development of agroforestry models and extension programmes.

Agroforestry models have been developed on farmer's land and community land with a view to study performance of two Bamboo species and crops taken for the study. Study of the growth performance of Bamboo species with respect to height, no. of leaves and number of culms has been done. Yield of agriculture/ other crops under different treatments has been recorded. Agroforestry model with wheat has been established in demonstration plot of *Bambusa arundinacea.*

Farmers' feedback has been collected for seedlings of Bamboos distributed under extension work.

EXTERNALLY AIDED PROJECT

Project 1: Research and development of Jatropha (*Jatropha curcas*) under National Network Programme

Status: As per technical programme, progeny, zonal and networking trials have been conducted in nursery as well as in the field. In field's trials, CSFER –1 showed the best performance in progeny as well as zonal trials. Under National Networking Trial, Coimbatore –TNMC-4 showed the best results. Maintenance and management of provenances of the year 2005-06 and 2006-07 has been done. Observations on flowering, fruiting pattern and calculation of yield per hectare is being done. The seed sample better performing provenances of different Institutes and centres were exchanged for the provenence trial in second phase of the project. Seed sample from different trials were sent to the Head Chemistry Division, FRI, Dehradun for oil content analysis. The average yield of 0.5 kg per plant has been estimated in the 3rd year of Jatropha from the fruiting in the month of November.

NEW PROJECTS INITIATED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Assessment of Suitable Age of Seedlings of Forestry Species for Plantation in Uttar Pradesh [FRI -396/CSFER – 7]

Status: Raising of seedlings of selected species in nursery viz. *Holoptelia integrifolia, Albizia* sp. *Terminalia arjuna, Gmelina arborea, Bombax ceiba, Madhuca indica, Aegle marmelos, Pongamia pinnata, Acacia catechu, Tamarindus indica, Azadirachta indica, Artocarpus heterophyllus, Prosopis juliflora, Acacia nilotica, Syzigium cumunii, Pithecellobium dulce, Haplophragma adenophyllum, Dalbergia sissoo, Tectona grandis* has been taken up. Maintenance and growth data recording of seedlings of selected species in nursery is in progress. Plantation trials to study the comparative growth performance of Khair, Semal, Imli, Prosopis and Siris in the field and the nursery conditions have been done in CRPF campus (under rain fed conditions) and Central Padilla nursery (under irrigated conditions) in RBD design in three replications.

Maintenance, management and monthly growth data recording of experimental plantations at CRPF campus and Padilla nursery is in progress. Two years old seedlings have been procured from the forest department and site has been selected for the plantation.

Project 2: Development of agroforestry models for Eastern Uttar Pradesh [FRI-397/ CSFER–8]

Status: Field survey and selection of study sites was done to identify farmers practicing Agroforestry in their fields in districts of Allahabad, Lucknow, Varansi, Mirzapur, Sonbhadra and Raebareli. Agroforestry plots with different tree- crop combinations viz. Eucalyptus –Rice, Eucalyptus-Sugarcane, Poplar-Rice, Poplar-Sugarcane, Teak-Rice, Aonla-Rice were selected for further studies. Data of forestry species viz. age, height, girth etc were recorded of these selected agroforestry plots. Collection of soil samples from the selected sites. Soil samples collected from selected sites of farmers fields are being analyzed for moisture content, electrical conductivity, pH, organic carbon, nitrogen and phosphorus. Questionnaire based survey was done for studying the perceptions of the farmers regarding the Agroforestry and problems of farmers in adoption of agroforestry in their fields. Collection of data regarding agricultural crop production and collection of soil samples from selected agroforestry fields after harvesting of the paddy and wheat in Phulpur, Allahabad and Jagatpur, Raebareli has been done. Survey for studying the market availability for agroforestry products and problems of farmers in adoption of agroforestry in their fields. Analysis of soil samples for organic Carbon is in progress.

Project 3: Demand supply gap analysis of important tree species of selected districts of Uttar Pradesh for extension and afforestation purposes [FRI - 397/CSFER –9]

Status: Preparation of questionnaire has been done for farmers regarding study of demand supply position of selected trees. Basic data about districts and villages had been collected from population census records. Random selection of Tahsil wise villages (2 %) has been done for Gorakhpur district for starting survey work from villages. Survey for demand-supply position of selected species has been done in four villages of Gorakhpur district under Campierganj Tahsil and five villages in Sahjanwa Tahsil.

PUBLICATION

Compiled abstracts of research papers presented in National Workshop on Problems and Prospects of agroforestry in U. P. has been published in form of booklet as well as in CD.

A Brochure containing the information about ongoing research activities at CSFER, Allahabad has been published in Hindi and English.

CONFERENCE/MEETINGS/WORKSHOPS/SYMPOSIA/EXHIBITIONS

1. A Farmers' Workshop was organized on 9th August 2007.
2. Training-cum-demonstration programme on Medicinal Plants on 4th December 2007.
3. National Workshop on Problems and Prospects of Agroforestry in U. P. sponsored by ICFRE, Dehradun and Department of Science and Technology, New Delhi on 17th and 18th March 2008.