

ANNUAL REPORT

2011-2012



INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION
(An Autonomous Council of Ministry of Environment and Forests, Government of India)
DEHRADUN (UTTARAKHAND)



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Media and Extension Division
Directorate of Extension
Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun- 248 006 (Uttarakhand), India

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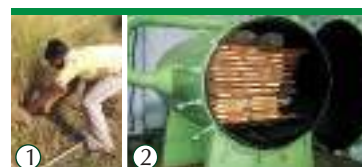
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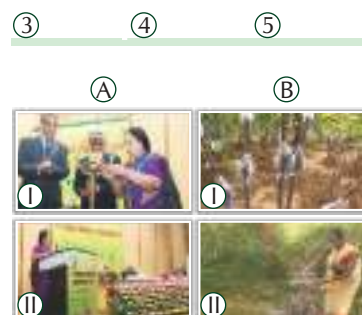
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सत्यमेव जयते

डॉ. वी. के. बहुगुणा, भा.व.से
महानिदेशक, भा.वा.अ.शि.प.
एवं कुलाधिपति, व.अ.सं. विश्वविद्यालय
Dr. V. K. Bahuguna, IFS
Director General, ICFRE
and Chancellor, FRI University



पर्यावरण एवं वन मंत्रालय, भारत सरकार
भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद्
(आईएसओ 9001:2000 प्रमाणित संस्था)
पो.ओ. न्यू फॉरेस्ट, देहरादून-248 006 (उत्तराखण्ड)
Indian Council of Forestry Research and Education
Ministry of Environment and Forests,
Government of India
(An ISO 9001-2000 Certified Organisation)
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FOREWORD

The Indian Council of Forestry Research and Education (ICFRE), Dehradun is a leading organization in the forestry sector which is actively engaged in holistic development of forestry research, education and extension for sustainable management and development of forestry resources through scientific deliberations and through delivering simple innovative technologies to the stakeholders.

The need for food and water security by focusing on management of forest fringe areas is growing in today's challenging milieu. The necessity of an active management in the fringe forests for water conservation and management of minor forest produces on sustainable basis, integrating Biodiversity Conservation with Climate Change, to provide food and livelihood security of nearly 300 million people abutting these forests is of prime importance. The Council focuses its activities on the livelihood issues of farmers, tribals and rural folks, especially women, besides its other regular activities. The Research Thrust Areas have been revamped, and six thrust areas and 35 themes have been identified. National Subject Matter Coordinators (NSMCs) have been appointed for each theme, and 35 State of Knowledge Reports (SKRs) on various themes of forestry are under preparation.

All India Coordinated Projects (AICPs), inter-institutional projects and networked projects have been envisaged to avoid duplication and for optimum utilization of resources. National Project Directors have been designated in all the six thrust areas to formulate the national programmes and to implement and execute them.

Besides the above, the Council has constituted a Task Force to prepare a change-matrix of the forest vegetation in the country considering the fact that the composition of the forest types of India was revised last in 1968. ICFRE has been entrusted with consultancies for the reclamation and rehabilitation (R&R) plans of mine-affected areas of the Bellary, Chitradurga and Tumkur districts of Karnataka. R&R plans prepared by the Council for 10 mines were subsequently approved by the Central Empowered Committee (CEC) of the Hon'ble Supreme Court.

The Council has established 26 Van Vigyan Kendras in different states/UTs under XI Five Year Plan with the objective of dissemination of various technologies developed by the Council. However, our presence is insufficient and therefore, to fill the gap between the need and resource, we have initiated collaboration for networking the VVKs with Krishi Vigyan Kendras of Indian Council of Agricultural Research (ICAR), New Delhi. ICFRE has also launched a new innovative scheme 'Direct to Consumers' for immediate transfer of technologies on completion of a research project to consumers/stakeholders. ICFRE is mandated to promote forestry education in the country. This year we have released grants-in-aid of an amount of Rs. 100.00 lakh to 10 universities. Besides, ICFRE has been actively involved in the Mid Career Training Programme of IFS officers (Phase-III).

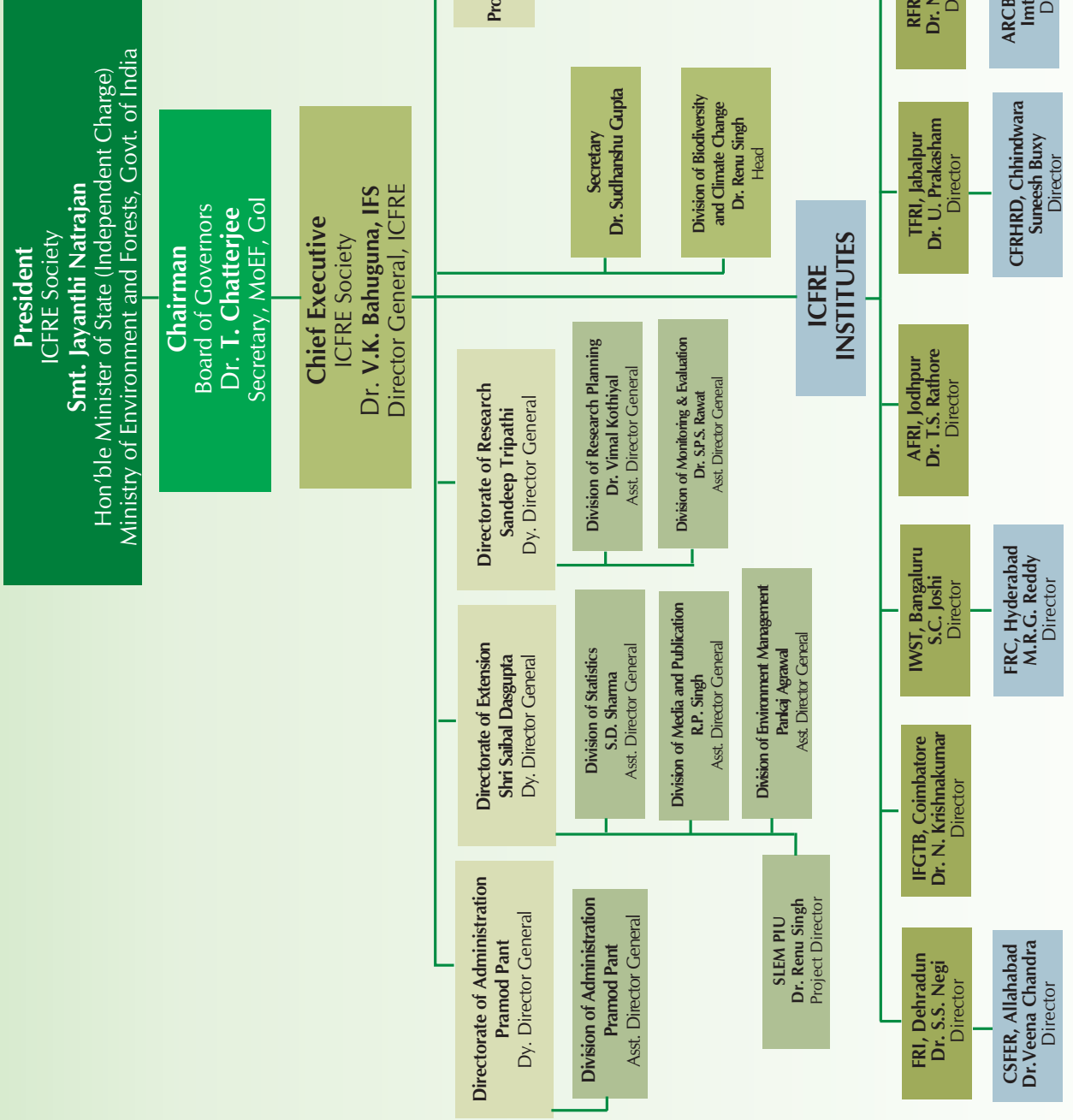
This year the Council organized the first ever Indian Forest Congress at New Delhi. The Congress was attended by 550 participants from over 50 organizations. New Delhi Forest Charter 2011 was adopted at the conclusion of the event. I have the pleasure to present the ICFRE Annual Report 2011-12 which, I am sure, will provide a brief account of activities performed by the Council during the year.

(Dr. V. K. Bahuguna)

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ORGANIZATIONAL STRUCTURE OF ICFRE SOCIETY



(As on 31st March 2012)

Executive Summary

Indian Council of Forestry Research and Education (ICFRE) is a premier organization engaged in the holistic development of forestry research, education and extension in the country. The Council, through its 8 institutes and 4 advance research centres, undertakes research programmes to meet objectives of national forest policy on the one hand and to contribute significantly in enhancement of livelihood of the rural folk on the other with clear perspective in addressing the problems in relation with food and water security of the nation. The Council publishes account of its activities in the form of Annual Report every year. A brief summary of the ICFRE Annual Report 2011-12 is as follows:

Ecosystem Conservation and Management

- Carried out studies on forest soils under natural forests/ plantations and prepared forest soil organic carbon inventory.
- Assessed vegetation carbon pool in 21 forest sites and 30 TOF (Trees Outside Forests) areas of Andhra Pradesh.
- Estimated Carbon stock in forests of six districts of Rajasthan which varied from 18.3 tons/ha in Jhalawar to 41.5 tons/ha in Kota in 0-90 cm soil layer.
- Developed technology for restoration of stress sites, landslides and marginal lands.
- Conducted eco-restoration studies in Uranium Mines at Jadugoda, Jharkhand.
- Carried out study on utilization of fungi for bio-treatment of industrial wastewaters.

FRI, Dehradun prepared Deodar and Kail maps of Uttarakhand, after due verification by ground truthing and also studied the role of Temple Forests in rejuvenating *microclimate of some villages of Uttarakhand*.

RFRI, Jorhat prepared invasion map of *Mimosa* in Kaziranga National park by developing a model integrating remote sensing, Global positioning System and GIS data/ information through Analytical Hierarchy Process (AHP).

- For air quality assessment, established an Air Pollution Bio-monitoring Station at Dehradun.
- Developed a Remote Sensing based Bio-climatic Index.
- Conducted ecological Impact Assessment of invasion of *Lantana*, its removal and subsequent restoration of habitats in Rajaji National Park of tropical moist deciduous forest.
- Studied *Ex-situ* conservation methods of *Vanda coerulea* and *Renanthera imschootiana* and carried out their multiplication.
- Studied socio-economic prospects of *Gnetum gnemon*, an endemic gymnosperm and that of *Livistona jenkinsia*, an indigenous and threatened palm.
- Isolated different strains of *Acoulospora* sp., *Glomus* sp. and *Gigaspora* sp. (VAM) and mass multiplied them through trap culture and pot/plot culture.
- Documented diversity of mycorrhizal associations with *Dipterocarpus* and *Shorea* species in Assam.
- HFRI, Shimla carried out phyto-sociological studies in the Kalatop Khajjiar Wildlife Sanctuary for devising suitable management strategies. 232 plant species, belonging to 76 families and 218 genera, were recorded in the sanctuary. Out of 100 plants species of medicinal importance, found 7 were found threatened.
- AFRI, Jodhpur established plantation trials on highly saline black, silty, clay soil of Little Rann of Kuchh. *Salvadora persica* proved to be the best in terms of survival rate (83.7%) and growth, followed by *Acacia ampliceps*. In rehabilitation of salt affected area, fertilizer treatments significantly influenced the fruit yields of *Salvadora persica* and *A. ampliceps*.

Forest Productivity

- Carried out programmes for developing cultivation protocols for enhancing productivity of some important medicinal plants with *Melia composita*



and *Emblica officinalis* and improvement of degraded land in Punjab and Uttarakhand.

- Studied the impact of ban on green felling in Deodar, Kail, Fir and Spruce forests of Uttarakhand.
- Silviculture studies were conducted on *Hippophae salicifolia* – A Lesser Known Wonder Plant of Uttarakhand.

Microwave irradiation reduces the time of oil extraction from the *Pongamia pinnata* seeds significantly.

0.5% sodium hydroxide and 1.0% potassium hydroxide catalyst concentration are optimum for production of standard biodiesel from *P. pinnata* oil under microwave irradiated conditions.

- Agroforestry and value addition was started to enhance productivity in abandoned jhum land. Rehabilitation of jhum land was also carried out through potential bamboo species with reference to carbon sequestration and livelihood development.
- Carried out comparative studies on optimum treatment time and durability in commercially important bamboo species (*B. pallida* and *D. hamiltonii*) and developed a viable technique for efficient charcoal production from different bamboo species of North East Region.
- In Bilara near Jodhpur, *Prosopis cineraria* was found best on the basis of survival rate and dry biomass with agriculture crops.
- On sandy hill pediment land, *Cordia graf* and *Cenchrus ciliaris* based silvipastoral system produced maximum biomass, followed by *Zizyphus mauritiana* with *C. ciliaris* at 38 months age at Bhuj in Gujarat.
- Refinement has been made to estimate oil content in standing tree by measuring colour intensity using portable colorimeter

Genetic Improvement

- Initiated a programme for improvement of *Eucalyptus*, *Dalbergia sissoo*, *Melia composita*,

Pongamia pinnata and some medicinal plants like *Asparagus racemosus*, and *Acorus calamus*.

- Using microsatellite (SSR) DNA markers 21 large contiguous deodar forests from Uttarakhand, Himachal Pradesh and Jammu & Kashmir were investigated for genetic diversity.
- In the process of developing DNA marker technique in *Cedrus deodara* for timber forensics, success has been achieved in isolating DNA from the dead wood of *C. deodara*.
- Two progeny trials of Red sanders have been established at Hyderabad and Bangalore. Evaluation of early growth performance of these progenies showed the superiority of CPT's collected from Karnataka especially at Kushalnagar, Kodagu.

One clone of *Eucalyptus* hybrid (*Eucalyptus camaldulensis* Dehn. X *E. tereticornis* Sm.) and One productive and wilt disease resistant clone of *Dalbergia sissoo* have been identified and recommended by the Regional Variety Testing Committee for release.

Identified a high oil yielding germplasm (with > 40.0% oil) of *Pongamia pinnata* which is now being evaluated under different site conditions.

- Established a vegetative multiplication garden (VMG) of *Ailanthus excelsa* in 0.5 ha area and created research infrastructure.
- Standardized shoot multiplication medium for *Dalbergia latifolia* and *Pterocarpus santalinus*.
- Selected two clonal seed orchards, one each in Karnataka (Janganamatti, Dharwad) and Andhra Pradesh (Achuthapuram, Rajamundry) to standardize flower induction schedule in clonal seed orchards of *Tectona grandis*.
- Fifteen new candidate plus trees of *Tectona grandis* were selected from different locations of Gujarat and Rajasthan. Genetic analysis of teak half sib progenies was carried out in Rajasthan for the first time.



IFGTB Coimbatore was nominated as the Local Focal Point by Food and Agriculture Organisation (FAO), for preparation of State of the World – Forest Genetics Resources – Country Report for India (SOW-FGR).

Expertise at IFGTB is recognized world over as a partner of multinational network for transcriptome sequencing for salt tolerance in *Casuarina* and *Frankia* of Joint Genome Institute, US, along with UCAD, Senegal; IRD, France and the University of New Hampshire, US.

- Selected 21 CPTs of *Prosopis cineraria* from different intensity of mortality areas in Rajasthan and carried out genetic variation and inheritance of pod characteristics which was not known earlier.
- Based on growth (height & girth) three clones, each of *Eucalyptus camaldulensis* and *Dalbergia sissoo* were selected in multilocation clonal trials in Gujarat. Progeny trial of 17 CPTs having high aza content (>5000 ppm) and oil (>40%) revealed that progenies of the CPT 4 & 7 were better on the basis of growth parameters as well as frost tolerance.
- In demonstration trial of male and female plants of *Ailanthus excelsa*, female plants exhibited superiority in terms of overall growth as compared to male plants at 3 year age.
- Based on clonal trial of *Commiphora wightii*, two clones were identified for highest biomass.
- Developed two seed yield equations in *Jatropha curcas*. In multilocal clonal trial across the country, 14 superior accessions of *J. curcas* were identified.
- Protocols for the seed germination and vegetative propagation using micro cuttings (2.5 mm) of *C. wightii* were developed.
- Identified superior genetic stock of *Picrorhiza kurroa* and *Valarina jatamansi* from different geographical locations of Himachal Pradesh and Uttarakhand.

- Carried out investigations in reproductive biology of *Aquilaria malaccensis* Lamk., a critically endangered and economically important species, for its conservation. A germplasm bank consisting of 50 progenies of *A. malaccensis* was established in RFRI campus and DNA from selected trees was screened, using various primers.
- Artificial inoculations of fungi were done for inducing agarwood in healthy trees within a relatively shorter period.

Using gene expression omnibus in combination with PLEX database, one putative gene having role in salinity stress tolerance was identified.

DNA marker studies on genetic fidelity of micropropagated plants of *Commiphora wightii* revealed genetic uniformity in the plants; hence protocol developed can be used for large scale cloning.

Forest Management

- Consultancy was given to Archaeological Survey of India for conservation of trees at *Ta Prohm* temple at Cambodia as well as to Bodhgaya Temple Management Committee, Bodhgaya, Bihar for the maintenance of *Bodhi-vriksha*.
- Designed and developed web database for timber of commercial importance in Southern India. System Analysis for the sandal web database was completed.

Studies conducted by IWST, Bangalore challenged the current theories for regulating Discrete Generation Cycles which are based on occurrence of natural enemies (as external factors) or cannibalism (as internal factors) and led to preparation of models showing a distinct possibility of factors like protandry for causing discrete generations of the forest pests.

- Conducted extensive surveys for identifying the natural population of *Abies spectabilis* in five Forest Divisions of Himachal Pradesh. Identified nine natural populations of *A. spectabilis*.
- Due to ecological and socio-economic significance of hill bamboos (*Arundinaria falcata* and *Thamnocalamus spathiflorus*), multi-localational



trials of all 22 identified clones of the two species were accomplished at two different locations in the forest areas in Kullu Forest Division and Kotgarh Forest Division.

- Preliminary growth data indicated that *Gmelina arborea* performed well on all the study sites and has attained an average height of about 250 cms within three years of its establishment. Though very early to predict, yet, it can be a potential species for carrying out future plantations in the lower hills.
- Analysed eleven populations of shisham for genetic variation and observed that populations from Jammu & Kashmir (J&K) and Himachal Pradesh (HP) had more genetic diversity as compared to Uttarakhand. Owing to the biotic pressure and local people enjoying the rights of seed collection, the regeneration of Chilgoza pine populations has been found to be very negligible in Kinnaur and Bharmour areas of HP.

Wood Products

- Studied the drying behaviour of chir pine and shisham wood in a self designed convection heating vacuum kiln.
- 22 species with origin from different countries were evaluated for natural durability in Dehradun test yard. After 36 months, all samples were found badly decayed except teak of Myanmar, Ghana and Tanzania.
- Performance of *Pinus roxberghii*, *Pinus radiata*, *Pseudotsuga menziesii* in prototype cooling tower with CCA, CCB and ZiBOC preservative

Treatment methodology for Douglas fir with ZiBOC was developed. Complete protection of Meranti (Red, Yellow and White) and Douglas fir in yard test was achieved after treatment with ZiBOC, CCA and CCB after 20 months of installation.

IWST, Bangalore improved dimensional stability and colour of wood samples of *Acacia auriculiformis* and *Hevea brasiliensis* with thermal modification making them more suitable for flooring.

revealed that *Pinus radiata* performed badly as compared to other species.

- Developed a solvent free process for chemical modification of wood by acetic anhydride and butyric anhydride with iodine as catalyst. This finding has commercial implications as reduction in treatment time will bring down the cost of modified wood.
- Jute and wheat husk were explored as a reinforcing materials for bio-fiber filled polypropylene composites. Jute filled composites exhibited superior mechanical properties to wheat husk filled composites.

Non Wood Forest Products

- Screened 25 prospective plant species for extraction of dye for application on human hair and conducted studies for the development of eco friendly PPD free natural hair colourants.
- New forest based raw materials viz., *Sesbania grandiflora*, *Gmelina arborea* and *Prosopis juliflora* responded well for their suitability for paper making characteristics.
- High xylanase content was observed during Bio-deinking in the crude enzyme preparation of *Coprinus disseminatus* which would be beneficial in enzymatic deinking as it increases brightness of hand sheets against conventional deinking process.
- Testing of *Garcinia* fruit rind (methanol and benzene-alcohol extracts) for acute and chronic effects was completed. The results indicated reduction of 60 % blood sugar after sub-acute observation (blood sample analysis for 14 days). In chronic studies, the blood sugar level was reduced to about 49% (i.e. 21 days after administration of extracts).
- Lac host species viz. *Flemingia macrophylla* and *Flemingia semialata* were transplanted for the establishment of lac based silvi-agri-lac system in the tropical region of Jabalpur. *F. macrophylla* species performed better as compared to *F. semialata*.



- Plantations of *Phyllanthus emblica* cv. NA7 and NA10 performed excellently during the 1st year of plantation. Both cultivars needed additional inputs including timely irrigation and proper doses of fertilizer for establishment.

FRI, Dehradun successfully attempted preparation of handmade paper from noxious weed *Lantana camara*.

Developed Natural dyes and their different shades which are capable of dyeing different type of textiles (silk, wool and cotton).

Also developed a simple and facile process to isolate Hederagenin, a potential bioactive compound known for its anticancer, anti-inflammatory, anti-depressant, anti-hyperlipidemic, anti-tyrosinase, skin lightening and cure of nephritis properties and in prevention and treatment of bone diseases along with a number of other biological activities, from seed kernel extract of *Sapindus mukorossii*

A novel green product named as 'Samriddhi', a silk productivity enhancer for sericulture industry, has been developed from the weeds and tested at Regional Sericulture Research Station, Sahaspur on Silkworm, *Bombyx mori* L. The product is capable of exceptionally reducing the complete spinning time from 32-36 to 15-18 hours.

- Raised seedlings of *Psidium guajava* and *Pterocarpus marsupium* intercropped with *C. cajan* for the development of silvi-horti-agri system. *P. marsupium* exhibited 50% survival and performed poorly in the lateritic soil.
- Developed technology for formulation of three value added food products viz. Mahua jam, squash and chutneys from dried *Madhuca indica* (Mahua) flowers. All the products developed were according to the Food Products Order (FPO) specifications.

Forest Protection

- Artificial cultivation of *Ganoderma lucidum* was achieved by using poplar wood billets. Diversity in

Ganoderma lucidum was studied with special emphasis on its medicinal uses.

- Documentation of macrofungi in rain forests of Makutta was done based on its prevalence during monsoon, pre and post monsoon. During the study, 30 species of macrofungi were identified. A manual for field identification of macrofungi is also under preparation.

A molecular diagnostic kit for *Cordyceps sinensis* & *Ganoderma lucidum* identification was developed.

- Durability of plantation timbers of various ages against bio-deteriorating agents was tested. Wood of *Acacia auriculiformis* and *A. mangium* even at five years of age can be used for different purpose as they showed considerably good resistance against decay fungi, whereas, even 20 year old *Ailanthus excelsa* and *A. malabaricum* were found nondurable.
- Studies have been initiated on insect mediated pollination biology of mangrove plants in Sonneratiaceae and Aviceniaceae in coastal Karnataka and on diversity of whiteflies (Aleyrodidae: Homoptera) and their natural enemies in Mangrove habitats of India.
- Conducted studies on biodiversity of parasitic *Chalcidoidea* (Hymenoptera) of Uttarakhand. Carried out taxonomic studies on parasitoids belonging to subfamily *Microgastrinae* (Hymenoptera: Braconidae) of Uttarakhand and Haryana.
- Studied bio-ecology and management of oak stem borer, *Aphrodisium hardwickianum* White (Coleoptera: Cerambycidae).
- Isolated and characterized phytoecdysteroids from *Achyranthes aspera* and *Achyranthes bidentata*. Also studied their effects on economic traits of silkworm *Bombyx mori* L.
- Detailed bio-ecology of the white grub complex was investigated in Maharashtra, based on which



the model for the integrated management was proposed to Forest Development Corporation, Maharashtra.

Artificial diet for conservation and utilization of preying mantis as biocontrol agents was developed.

Three new species of white grubs (*Holotrichia rustica*, *H. mucida* and *Schizonchya ruficollis*) were identified for the first time. These grubs caused vast scale damage to teak seedlings in forest nurseries

- Aonla cv. NA-10 was found to be relatively resistant followed by Kanchan against gall forming insect *Betousa stylophora*, defoliator *Garcillaria acidula* and bark eating caterpillar *Indarbela quadrinotata*. In nursery, foliar spray of monocrotophos 36 E.C. 0.05% followed by metasytox 25 E.C. 0.05% and soil application of phorate 10G and furadon 4G each @ 25g/1mx1m plot were also found to be equally effective against *Betousa stylophora*.
- Blue gum chalcid wasp, *Leptocybe invasa*, was found to be a major threat to *Eucalyptus* in nurseries of central India.
- Seven entomopathogenic nematode strains native to central India were isolated. One of them was identified for the first time, as an important biological control agent against major forest insect pests.
- From different conifer bearing sites, 2740 and 1360 specimens of moths were collected during 2010 and 2011, respectively. 69 species of moths were dissected so as to study wing venation and genitalia for taxonomic updates.
- New mite species have been found infesting the stored seeds. The different treatments applied and analyzed for developing suitable control measures to protect the stored Chilgoza seeds for longer period.

Release of indigenous strain of eggs parasitoid, *Trichogramma raoi* @ 1.25 lakh/ha was found to be effective in minimizing damage impact caused by teak defoliator and leaf skeletonizer.

Twenty five species of *Apanteles*, promising biological control agents of key defoliators of teak and sal forests, were recorded for the first time from Odisha.

Forestry Education

- ICFRE provided scores of trainings regularly, a few important include, a three day training programme on “CDM Validation and Verification” with the help of M/S TUV SUD SOUTH ASIA Pvt. Ltd., New Delhi; ICFRE-IDS collaborative workshop on “Strengthening Knowledge Sharing for Effective Development in Uttarakhand”; one week compulsory training course for Indian Forest Service Officers on “Forest and Climate Change: Opportunities and Challenges of Mitigation and Adaptation”; one week DST training programme on “Climate Change and Carbon Mitigation” for scientists and technologists; Convention on Biological Diversity (CBD) Expert Group Meeting on “Biodiversity for Poverty Eradication and Development”; one week training programme on “Climate Change and Carbon Mitigation” for women scientists and technologists; two-day training workshop for Indian Forest Service officers on “Significance and Scope of REDD/REDD+ for Indian forest”. The officers and scientists from ICFRE also participated in various international meetings including 14th session of the *Ad-hoc* Working Group on Long-Term Cooperative Action (AWG-LCA) under the United Nations Framework Convention on Climate Change; 16th session of the Ad-Hoc Working Group on Future Commitments for Parties under the Kyoto Protocol (AWG-KP) at Bangkok, Thailand; UN Climate Change Conference at Bonn, Germany; UNFCCC COP 17 and COP/MOP-7 at Durban, South Africa.



ICFRE is providing Grants-in- Aid to various universities and institutions imparting Forestry Education in the country. ICFRE released Grants-in Aid of Rs.100 Lakh to 10 universities during the year under report. Besides, ICFRE has been actively involved in the Mid Career Training Programme of IFS Officers (Phase-III).

Forestry Extension

- ICFRE conducted and participated in a number of seminars, workshops, fairs etc. for the benefit of farmers, tree growers, and other stakeholders; publication and dissemination of technologies through VVKs and DVs.
- 4 **Tree Growers Mela** was held at IFGTB, Coimbatore on 23-24 February 2012. It was inaugurated by Smt. Jayanthi Natarajan, Hon'ble Minister of State (Independent Charge), Ministry of Environment and Forests, Government of India.
- ICFRE organized First ever **Indian Forestry Congress (IFC)** in New Delhi from 22 to 25 November 2011. New Delhi Forest Charter 2011 was adopted at the Congress which was attended by 550 participants from over 50 organizations. The congress was inaugurated by Smt. Jayanthi Natarajan, Hon'ble Minister of State (Independent charge), Ministry of Environment and Forests, Government of India.
- The Council organized trainings on various topics including "Urban Plantation: Choice of tree species, Techniques & Specification", "Nursery and Plantation Technique of Medicinal Plants & Utilization", "Nursery and Plantation Techniques of Fast Growing Tree Species", "Micro and Macro propagation Techniques for Quality Planting Stock Production", "Sustainable Management, Product Diversification and Value Addition of Bamboo and Wildlife Management" and "Sustainable Utilization, Conservation and Cultivation of Medicinal Plants" through its network of Van

Vigyan Kendras and Demo Villages throughout the length and breadth of the Country.

- ICFRE is regularly publishing books, newsletters, bulletins, booklets, brochures, and pamphlets besides numbers of research papers in various Indian and foreign journals. An outstanding book on the achievements in the field of forestry research in the country spread over a century, "**Forestry in the Service of the Nation: ICFRE Technologies**" was published along with other important publications including "**Voices From the Field**". ICFRE compiled a report on the occasion of celebration of the International Day for Biological Diversity (IBD) on 22 May 2011 and submitted it to the Ministry of Environment and Forests.
- During 2011-12, under the Integrated Community Based Forest Management Project in Bihar {Samudai Adharit Samanvit Van Prabandhan Evam Sanrakshshan Yojna (SASVPESY)} commonly known as Bihar Project, 3.87 Lakh ETPs were planted at farmers field, while 1.68 Lakh ETPs were used for raising the nurseries and a total of 7.12 lakh seedlings/plants of various tree species like poplar, teak, mahogany, gamhar, semal, kadam, jamun, bamboo etc. were distributed to farmers from model nurseries.

Consultancies were undertaken in the areas of hydropower, mining, infrastructure etc.

ICFRE on the directions of Honorable Supreme Court of India conducted Macro level EIA for Mine affected districts of Karnataka. The recommendations made were implemented *in toto* by the Hon'ble Supreme Court of India.

Government of Karnataka has awarded the preparation of Reclamation and Rehabilitation Plan for the mine affected districts of Bellary, Chitradurga and Tumkur to the Council.



- During the year under report, 125 new projects were initiated including 28 externally aided projects, whereas, 120 projects were completed including 31 externally aided projects.

New Initiatives

An assembly of new innovative ideas has initiated reshaping of forestry research and extension in the country with a people-centric approach.

The Research Thrust Areas of ICFRE have been revised with a focus on the enhancement in livelihood of the rural and tribal people and on the food and water security, and six thrust areas and 35 themes have been identified.

The Thrust Areas are:

- i) Managing forests and forest products for livelihood support and economic growth,
- ii) Biodiversity conservation and ecological security,
- iii) Forests and climate change,
- iv) Forest genetic resource management and tree improvement,
- v) Forestry Education and Policy Research to meet emerging challenges, and
- vi) Forestry Extension for taking research to people.

Networking of VVKs with KVKs of ICAR has been initiated with a view to provide better outreach to the ICFRE technologies and processes.

International cooperation was initiated with a number of organizations including ICMOD, JICA, UK Forestry Commission, Chinese Academy of Forestry etc.

The composition of **Forest Types of India** in the field have changed a lot since last revision in 1969. Their revision was long overdue. ICFRE constituted a task force to prepare a change matrix of forest vegetation in the country which is going to be completed by December 2012. This will act as a baseline for monitoring climatic changes in the forests of the country.

Creation of Ginger Group/ Knowledge Pool – Consultative groups of ICFRE scientists and other eminent forests officers to think beyond the traditional concept of stakeholder / demand driven / need driven research concepts has been created to bring 'innovative ideas and out of box thinking' for solving the problems of Consumers on the issues relating to emerging challenges of forestry science.

National Subject Matter Coordinators (NSMCs) have been nominated to develop systematic approach on various subject matters and to develop site specific and subject specific research programmes. They are expected to coordinate research, extension and marketing activities in identified themes. National subjected matter experts have been designated in 35 thematic areas.

National Project Directors (NPDs) nominated in six thrust areas to develop All India Coordinated Projects on the Thrust Areas and prepare a road map to undertake research in program mode.

To enhance the outreach of research findings in the field the **“Direct to consumers”** scheme for immediate transfer of recently developed technologies to the consumers has been initiated.

A coffee table book, **Biodiversity of India** depicting diverse forest types, biodiversity hotspots, floral and faunal biodiversity, conservation steps etc in the country is conceived for publication and subsequent release in COP -11 meeting at Hyderabad during October 2012.

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Introduction



Introduction

Indian Council of Forestry Research and Education (ICFRE), an apex body in the National Forestry Research System, deals with the solution based forestry research in tune with the emerging issues in the sector, including global concerns such as climate change, conservation of biological diversity, combating desertification and sustainable management and development of resources. Topical research by the Council enhances public confidence in the ability of forest managers and researchers to successfully handle challenges related to natural resource management.

Mission Statement:

To generate, preserve, disseminate and advance knowledge, technologies and solutions for addressing the issues related to forests and promote linkages arising out of interactions between people, forests and environment on a sustained basis through research, education and extension.

Vision:

Increasing forest cover and enhancing forest productivity through operationalisation of National Forestry Action Programme and National Forestry Research Plan.

Objectives of ICFRE:

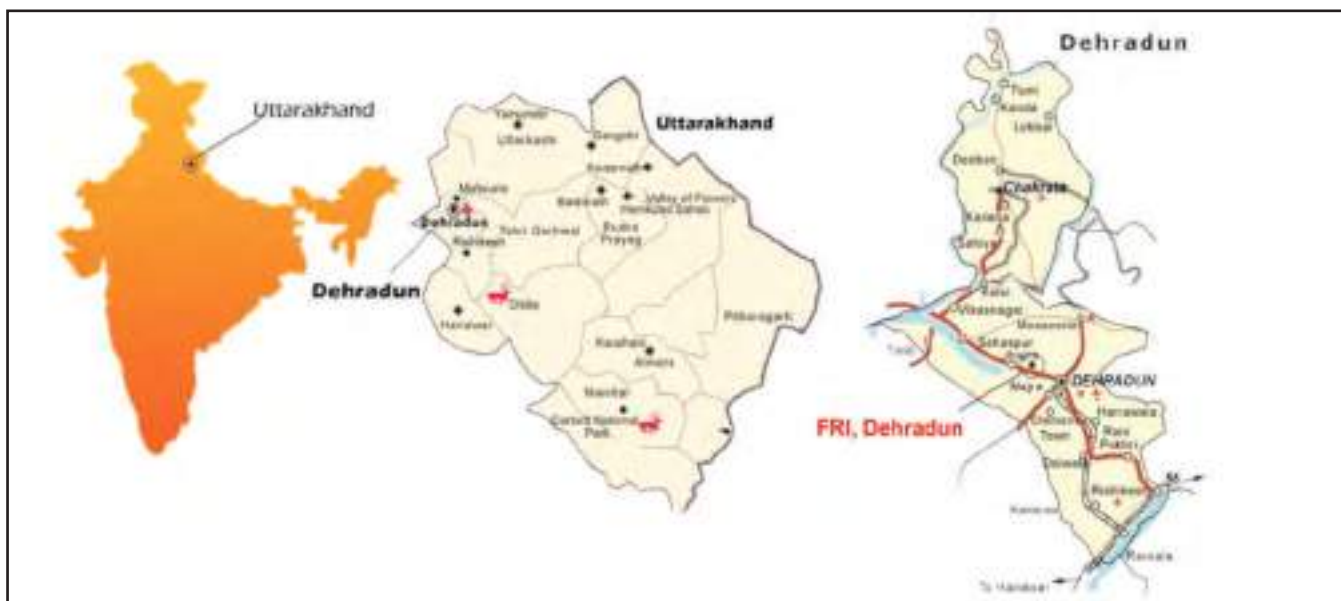
1. To undertake, aid, promote and coordinate forestry education, research and their applications.
2. To develop and maintain a national library and information centre for forestry and allied sciences.
3. To act as a clearing-house for research and general information related to forests and wildlife.
4. To develop forestry extension programmes and propagate the same through mass media, audio-visual aids and extension machinery.
5. To provide consultancy services in the field of forestry research, education and allied sciences.
6. To undertake jobs considered necessary to attain these objectives.

Institutes and Centres:

Indian Council of Forestry Research & Education (ICFRE) with headquarters at Dehradun has eight research institutes and four research centres spread over across the country to facilitate the forestry research, education and extension.

Forest Research Institute (FRI), Dehradun

Established in 1906 **Forest Research Institute (FRI)**, Dehradun is a premier scientific Forestry Research Institute. FRI has established itself in global arena of forestry and related allied sectors through its persistent innovative and rigorous research approach to foster the needs of the forestry for entire India and even in the other countries of the subcontinent. Presently its research is prioritized on the basis of needs in its jurisdiction over Uttarakhand, Uttar Pradesh, Haryana, Punjab and National Capital Territory of Delhi. The Institute is involved in meticulous research work related to improvement and management of forests and associated issues through different research divisions viz. Botany Division, Cellulose and Paper, Chemistry Division, Climate Change and Forest Influence Division, Ecology and Environment Division, Entomology Division, Extension Division, Forest Informatics Division, Forest Products Division, Forest Soil and Land Reclamation Division, Genetics and Tree Propagation Division, Non Wood Forest Products Division, Pathology Division, Resource Survey and Management Division, Silviculture Division. Apart from conducting research in the forestry sector it also undertakes the research in allied sectors of environment, climate change, soil reclamation, extension etc based upon the need and precedence. The Institute also has a field research station at Khirshu, Pauri Garhwal and a **Centre for Social Forestry and Eco-Rehabilitation** at Allahabad.



FRI, Dehradun has also been conferred the status of 'Deemed University' and at present is running courses on M.Sc. Forestry, M.Sc. Wood Science & Technology, M.Sc. Environment Management, Post Masters diploma in Natural Resource Management, Post Masters diploma in Non Wood Forest Products, Post Graduate diploma in Pulp & Paper Technology. It also has Doctoral program leading to award of Ph.D. degree.

The institute has excellent laboratory facilities for conducting advanced research. The **National Forest Library and Information Centre (NFLIC)** of the Institute is richest in documents on forestry and allied sciences in South and Southeast Asia. The Institute is ISO 9001:2000 certified.

Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore

Institute of Forest Genetics and Tree Breeding at Coimbatore, was formed in April 1988 by up-gradation of the Forest Research Centre (FRC), Coimbatore under the Forest Research Institute and Colleges, existing since late 1950s. IFGTB spread over about 150 acres, is located in the Forest Campus in Coimbatore city. It attends to the regional forestry research problems of Tamil Nadu, Kerala, Puducherry, Andaman & Nicobar



Islands and Lakshadweep. The Institute conducts national level research on the subjects of genetics and tree breeding of important forest tree species. IFGTB has been mandated to identify and evolve varieties of species used in afforestation and social forestry that will contribute to the national goal of achieving a growth of 3 to 4 cubic meters of biomass per hectare per year within the ecological considerations applicable to the area.

The Institute has various research divisions namely Genetics and Tree Breeding, Plant Biotechnology, Forestry, Land Use and Climate Change, Forest Protection, Seed Technology, Biodiversity, Bioprospecting, Forest Economics and Extension,



Information Technology and FGRMN Division with a number of specialized theme based laboratories namely Microscopy Lab, Soil and Water Testing Lab, Tissue culture Lab, Genomics Lab, DNA Finger Printing Lab, Genetic Transformation Lab, Molecular Physiology Lab, Isozyme Lab, Genotyping Lab, Entomology Lab, Pathology Lab, Entomopathology lab, Phytochemistry Lab and Oil and Seed Testing Labs.

Facilities like Vegetative Propagation Complex, Model Nursery Complex, Seed Bank are also available. The Institute maintains one of the country's old herbaria established in 1911, the oldest forest museum in the country, the Gass Forest Museum, established in 1906 and a Botanical Garden recognized by the Botanic Gardens Conservation International (BGCI) and the Indian Botanic Gardens Network, established in 1973 over an area of 3.7 ha supporting *ex-situ* conservation activities.

IFGTB has field units in Reserve Forests of Kerala and Tamil Nadu. In Kerala it is situated at Walayar and Panampally while in Tamilnadu the field units are in Gudalur RF in Chennai, Kurumbapatty in Salem, Kurichi, Bharathiar University, Karunya University and Forest Campus in Coimbatore. Field stations at Neyveli, Tirunelveli, Nagercoil and Rameshwaram in Tamil Nadu are also being established. To support fruitful forestry research IFGTB is in the process of establishing more field units across different agroclimatic zones in the mandated states. Keeping abreast in literature, a collection of over 7000 books on forestry and allied subjects, 40 Indian and foreign journals and 125 back volumes are available for ready reference in the relevant areas of forestry in the Institute Library.

Goals

1. Increasing productivity in farmlands / plantations / homesteads by making available quality planting stock through quality seeds, scientific breeding programmes and biotechnological interventions.
2. Forest Genetic Resources Networking for conservation, management and sustainable

utilization of commercial species to move towards the establishment of National Bureau of Forest Genetic Resources.

3. Promoting Consortia Based Research with a view to meeting the demands of wood based industries involving tree growers' co-operatives.
4. Resilience forestry to meet the challenges of climate change.
5. Strengthening forests and plantation health, productivity enhancement, precision silviculture techniques through species specific approaches.
6. Restoration of fragile and degraded ecosystems
7. Forestry Extension and education programmes for stake holders

Institute of Wood Science and Technology, (IWST) Bangalore

The Institute of Wood Science and Technology (IWST), Bangalore formed in 1988, is mandated to conduct research on Wood Science and Technology as its national objective and focuses its research on important forestry research needs of the States of Karnataka, Andhra Pradesh and Goa at regional level. Taking into consideration the expertise available and contributions made it has been assigned the status of Centre for Advanced Studies in the areas of Improved Utilization of Wood; Mangroves & Coastal ecology and Research on Sandal. The focus of research being carried out at IWST is coherent with the aims of National Forest Policy in the areas of utilisation of timber and non-timber products and increasing productivity. The Institute aims to develop strategies for use and production of wood and other forest products in a way that sustain their supply.

The Vision of the Institute is to attain excellence in forestry and wood science research for generation of resource, products, services in a way that sustains diversity and productivity in an eco-friendly regime.

It has a campus of 10 hectares housing the main laboratories (6997 sq.m.) and workshops for wood processing machinery, timber seasoning and



preservation plants. The Institute also has a tissue culture laboratory, mist chamber, shade house and green house, nurseries, extension support building, scientists hostel, guest house, library and information facilities. There are 91 residential quarters. A Shore Laboratory at Visakhapatnam and a **Forest Research Centre** at Hyderabad have been established. It has field stations at Gottipura & Nallal near Bangalore and Yelawala near Mysore.

The Institute's laboratories are well equipped with TLC, GLC, and HPLC and UV, IR and Atomic Absorption Spectrophotometer, X-ray Fluorescence Analyzer, Flow Injection Analyzer, Nitrogen Analyzer, Compound Research Microscopes with CCTV, Image Analysis System, Porometer, Photosynthetic Analyzer, Leaf Area Meter, an Universal Testing Machine and Xenon-Arc Weatherometer, FTIR, Spectrofluorometer, Molecular biology equipments like Electrophoresis unit with power supply, Zeal Documentation System, PCR (Thermal cycler), Micro Centrifuge, Deep Freezer (-30°C), Laminar Air Flows, Autoclaves, Electronic Balance, Water Purification System, temperature controller, sequential timer, culture racks, seed germinator, seed germination trolleys, seed storage cabinets, twin screw extruder, Automatic Bomb Calorimeter, computers with internet facilities etc.

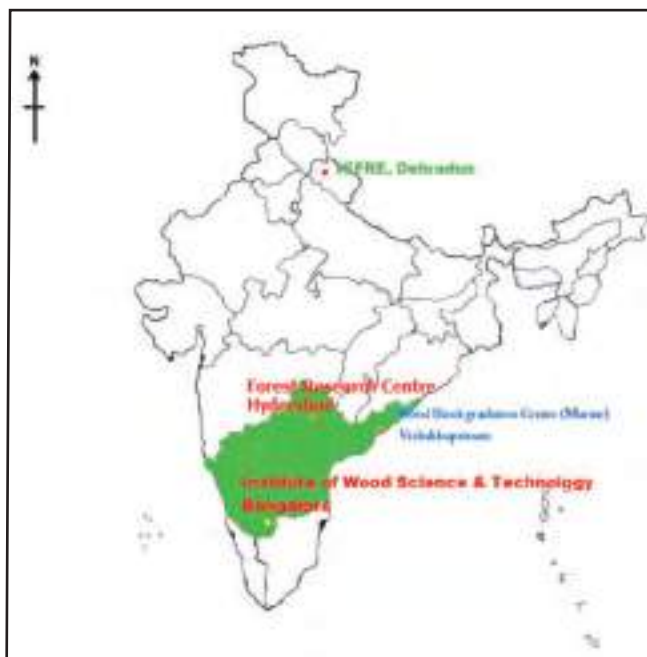
The Institute conducts a number of training programmes and carries out extension activities. It is one of the Regional Centres of the FRI University to enable candidates to pursue their Doctoral (Ph.D) programme. It also attends to queries related to wood properties and uses, biodeterioration and its control, cultivation of timber trees, chemistry of forest products, agro-forestry etc.

IWST is an ISO 9001:2008 Certified institute concerning all activities related to R & D activities, Consultancy, Training and Testing Services related to Forestry and Wood Science.

Forest Research Centre (FRC), Hyderabad

To cater to the research needs of the states of Andhra Pradesh, Karnataka and Goa in the field of forestry, Forest Research Centre (FRC), Hyderabad started functioning under the administrative control of Institute of Wood Science and Technology, Bangalore from July, 1997. The campus is spread over 100 acres of area in Dulapally Reserved Forests. The research activities of the centre are grouped under six categories namely Agroforestry, Climate Change, Ecology and Biodiversity, Information Technology, Soil Science and Tree Improvement & Propagation.

Research activities include carrying out tree improvement studies for improving productivity in socially relevant multipurpose forestry species, establish and maintain seed production areas & seed orchards, do research on biotechnology and mass propagation of quality planting stock, establish model nursery, Clonal and Seedling Seed Orchards, germplasm bank, provenance trials of selected MPT species for improving forest productivity, demonstration of agro-forestry models, study Biodiversity of Eastern Ghats, impact assessment of eco-disturbance and rehabilitation, ecological and





vegetation studies of mangrove forests, studies on non-wood forest products and ethno-botany, and establish medicinal plant garden and museum, chemistry of forest products, evaluation and standardization techniques, forest fire, diseases and pests, research relating to climate change and soil sciences.

Rain Forest Research Institute (RFRI), Jorhat

The Rain Forest Research Institute (RFRI), Jorhat, Assam was established in 1988 with an aim to extend knowledge on forestry related issues through research, education and extension in general and to support forestry research of northeastern states including Sikkim, in particular.

The strategic location of the Institute offers easy access to a variety of forest ecosystems of North East like tropical wet evergreen, semi evergreen, moist deciduous, sub-tropical broad leafed hill and montane forests. The RFRI has adopted multidisciplinary approach to tackle research problems and has a network of coordinated projects with forest departments, NGOs, industries, universities, and farmers. The Advanced Research Centre for Bamboo and Rattan (ARCBR) at Aizawl, Mizoram; a unit of RFRI is specially meant for handling research problems on Bamboo and Rattan.

The mandate of the Institute lays special emphasis on conservation methods to restoration of degraded lands under shifting cultivation, management of community forests, preserve the unique heritage of the region for eco-restoration and multi-faceted use of bamboo and cane without damage to the ecology. In keeping with its mandate and need of the hour, the Rain Forest Research Institute during its short period of existence has made significant strides in research under different disciplines.

In NE Region Forestry Research Priorities underway are Managing Shifting Cultivation, Development of Models for Cultivation of medicinal & aromatic plants & Bamboos and Rattans on farm lands, Biodiversity



Conservation and Utilization, Development of Agroforestry/Social Forestry Models, Impact Study of Shifting Cultivation, Tissue Culture of Important Species, Soil and Water Conservation, Extension of tested technologies and Impact Assessment, Information on Economics and Market Studies, Value Addition to NTFPs, Natural Regeneration of Important Species, Management of Natural Forests, *Bio-diesel*—developing alternative fuel species, Nursery Techniques of Important Species and Carbon Credit.



Rain Forest Research Institute, Jorhat

Arid Forest Research Institute (AFRI), Jodhpur

Arid Forest Research Institute at Jodhpur under ICFRE is mandated to carry out scientific research in forestry & allied fields to enhance the productivity & vegetative cover, to conserve the biodiversity and to



develop the technologies for the end-users in Rajasthan, Gujarat and Dadra & Nagar Haveli.

The main areas of forestry research are soil, water & nutrient management, technologies for afforestation of stress sites, management of plantations, growth and yield modeling, biotechnology and planting stock improvement, bio-fertilizers and bio-pesticides, Agroforestry, JFM & extension, Phytochemistry & non-timber forest products, integrated pest & disease management and forestry education and extension. During 2011-12, three consultancy projects and thirty eight projects were executed including ten externally funded projects from the Rajasthan Forest Department, Gujarat Forest Department, Department of Biotechnology, National Medicinal Plant Board and CSIR, New Delhi.



Mandated states of AFRI, Jodhpur

Tropical Forest Research Institute (TFRI), Jabalpur

Tropical Forest Research Institute, came into existence in April 1988, although its origin goes back to 1973 when a Regional Centre of FRI, Dehradun was established at Jabalpur to provide research support to the problems of forest management in central India. It caters to the forestry research needs in three states of central India, viz. Madhya Pradesh, Chhattisgarh and Maharashtra. Thrust areas of research in the Institute

relates to Non-wood Forest Produce, rehabilitation of mined areas and other stress sites, development and demonstration in Agroforestry Models, Planting Stock Improvement, Sustainable Forest Management, Biodiversity Conservation and control of forest diseases and pests.

It has an area of 109 ha and a constant liaison with state forest departments, NGOs working in the field of forestry and allied areas, universities imparting education in forestry, and forest based industries.



Centre for Forestry Research & Human Resource Development (CFRHRD), Chhindwara under TFRI, Jabalpur came into existence in 1995. The mandate of the centre is to take up forestry research in the specialized areas like biodiversity conservation, non-wood forest products, forest protection, Silviculture and tree improvement. In addition to this, the centre has also been assigned to develop human resource in forestry sector by imparting vocational training leading to poverty alleviation through self employment in Central India.



Himalayan Forest Research Institute, Shimla

Himalayan Forest Research Institute (HFRI), Shimla, Himachal Pradesh started its journey as High Level Conifer Regeneration Research Centre during 1977 with an aim to carry out research on the problems associated with natural regeneration of Silver fir and Spruce. However, during 1987 with coming up of *Indian Council of Forestry Research & Education (ICFRE)*, Dehra Dun, the mandate of this centre was also expanded from Regeneration of Silver fir and Spruce to Eco-Rehabilitation of Cold Deserts, Mined Areas Rehabilitation, Insect-pests and Disease incidences & Management, besides studies on Agro-forestry practices in hills including existing mandate of regeneration studies on Coniferous and their broad-leaved associates. This Centre was re-designated as **Himalayan Forest Research Institute, Shimla** in 1998. The Institute has contributed its expertise to this most fragile, sensitive and susceptible eco-system for better and scientific management of the forest eco-system in the states of Himachal Pradesh and Jammu & Kashmir.



Spread over in different agro-climatic zones the institute has nine **Field Research Stations** for carrying out site specific/ objective research as per the mandate of the Institute. In the process of broadening of research base in different Agro-climatic zones in the state of Jammu & Kashmir for carrying out required and more pointed research, the institute has recently established **Field Research Stations** at Nagbani (Jammu region) and at Badami Bag (Leh & Laddakh).

The Institute has been declared as the **Advanced Centre for Cold Desert Afforestation & Pasture Management** for taking up advanced research in Eco-restoration of these harsh sites. Forest Research Station located at Tabo, Lahaul-Spiti (HP) and another Station established recently in Leh (J&K) are catering to the specific research needs of the Cold Deserts in the mandated states.

This Institute till the recent past has made significant contribution to the research on artificial regeneration of Silver fir (*Abies pindrow*) and Spruce (*Picea smithiana*). Other notable achievements include development of nursery and planting techniques of other conifers like, Deodar, *Taxus*, Chir-Pine, Blue-Pine, including their broadleaved associates like, Birds cherry, Horse-chestnut, Oaks, Maples, Poplars and of the species endemic to the cold desert areas. Research and extension activities of the Institute include establishment and standardization of agro-forestry models in the lower hills of Himachal Pradesh, Eco-economic rehabilitation of mine damaged areas including organizing the workshops and trainings for the user groups.

Considerable work has been taken up in the cold desert areas of Himachal Pradesh and Jammu & Kashmir for documentation of flora of such areas including standardization of the nursery techniques for the species endemic to these areas. Insect-pest attacks and diseases of Deodar, Shisham, Chir-pine, Oaks and Willows were investigated and remedial measures suggested to the State Forest Departments of Himachal Pradesh and Jammu & Kashmir.



Sharing Planting Techniques of Cold Deserts Species with the End Users

The institute in collaboration with the State Forest Departments of Himachal Pradesh and Jammu & Kashmir established **Van Vigyan Kendras (VVKs)** at Sundernagar, Mandi and at Janipur, Jammu & Kashmir through which the Institute is now having more focused approach for carrying out extension activities with sufficient means for reaching and penetrating deep into the mindset of the people. Besides, show-casing research activities of the Institute, a **Model Village** at Lanabanka, Distt. Sirmour, Himachal Pradesh had also been established.

Institute of Forest Productivity, Ranchi

The Institute of Forest Productivity caters to the forestry research needs of eastern States of Bihar, Jharkhand, West Bengal and Odisha in India and came into existence in the year 1993 with the objective to formulate, organize, direct, manage and carryout forestry research & education in eastern region of the country, comprising approximately 46,581 square kilometre forest area which is 17% of the total geographical area of the country. The operational area comprises of six agro-ecological zones viz., Eastern Plateau, Chhotanagpur Plateau, Bengal Plains, Northern Plain, Eastern Plain and Eastern Himalayas

and eight main forest types falling in the mandated states.

The Institute has taken up a number of research and training programmes for the benefit of different stakeholders and user agencies, NGOs., Research Organizations in the states of Bihar, Jharkhand and West Bengal and the public at large.

The administrative building of the Institute is located at Lalgutwa on Ranchi–Gumla National Highway. The Institute also functions as one of the research centre of FRI University. The following research & extension centres are functioning under the Institute:

- (i) **Forest Research Centre, Mandar, Ranchi (Jharkhand)** – This centre is spread over an area of 24.32 ha. It is equipped with Tissue culture laboratory, soil testing & biochemistry laboratories; modern nursery facilities with mist chambers, agronet shed houses and composting units; seed processing, packaging & storage unit are functioning apart from vast experimental area for provenance / progeny trials and demonstration plantations.
- (ii) **Environmental Research Station, Sukna, Darjeeling (West Bengal)** – It is equipped with observatories at Sonada and Sukna with Hydro-meteorological recording facilities in Darjeeling district of West Bengal for hydrological data recording in selected watersheds.
- (iii) **Forest Research & Extension Centre, Patna (Bihar)**- The centre is functioning for providing technology and services to the Environment & Forest Department, Govt. of Bihar, for implementation of agro forestry component of “Integrated Community Based Forest Management Project in Bihar” funded by Planning Commission, GOI.

Research Highlights



Research Highlights

The Biodiversity and Climate Change (BCC) Division is working on forestry and climate change related policy issues leading to international negotiations under United Nations Framework Convention on Climate Change (UNFCCC). BCC Division has undertaken several short and long term policy programmes to address the problems of Biodiversity Conservation and Climate Change. Division is also engaged in capacity building programmes by conducting various training programmes on climate change, clean development mechanism (CDM) and forestry for forest officers and other stakeholders.

Research Planning Division of the Directorate of Research deals with the planning, formulation and finalization of plan funded forestry projects of eight

research institutes and four research centres of ICFRE located in different geographical regions of the country. The process involves stakeholders meets, Research Advisory Group (RAG) meetings at each institute and National level Research Policy Committee (RPC) meeting at ICFRE HQ, keeping in view the balance among international, national, regional and state research requirements and decide investment in high quality forestry research with bottom-up, transparent and participatory approach. It also reviews the ongoing projects under Five Year Rolling Plan.

Recently, four research thrust areas and thirty five themes have been identified for ICFRE research. Also two thrust areas, one each for Forestry Extension and Forestry Education were identified. These are :

Thrust Area	Themes
A. Research	
1. Managing forests and forests products for livelihood support and economic growth	1. Silviculture
2. Biodiversity conservation and ecological security	2. Social Forestry, Agro-forestry /Farm Forestry
3. Forests and Climate Change	3. Sustainable Forest Management (SFM)
4. Forest Genetic Resource Management and Tree Improvement	4. Forest Economics
	5. Forest Biometrics and Yield Modelling
	6. Participatory Forest Management
	7. Wood Science and Technology
	8. Chemistry of Forest Products
	9. Wood Based Industries
	10. NTFP Resource Development
	11. Bio-prospecting and Bio-piracy
	12. Seed Science and Technology
	13. Forest Certification
	14. Forest Hydrology
	15. Food Security
	16. Bio-fuels and Bio-energy
	17. Integrated Pests and Disease Management
	18. Application of Microbes in Forestry
	19. Weeds and Invasive Species
	20. Forest Fire and Grazing



21. Bio-informatics and Geo-informatics
22. Policy and Legal Issues
23. Biodiversity conservation
24. Forest Botany
25. Ethnic and Traditional Knowledge Systems
26. Tree Improvement
27. Vegetative Propagation
28. Biotechnology
29. Environment Management

B. Forestry Education

Forestry Education and Policy Research to meet Emerging Challenges

1. Extension and Technical Support towards improving formal Forestry Education
2. Quality Assurance in Forestry Education through Accreditation
3. Networking Forestry Education with Research and Extension
4. Capacity Building of Scientific and Management cadre in Forestry

C. Forestry Extension

Forestry Extension for taking research to people

1. Collection, compilation and publication of forestry related reports, statistics, periodicals, books and brochures.
2. Dissemination of developed technologies to the various stakeholders.
3. Evolving and coordinating comprehensive extension strategies in Forestry Research.
4. Consultancy services related to Environment Management.

Also Institute –wise specialization/ priority areas of excellence were laid down and are given below:-

Institutes

1. Forest Research Institute (FRI), Dehradun

Specialization/Priority area

- Managing forests and forest products for livelihood support and economic growth
- Biodiversity conservation and ecological security
- Forestry interventions for climate change mitigation and adaptation
- Management and improvement of forest genetic resources



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2. Institute of Wood Science and Technology (IWST), Bangalore	<ul style="list-style-type: none"> Managing forests and forest products for livelihood support and economic growth
3. Rain Forest Research Institute(RFRI), Jorhat	<ul style="list-style-type: none"> Biodiversity conservation and ecological security
4. Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore	<ul style="list-style-type: none"> Management and improvement of forest genetic resources
5. Himalayan Forest Research Institute (HFRI), Shimla	<ul style="list-style-type: none"> Himalayan ecosystem management
6. Arid Forest Research Institute(AFRI), Jodhpur	<ul style="list-style-type: none"> Arid and semi-arid forest management, especially in western India
7. Tropical Forest Research Institute(TFRI),	<ul style="list-style-type: none"> Tropical forestry in Central India
8. Institute of Forest Productivity (IFP), Ranchi	<ul style="list-style-type: none"> Forestry in fertile plains in the eastern part of India comprising Bihar, Jharkhand, West Bengal and Sikkim

Stakeholders Meet: Coordinated with the institutes for holding of stakeholders meet in each of SFD headquarters to facilitate a meaningful and continuous exchange of research information, and project implementation.

Research Advisory Group (RAG) meetings of each of the eight ICFRE institutes were convened at Institute level on the dates mentioned below:-

Name of Institute	Date of RAG
IFP, Ranchi	19 – 20 September 2011
IFGTB, Coimbatore	3 – 4 October 2011
TFRI, Jabalpur	12 – 13 October 2011
FRI, Dehradun	20 – 21 October 2011
RFRI, Jorhat	8 & 9 November, 2011
AFRI, Jodhpur	3 – 4 November 2011
IWST, Bangalore	8 November, 2011
HFRI, Shimla	17- 18 November, 2011

Research Policy Committee Meeting (RPC)

XII Research Policy Committee (RPC) meeting was convened on 8 and 9 April, 2011 at Van Vigyan Bhawan, New Delhi under the Chairmanship of Shri A.K. Bansal, DG, ICFRE. 157 new projects with budget outlay of Rs. 2349.3 were placed before the XII RPC.

118 New projects with budget outlay of Rs.1602.18 lakhs were approved by the RPC. However, due to financial constraints, these approved projects were relooked and revisited. After revisit and relook, outlay of Rs.1198.00 lakhs were approved.



Thrust area wise details of 98 approved projects are given below:-

Thrust Area	Number of projects
Managing forests and forests products for livelihood support and economic growth	55
Biodiversity Conservation and Ecological Security	18
Forests and Climate Change	1
Forest Genetic Resource Management and Tree Improvement	24
Total	98

XIII RPC Meeting was convened on 14-16 Feb., 2012 under the Chairmanship of Dr V.K Bahuguna, DG ICFRE at ICFRE HQ. All the proposals were placed in

four thrust areas. Thrust area wise number of projects with proposed budget are given below:-

Thrust Area Wise Abstract of New Research Project Proposals along with Budget	
Managing Forests & Forest Products for Livelihood Support and Economic Growth	50 projects with budget of Rs. 674.3 lakhs
Biodiversity Conservation & Ecological Security	24 projects with budget of Rs. 333.3 lakhs
Forests and Climate Change	7 projects with budget of Rs. 209.3 lakhs
Forest Genetic Resource Management and Tree Improvement	29 projects with budget of Rs. 842.9 lakhs

All the proposals were segregated and merged to formulate the AICP/Inter Institutional/Net working projects in these four Thrust Areas. Final approval of these projects will be done in the Follow up meeting of XIII RPC through Video conferencing.

Directors' Meet: On 28 June, 2011, VI Directors' meet was organized at ICFRE hqrs, under the chairmanship of DG ICFRE. The Directors' Meet was organized to discuss some of the important issues for which agenda was fixed by different directorates in consultation with the Directors of the Institutes.

Monitoring and Evaluation Division under the Directorate of Research deals with the annual review and evaluation of all the ongoing research projects of

ICFRE institutes. It suggests corrective measures for timely completion of the projects and achievements of the objectives with perfection. During June – October, 2011, the annual review of 426 (337 ICFRE funded and 89 externally aided) ongoing and completed research projects of all ICFRE institutes was conducted and reviewed. Apart from above, independent review of 17 (completed/ ongoing) research projects have also been carried out through independent subject matter experts/agencies.

All ongoing research projects were reviewed and corrective measures were suggested to expedite the physical and financial achievements for timely achieving the objectives of the projects. The Annual



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Review Reports have been communicated to all Directors of the ICFRE Institutes by November, 2011 to take follow up action on the observations made in the report.

Total 83 ICFRE plan funded and 33 externally aided projects were completed during 2010-11. Total 98

ICFRE plan funded projects have been initiated during 2011-12. Total ongoing research projects, (2011-12) of ICFRE are 409 i.e. 352 ICFRE plan funded projects are and 57 externally aided projects.

The details of reviewed research projects for ICFRE institutes as per annual review, 2011-12 are as follows:

Institute-wise Ongoing Research Projects Reviewed During 2011-12.

Sl. No.	Name of Institute	Date of Review	No. of Ongoing & Completed Projects Reviewed		
			ICFRE Funded	EAP	Total
1	AFRI, Jodhpur	5 – 6 Sept., 2011	24	10	34
2	FRI, Dehra Dun and CSF & ER, Allahabad	12 – 18 July, 2011	104	22	126
3	HFRI, Shimla	21 – 22 June, 2011	17	7	24
4	IFGTB, Coimbatore	25 – 26 July, 2011	62	14	76
5	IFP, Ranchi	23 August, 2011	23	2	25
6	IWST, Bangalore and FRC, Hyderabad	27 – 29 July, 2011	48	13	61
7	RFRI, Jorhat	10 –13 October, 2011	34	5	39
8	TFRI, Jabalpur and CFHRD, Chhindwara	8 – 9 Sept., 2011	25	16	41
Total			337	89	426

Half yearly Progress Reports of individual projects from Directors for the period ending September, 2011 were scrutinized for conformity with the approved action plan and corrective measures were suggested for timely achieving the objectives.

The erstwhile **Project Formulation Division** of ICFRE was created to function as a facilitator between the ICFRE institutes and its centres and potential funding agencies for the formulation of research projects in the identified thrust areas and their submission to various national and international funding

agencies. It also coordinates with ICFRE institutes and other institutions /ministries etc with respect to signing of MoUs, consultancies etc. Besides, it maintains the database of external funded projects. The Division also looks after matters pertain to international cooperation. The division has now been redesignated as **Policy Networking and Local Governance Division** with a broadened mandate of initiating studies on Policy Networking and Local Governance.



Summary of Achievements

- 1) Collaborated projects are being carried out with a number of National and International donor agencies for project funding. The total no of ongoing externally aided projects (EAP) (2011-12) are 57 with the sanctioned worth of Rs. 1153.64 Lakhs. 04 projects are internationally funded out of 57 externally aided projects with the sanctioned worth of Rs. 83.13 Lakhs. 33 externally aided projects worth of Rs. 597.46 Lakhs have been completed in this year. The international funding agencies providing funding support to ICFRE for research include, International Foundation for Science (IFS), Sweden; Australian Agency for Industrial Development, Australia and Department of Primary Industry and Fisheries, Australia.
- 2) In order to carry out collaborative projects/programmes, 09 MoUs and agreements were signed between ICFRE institutes and various National and International agencies including research institutions and industries. Division is also involved in reviewing of half yearly and annual progress of all the EAP projects/programmes in ICFRE and collects their status reports.
- 3) International Poplar Commission (IPC): In recognition of the significant place of Poplars and Willows in livelihood and economy of the people of India as well as the pioneering work done by ICFRE, the FAO and the IPC, a technical statutory body of FAO have agreed to hold the 24th Session of the IPC and 46th Meeting of its Executive Committee to be held in Dehradun in October, 2012. It is for the first time that this prestigious event of IPC would be held in India.
- 4) Integrated Community Based Forest Management Project in Bihar {Samudai Adharit Samanvit Van Prabandhan Evam Sanrakhshan Yojna (SASVPESY)}/Bihar Project: This project was launched during 2006, funded by Planning Commission, Govt. of India and being implemented by ICFRE, Dehradun. Actual physical activity started

in January, 2007 in Vaishali Dist. of Bihar with focus on wellbeing of each and every section of the farming community including landless labourers, small, marginal and big farmers by involving them into nursery raising, uprooting and seedling transporting and planting in farmlands. The project will be completed in two phases. In Phase-I, Vaishali District has been taken up and in the Phase-II remaining districts of North Bihar have been taken up. Total outlay for agro-forestry component being implemented by ICFRE is Rs.1894.76 Lakh. The main activities undertaken for implementation of the project are i) Socio-economic Survey, ii) Selection of Suitable Plant species and their propagation, iii) Raising quality planting stock, iv) Facilitating plantation on farmlands, v) Establishment of field demonstration plots, vi) Training extension and NGO involvement, vii) Establishment of Clonal Seed Orchards, viii) Identification of VAM fungi and inoculation, ix) Engagement of consultants / experts, and x) National Seminar/Workshop.

During 2011-12, 3.87 Lakh ETPs were planted at farmers field while 1.68 Lakh ETPs were used for raising the nurseries and total 7.12 Lakh seedlings/plants of various tree species like poplar, teak, mahogany, gamhar, semal, kadam, jamun, bamboo etc. have been distributed to farmers from model nurseries. However, more than 6000 farmers have been trained in nursery practices and Agroforestry Systems based on Poplars and other forestry species till date. A European Union Inter-parliamentary delegation village Sheetal Bhakur, Lalganj visited during April, 2011 and interacted with farmers who have planted Poplar on their fields.

2) New initiatives

International level

International Cooperation

- To foster International Cooperation among the countries of the Hindu Kush – Himalayan Region, especially in the field of REDD+ and other Climate



Change issues, an ICFRE team under the leadership of Dr. V.K. Bahuguna, Director General, ICFRE visited the International Centre for Integrated Mountain Development (ICMOD), Nepal where extensive discussions on various issues were held. An MoU has also been signed between ICMOD and ICFRE.

- A UK-India Forest Land Restoration Project in collaboration with UK Forestry Commission has been effective in providing a close look in providing a long going conservation strategies in three states viz. Odisha, Madhya Pradesh and Uttarakhand for building sustainable relationship between community and eco-system. The phase I of the project is being extended to 2012 – 2013, while in phase II, the project will be extended to other states in India. Besides, an umbrella project is also being developed.
- A five member delegation from ICFRE under the leadership of Dr. V.K. Bahuguna, Director General, ICFRE visited the Chinese Academy of Forestry on 23 April, 2010 to foster new linkages. A six member delegation from Chinese Academy of Forestry paid a return visit to ICFRE, Dehradun on 19 December, 2011. Opportunities for bilateral cooperation in the area of forestry research between ICFRE and Chinese Academy of Forestry were deliberated. The strength of China in Bamboo Technology and the strength of India in Tree Improvement Programme will be shared in an institutional manner in sustainable management of natural resources and livelihood support.

Japan International Cooperation Agency (JICA) Project

To meet the future challenges in forest management, particularly in biodiversity, livelihood issues and scientific management of forestry, particularly carbon sequestration, floral and faunal biodiversity conservation and soil amelioration, the forestry research has to broaden its horizon by

developing technologies and tools to be utilized by stakeholders including field foresters and farmers. A comprehensive All India Coordinated Projects developed by ICFRE has been submitted to Japan International Cooperation Agency (JICA) for funding for an amount of Rs 1800 crore over a period of 5-8 years.

National level

- a) **Creation of Ginger Group/ Knowledge Pool:** Consultative group of ICFRE scientists and other eminent forests officers to think beyond the traditional concept of stakeholder / demand driven / need driven research concepts has been created to bring 'innovative ideas and out of box thinking' for solving the problems of Consumers on the issues relating to emerging challenges of forestry science.
- b) **Designation of National Subject Matter Coordinators (NSMCs):** The NSMCs have been nominated to develop systematic approach on various subject matters and to develop site specific and subject specific research programmes. They are expected to coordinate research, extension and marketing activities in identified themes. National subject matter experts have been designated in 35 thematic areas.
- c) **Appointment of National Project Directors (NPDs):** National Project Directors (NPD) nominated in six thrust areas to develop All India Coordinated Projects on the Thrust Areas and prepare a road map to undertake research in program mode. The thrust areas are i) Managing forests and forest products for livelihood support and economic growth, ii) Biodiversity conservation and ecological security, iii) Forests and Climate Change, iv) Forest Genetic Resource Management and Tree Improvement, v) Forestry Education and Policy Research to meet emerging Challenges, and vi) Forestry Extension for taking Research to People.
- d) **Direct to Consumer Scheme:** Research communication is a two way process. The forest



officers are vital link between linking research/scientists and management practices in the field of forest conservation / development and forest based livelihoods. The work of ICFRE scientists/professionals needs to be transferred to the field to meet the emerging challenges of climate change, forests and water security and biodiversity

conservation. The existing requirement is to enhance the outreach of research findings, so that the extension of research makes immediate impact of research in the field. Therefore the **“Direct to Consumers”** scheme for immediate transfer of recently developed technologies to the consumers has been initiated.



Growth of Poplar Planted in January, 2008 at Vaishali



Model Nursery at Jadua Site I, Vaishali, Bihar



ICFRE Demo Plot at Goraul



Pre-Planting Farmer's Training at Goraul



Farmer's Demonstration Plot at Patepur

2.1 Ecosystem Conservation and Management

Overview

Systematic and scientific studies in respect of forest ecology have become inescapable in the present scenario when **Climate Change** is impinging upon the dynamics of forest ecosystem. It is important to understand the behaviour of ecosystems in the wake of changing climatic patterns. Climate change has multifaceted implications, accordingly addressing on the related issues in a scientific manner requires good scientific understanding in maintaining the flow of goods and services from existing forests both at National as well as global level. Efforts and the provisions made in the past under United Nation's Framework Convention on Climate Change (UNFCCC) in Kyoto-Protocol are mainly at broader levels and are inadequate to address the challenges and adaptive capacity of communities (human, floral & faunal) at ground level especially in the developing countries. Even as per the prediction by Intergovernmental Panel on Climate Change (IPCC), the GDP of the country like, India can decline up to 9% due to shifting of growing seasons, which will have catastrophic impact on more than 400 million people, largely India's poor.

As far as the Biodiversity is concerned, India being the seventh largest country in the world and Asia's second largest nation has now emerged as the twelfth largest economy in the world. The ever growing economy and the vision 2020 of India, will directly impinge upon the natural resources, particularly the remaining forest ecosystems and is certainly becoming a matter of concern.

Conservation of wildlife and biodiversity in natural heritage sites including sacred groves, protected areas, and other biodiversity '**Hotspots**' is crucial for maintaining the resilience of ecosystems. Specific actions in this programme may include *in-situ* and *ex-situ* conservation of genetic resources, especially of threatened flora and fauna, Creation of biodiversity

registers (at national, district, and local levels) for documenting genetic diversity and the associated traditional knowledge, Effective implementation of the Protected Area System under the Wildlife Conservation Act and Effective implementation of the National Biodiversity Conservation Act, 2001.

Project under the Theme			
Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	17	15	12
Externally Aided	05	08	06
Total	22	23	18

2.1.1 Climate Change

Carbon Foot-print Mapping of FRI, Dehradun.

A Project on carbon footprint mapping of FRI Dehradun has been envisaged for a period of two years from 2011-13 for an amount of Rs. 7.50 lakhs. An inventory of GHG emitting appliances of FRI will be prepared. The carbon footprint from such sources will be calculated through appropriate statistical modeling by calculating the average working hours of such sources. The carbon footprint mapping of its employees on sampling basis will be undertaken through structured questionnaires. The overall carbon emissions of FRI will be calculated. Once the size of a carbon footprint is known, appropriate strategies and interventions for mitigation of such emissions will be proposed to offset the emissions in a rational manner in Indian context.

Energy and Mass Exchange in Vegetative System

Agro Meteorological Station has been installed in New Forest Dehradun Campus. One year physiological



data pertaining to photosynthesis, respiration and soil respiration has been measured. Similarly, biophysical parameters such as plant height, DBH, LAI and PAR for about two years have also been recorded. In addition, the other physical parameters such as radiation and energy balance, latent and sensible heat were also recorded for about two years. Further analysis of data is in progress.

There are evidences that (i) The Himalayas are warming more than global average rate, (ii) that the extent of warming increases with altitude, and (iii) is greater during winter than summer. The climate change is going to affect forest ecosystems variously: species migration and extinction, phenological “disturbances” and changes in rates of basic ecosystem processes are some of the most common changes that would affect forests. It is quite likely that new forest communities may be created and old ones may disappear.

The Rhododendrons are an indicator species and important forest element. These species are commonly found in north-western, central and north-eastern parts of Indian Himalaya. It provides an interesting example of phenological variations within time limits along altitudes. To study the effect of climate change on phenology of Himalayan Rhododendron, a project proposal funded by UCOST was implemented by FRI, Dehradun at Chopta-Tung Nath area of Rudraprayag District (UK) during the year 2009-11. The meteorological data and phenological events were regularly recorded from September 2009 to December 2011. Based on the data collected and analyses, following conclusions were drawn.

The Alpine species (*R. anthopogon* & *R. lapidotum*) took minimum time from flower initiation to seed dispersal (June to September), however, the sub alpine species (*R. campanulatum*) took one month more time from flowering to seed dispersal than alpine species. *R. arboreum* and *R. barbatum* which are temperate species take maximum time from flowering to seed dispersal i.e. March to November that means alpine species complete their cycle within 4 months, when the snow melts and weather is convenient for plant growth.

However, the sub alpine species takes 5-6 months and temperate species 8-9 months to complete their life cycle.

The floral and vegetative bud break was noticed 10 to 15 days early in all four species. In *R. arboreum*, 100% flowering was observed in the month of April. At the end of April, flower colour faded and turned into light pink colour. The flowering completed from 5% to 100% in 10 to 35 days in *R. arboreum* and *R. barbatum*. After completion of flowering time, the vegetative bud grew rapidly and broke to leaf flush in May- June, in case of these two species. However, in case of *R. campanulatum* the vegetative bud break was observed 10-15 days later than *R. arboreum* and *R. barbatum*. The alpine species were fast in performing phenological events and just after 20 days of flowering, the vegetative bud break was observed followed by new leaves flushing in mid of June. The capsule mature and seed dispersed in September in alpine species followed by Sub alpine species in October and temperate species in November-December.

The regeneration in all four species was normal. It was found more in open sites than under dense canopy. *R. campanulatum* was observed upwards shifting from sub alpine (3400 mt.) to alpine region (3800 mt.). Therefore altitude has a strong impact on phenology of all four species being studied.

The Comparative study of meteorological data and Phenological events of four Rhododendron species did not lead to any significant conclusion. In some cases,



R. arboreum



R. barbatum



R. lapidotum



R. campanulatum



R. anthopogon

flowering in *R. arboreum*, *R. barbatum* and *R. campanulatum* was advanced by 5-10 days. However, no significant change noticed in alpine species. The seed dispersal was delayed by 10-15 days in the case of the alpine species in 2011 as compared to 2010.

However, not much difference was observed in opening of capsule and dispersal of seed in case of sub-alpine and temperate species.

Effect of Elevated CO₂ on Active Principles of Important Medicinal Plants

Raised the seedlings of *Withania somnifera*, *Ocimum sanctum*, *Coleus forskholii*, *Azadirachta indica*, *Gymnema sylvestre* and *Catharanthus roseus* in the nursery and kept under the different elevated CO₂ levels. Periodical data on growth, total plant, fresh and dry weight, root shoot ratio, no. of leaves, no. of primary and secondary roots etc; were taken. Observations on physiological parameters were taken under different elevated CO₂ levels. Medicinal plants parts were dried for alkaloids estimation. Worked out the chlorophyll 'a', 'b' and total for above medicinal plants under different CO₂ levels. Worked out the morphological parameters like SPA, LAR, etc.

Vegetation Carbon Pool Assessment of the North Region of Andhra Pradesh

Vegetation carbon pool assessment was taken up in 21 forest sites and 30 TOF (Trees outside forest) areas in Srikakulam, Vizianagaram and Visakhapatnam districts. Site details, forest type, soils and other relevant data were recorded. All the plant specimens were identified and made into herbarium for further studies. Quadrats were laid to meet sampling requirements and trees, shrubs and herbs were identified in each quadrat. GBH, height, fresh and dry biomass of plant species



were recorded. The quantitative measurements were recorded in the prescribed formats of IIRS for further analysis.

National Vegetation Carbon Pool Assessment for Six Districts of Andhra Pradesh

A total of 36 plots at pre-assigned geographic coordinates were studied by laying out four quadrats of 0.1 ha each. The data on above ground biomass and locality information were collected. Total forest biomass was estimated in six districts of Andhra Pradesh viz., Medak, Mahabubnagar, Guntur, Nalgonda, Ranga Reddy and Hyderabad districts. Similarly, biomass estimation of trees outside forests has been completed at 30 sites.

Utilization of Automatic Weather Station/Agrometeorological Station Data for Agriculture, Forestry and Hydrological Applications in Madhya Pradesh.

Conducted grass biomass studies from three national parks viz. Kanha National Park (KNP), Bandhavgarh National Park (BNP) and Madhav National Park (MNP) in Madhya Pradesh in three seasons including March, September and December. The studies were conducted near Automatic Weather Station (AWS) and Agro - Meteorological Station (AMS) installed by Space Applications Centre (SAC), Ahmedabad to quantify grass biomass per unit area. Maximum grass production was found in September (post rainy season) and December (winter season), which gradually decreased in the month of March.

Measured soil moisture profile by volumetric method at an interval of 30 cm and till the depth of 150 cm near AWS and AMS in MNP, BNP and KNP. Soil moisture increased with depth due to vertical seepage and accumulation of water to lower horizons in different seasons. Maximum soil moisture was recorded in September, followed by December and March.

Specific Leaf Area (SLA) of abundantly available tree species in MNP, BNP and KNP was quantified in the selected seasons. No regular trend in different seasons was found.



Conducting Grass Biomass Studies at Supkhar (KNP)



Collecting Meteorological Data from AMS Installed at Raunda (KNP)

Also developed regression equation for quantifying above ground biomass against GBH for *Shorea robusta*.

Carbon Sink and Fertility Status Relation of Soil under Different Land Use System of Some States of NE India.

Characterized soil under six land uses e.g., plantation forest, tea, coffee, rubber, Jhum land areas and cardamom plantation areas. Surface soil samples were collected from six NE Indian states viz., Assam, Meghalaya, Arunachal Pradesh, Sikkim, Tripura and Nagaland. Carbon sequestration potential and fertility status of soil under six land use systems were assessed. Wide variation of organic carbon content (low to high) in soil was found among the six land use systems. Soil organic carbon (SOC) range under all the land use systems was found: 2.6 - 200.6 t/ha.



Highest amount of organic carbon sink in soil (200.6 t/ha) was found under sub-alpine and alpine plantation forest soil of Arunachal Pradesh state followed by cardamom plantation areas soil of Sikkim State (130.0 t/ha) with respect to the other land use types viz. coffee, tea, jhum land and rubber plantation area. Lowest amount of organic carbon sink in soil (42.4 t/ha) was found under Tea plantation area. Minimum quantity in the range of total soil organic carbon sink, among six different land uses was found below 10 t/ha except that under cardamom plantation area, where it was found 26.0 t/ha. Organic carbon content in soil under all the six land use systems found increased with the increase in altitude of site. Maximum amount of organic carbon sequestration in soil was found under the six land uses such as, plantation forest (200.6 t/ha) > Cardamom plantation (130 t/ha) > Jhum land (73.2 t/ha) > Rubber plantation (52.0 t/ha) > Coffee plantation (47.0 t/ha) > Tea plantation (42.4 t/ha).

Soils, collected from all the Plantation Forest, Cardamom, Jhum land, Rubber, Coffee and Tea plantation areas were acidic. Few exceptions were observed where neutral or alkaline soil was found under some sites of tea plantation areas of Sibsagar, Assam; coffee plantation areas of Haflong, Assam; and jhum land areas of Lumding, Nagaon district; Rongmriden of Karbianglong and Gurbasti of NC Hills district of Assam. Wide variation was found in available nitrogen (N) content in soil sample belonging to six land use systems. Low and medium content of available nitrogen was found under some locations whereas other locations showed high status of soil available nitrogen. Available nitrogen range, under all the six land use systems was found: 194 - 4180 kg/ha. Available phosphorous (P) content was found low in most of the areas under all the six land use cover. High available phosphorus status was found only in two plots of tea garden soil sample, collected from Raidang TE, Tinsukia, Assam. Available phosphorous range under all the six land use systems was found: 0.2 - 105 kg/ha. Low to Medium available potassium (K) content in soil was found under all the six land use systems. In few locations, high available potassium (K) status of soil was

also found. Available potassium range under all the six land use systems was found: 60 - 2640 kg/ha. Soils were found light with loamy and sandy texture under all the six land use systems with few exceptions where clay texture was found.

Studies on Carbon Sequestration in Different Forest Types of Rajasthan

Project was started with the objectives; (i) to estimate carbon stock in forest soils, (ii) to estimate carbon stock in forest litter, and to estimate carbon stock in above ground and below ground biomass; with broader objective 'to provide an estimate of carbon stock of forests in Rajasthan' for its utilization in planning and execution of afforestation/ reforestation programme in this region. In the year 2011-12, six districts namely; Jhalawar, Bundi, Karauli, Sawai Madhopur, Jodhpur and Kota, covering 239 forest blocks and 466 sampling plots were surveyed growth of trees and shrubs measured and vegetation studied. 680 soil samples, 300 Coarse Woody Debris (CWD) samples and 240 litter samples were collected for carbon analysis. Biomass of 90 plants recorded, 103 trees recorded and carbon estimation carried out. Some important forest types were *Anogeissus pendula* scrub, *Acacia catechu* and *Boswellia serrata* type. In Kota and Bundi Forest Divisions, most of the forests are infested by *P. juliflora*. In the forests of these divisions, soil organic carbon content (0-90 cm soil layer) was highest in Kota (41.46 ton/ha) and lowest in Jhalawar (18.27 ton/ha), whereas, soil inorganic carbon was highest in Karauli (57.72 ton/ha) and lowest in Bundi Forest Division (2.88 ton/ha). Average soil organic carbon was highest (0-30 cm soil layer) in Kota in 30-60 cm soil layer in Sawai madhopur and in 60-90 cm soil layer in Karauli, Jhalawar and Bundi Forest Division.

Data compilations on *P. juliflora* revealed that about 38% of forest blocks are infested by *P. juliflora* in Rajasthan. Above ground biomass of *P. juliflora* was highest (53007.83 Kg/ha) in Jalore, followed by Bhilwara (40415.68 Kg/ha) and Jhunjunu (7167.20 Kg/ha). The lowest above ground biomass (126.38 Kg/ha) was recorded in Sikar District. Below ground



Pit Opening for Soil Carbon in *Anogeisus pendula* Scrub Type Forest in Kota Division



Acacia catechu Forest in Kota Division



Boswellia serrata Forest in Darra Sanctuary, Kota Division



Phoenix savannah Forest type in Chitorgarh

biomass showed similar trend as in the case of above ground, biomass was highest in Jalore (20872.78 Kg/ha) and lowest (94.04 Kg/ha) in Sikar forest area. If all the districts categorized into 3 ecological zone i.e., arid, semi arid and sub-humid, then *P. juliflora* showed highest above ground biomass of 6552.83 Kg/ha and below ground biomass of 2611.10 Kg/ha in sub-humid zone, 2658.65 Kg/ha and 1048.78 Kg/ha in semi-arid zone and 1169.25 Kg/ha and 502.37 Kg/ha in arid zone, respectively.

Assessment of Carbon Stock in Forest Types of Shimla Forest Circle, Himachal Pradesh

Collected the relevant data for each of the forest types from compartment history files of Shimla, Theog, Chopal and Rohru forest divisions of Shimla forest

circle. The major forest types identified in this circle included; Chirpine, ban oak, deodar, silver fir, spruce, Kharsu oak and alpine pastures.

Detailed field survey was carried out in selected sites of these forest types. The sites for alpine pastures were identified at Chansel (3600-4000m) and Kawar (2800-3000m) of Rohru forest division and Talra (3000-3300m) of Chopal forest division whereas sites for mixed forest of Silver fir and Spruce were selected at Deya (2500-2800m) in Chopal forest division and Larot (3200m) in Rohru Forest Division. The sites for ban oak forest were identified at Taradevi (2000m) and Koti (2100m) in Shimla Forest Division, whereas, for deodar forest sites were identified at Deya (1950-2300m) in Chopal Forest



Alpine Pasture at Chansel (Dodra Kwar)



Deodar Forest, Koti (Shimla Division)



Ban oak Forest, Taradevi (Shimla Division)

Division, Garakufer (2250m) in Theog Forest Division and Koti (2150m) in Shimla Forest Division. Sites for chirpine forest were identified at Dhama (1500m) and Taradevi (1900m) of Shimla Forest Division, whereas, for Kharsu oak site was identified at Chansel (3500m) in Rohru Forest Division. Biomass studies were also conducted in alpine pasture of Chansel, Kwar and Talra. Soil samples were collected for nutrient studies.

Evaluation of the Potentialities to Reduce Green House Gas (GHG) Emission from Municipal Dumping Sites for Effective Solid Waste Management

The waste fraction data were collected from two dumping sites i.e. - Doiwala and Rishikesh. Degradable Organic Carbon (DOC) percentage of dumped municipal waste at these dumping sites was done for

summer, rainy and winter season. Estimation of Carbon dioxide was also done in Nanurkheda, and Vikas Nagar in addition to the above dumping sites for 2011-12. GHG emission from alternative scenario i.e. from composting/vermi-composting was also estimated.

Soil, Vegetation – Atmosphere Carbon Fluxes Measurement and Modeling (SVF)

The Indian Institute of Remote Sensing (IIRS) has undertaken a National Carbon Project (NCP) under Geosphere Biosphere Programme (GBP) of the Indian Space Research Organization (ISRO) to estimate the carbon pools and fluxes in different terrestrial ecosystems of India. The project envisages temporal inventory of the forest and soil carbon stocks as well as measurement and modelling of carbon



exchange along atmosphere-vegetation boundary. Six carbon flux measurement towers using eddy covariance techniques are installed in five major forest types of the country. Betul (teak forest) in Madhya Pradesh is one of them. The objectives of the project are to measure the vegetation and soil parameters to support modelling and to collect the data related to silviculture, inventory, management and utilization, to estimate the net ecosystem exchange of carbon carried out inventory of teak forest in experimental site. Collected leaf samples of 9 tree species for Leaf Area Index; Collected soil samples and analyzed soil moisture % and soil carbon%, EC, pH, N, P and K. Litter production and decomposition rate and Herb/Shrub Biomass were recorded. Data for phenophase of 10 species was also recorded.



Litter Trap

Monitoring the Impact of Climate Variables on Plant Diversity in Bhimashankar Permanent Preservation Plot of Sub Tropical Hill Forest of Maharashtra

The study is being carried out in Bhimashankar permanent preservation plot of subtropical hill forest (8A/C₂), one of the 23 preservation plots of Maharashtra state. The Bhimashankar preservation plot is rich in biodiversity and efforts will be made, in the present study to monitor the impact of possible climate variables on vegetation dynamics. Previously, plant diversity of this preservation plot was studied by TFRI, Jabalpur in the year 1999. Such types of study which include scientific investigations at ecosystem level have not been undertaken in this region. The data generated through this study will be provided the base for future strategies to be adopted for ecosystem monitoring in relation to climate change on global basis.



Collection of Herb/Shrub Biomass



Litter Decomposition Bags



Subtropical Hill Forest



Secondary information collected from available resources. Collection of climatological data is in progress. Preliminary survey was carried out in comptt. No. 19 for general information pertaining to site, terrain, physical features and vegetation. Floristic identification for inventorization and phenological observations on important species was carried out. Total 16 tree species recorded. Vegetation sampling was done to know the type of plant species present, so that vegetation of the area can be assessed quantitatively and qualitatively. Simple Random Sampling was carried out through laying out quadrats.

2.1.2. Ecosystem Services

Study on Ecosystem Services Imparted by Reserve Forests of Mussoorie Forest Division

A three year project on ecosystem services imparted by reserved forests has been implemented from 2009-10 to 2011-12. Four distinct ecosystems/ forest types at different altitudes have been selected for the study. Sal Forest area below 1500 m altitude, Chir Forest Area between 1500-1800 m altitude, Oak Forest Area between 1800-2100 m altitude and Deodar Forest Area above 2100 m altitude were identified and selected for the study.



Deodar Forest Area at Devalsari

A total of 58 sample plots were laid for data collection in different locations. Average GBH and height of trees was recorded in different girth classes for each forest type for valuation of carbon sequestration potential, based on biomass. The total biomass in each girth class was calculated to estimate the tree biomass in tonnes per hectare.



Site Selection at Ringalgarh, Mussoorie



Biomass Collection at Ringalgarh

Estimations indicated that biomass in deodar forests was almost twice that of pure Sal forests which was closely followed by Oak and Chir forests. Field data collection through Questionnaire has been done for valuation of other environmental services using Surrogate Market Technique, CVM, WTP and Hedonic Pricing methods. The recreation value was calculated through structured Questionnaires based on Travel Cost Method (TCM).



2.1.3. Hydrology

Comparison of Hydrological Regime of Degraded and Dense Oak Forest in Mussoorie Area

A five years project on forest hydrology is being implemented from 2007-2012. It is jointly funded by ICFRE and UCOST on 50:50 basis for a total cost of Rs. 31.20 lakh. The purpose of the project is to study the impact of forest cover on the hydrological regime and comparison of the same having dense Oak forest with a degraded micro-watershed to establish the functional relationship between forest cover and various hydrological parameters.

Two micro-watersheds viz (1) Arnigad micro-watershed (dense oak forest – 285 ha) and (2) Bansigad micro-watershed (degraded oak forest – 190 ha) have been selected about 36 km away from Dehradun towards Mussoorie.

Meteorological observatory was set up at both the locations and about 64,800 readings at each micro-watershed were recorded for temperature, rainfall, humidity, wind velocity and evaporation through different instruments. Soil moisture sensors were installed at different elevations and depths in each micro-watershed and 70 readings of soil moisture were recorded. Initial analysis of both meteorological data and soil moisture data has been completed. Two weirs at the exit points of each project site were constructed and about 53851 readings of water discharge were recorded. Both, hydrological and meteorological data were recorded from March 2008 to February 2011 and a data base for first three years developed for analysis.



Dense Micro Watershed at Arnigad, Mussoorie



Meteorological Observatory, Bansigarh, Mussoorie



Degraded Micro Watershed at Bansigarh, Mussoorie



Weir at Site



Soil samples for physio-chemical properties in different locations of each micro-watershed were also collected. About 800 water samples were collected to measure suspended load from each micro-watershed. Infiltration tests at four locations of each micro-watershed were done through double ring infiltrometer and interpretation of infiltration rate completed. About 5000 water and precipitation samples were collected for isotopic and tritium analysis at NIH Roorkee. Annual budgeting of rainfall and runoff for three years has been done to indicate the correlation of hydrology on forest.

2.1.4. Ecology & Environment

Development of Biomass Expansion Factor (BEF) for Some Tree Species of Garhwal Himalaya, Uttarakhand

Felling of *Shorea robusta* (sal) and *Pinus roxburghii* (chir) trees was done. Fresh weight of each component viz. leaf, twig, branch, bole, root, bark etc of all felled trees were taken in the field and representative samples of all these components were carried to the laboratory for oven dry weight estimation. Drying of some of tree components completed and calculation for biomass and BEF estimation is in progress. Drying of some thick discs of boles of some big trees is also in progress. Tabulation, computerization of fresh and dry weight of already felled trees of both the species done and biomass of these trees estimated.

Study of Bioaccumulation of Heavy Metals and its Impact on Different Plant Species

Heavy metal (Cu, Co, Cr, Pb, As) doses of four different concentrations i.e.- 10mg/l, 20mg/l, 30mg/l and 40mg/l were given to the plant species (*Lagerstroemia* sp., *Holoptelea integrifolia*, *Alstonia scholaris*, *Grevilia robusta*, *Dalbergia sissoo*, *Terminalia arjuna*), which were sown for experimentation in the Central Nursery of FRI for one year. The effect of above heavy metals on plant morphological parameters was noted. The morphological parameters i.e. root length, shoot length, root- shoot ratio, biomass etc. were also

recorded. Sample preparation for heavy metal analysis in laboratory was also started during 2011-2012.

Ecological Study of Watershed in Mussoorie Hills of Dehradun

In kairkuli watershed of Mussoorie hills under protected and degraded natural forests, plantation were selected after consultation with forest officials of the Mussoorie Forest Division. Several quadrats of 10 x 10 m, 5 x 5 m and 1 x 1 m. were laid out under selected landscapes for phytosociological determination of trees, shrubs, and herbs. *Quercus leucotrichophora* was dominant under natural forest where as *Cupressus torulosa* was dominant under plantation. Under degraded natural and plantation sites *Berberis* spp were dominant in shrubby form. Under growth biomass was determined by harvest method from the selected sites and degraded natural forest shows more biomass followed by protected natural forest. Soil samples were collected from the selected permanent plots from the depth of 0 -30 cm. and 30 - 60 cm. Soil moisture % from protected natural forest was observed more than others. Physico – chemical determination of soils are in progress. Microclimatic data of the selected landscapes were collected in day time when sun shining was in peak. Temperature (°C) and relative humidity (%) recorded from protected and natural forest show more value than plantation, whereas degraded natural forest and plantation did not show any variation.

Impact of Human Induced Disturbances on Regeneration and Population Structure of *Rhododendron arboreum* and *Myrica esculenta* in Mid Hills of Garhwal Himalaya

The viability of seeds of *Rhododendron arboreum* was found to be declining from 70-80% to 30-40% over the years from the date of collection of seeds from the forest area. Germination rate was recorded high in undisturbed sites as compared to that in disturbed sites both for *R. arboreum* and *M. esculenta*. Seed germination in the field was recorded higher in undisturbed sites than that in the disturbed sites both for *R. arboreum* and *M. esculenta*.



Ecological Study of Wetland Forest Ecosystem of Doon Valley, Uttarakhand

Asan Barrage

The ecological studies conducted in Asan Barage in Doon valley revealed that there were 57 plant species belonging to 27 families. Out of this, 10 were tree species, 21 shrub species and 26 herb species. The study of water indicated that water was free of pollution.

Jhilmil Area

Similar study was also carried out in Jhilmil Area and data revealed that there were 76 plant species belonging to 30 families. Out of this, 20 were tree species, 26 shrub species and 30 herb species. The study of water indicated that water was free of pollution.

Impact of Forest Plantations on Ground Flora Diversity and Soil Characteristics

For the study of Ground flora diversity and soil properties, *Eucalyptus grandis* and *Acacia mearnsii* plantations were selected in Pykara and Naduvattam ranges of Nilgiris (TN) and Munnar and Devikulam Ranges of Munnar (Kerala). Enumerated plant species in and around the selected Teak plantations for quantitative assessment of ground flora diversity in different Teak plantations like Aravallikavu (1975 and 1939), and Mayiladi area (1987) in Nilambur Range, Kerala, Sadvayal (1968-1969) and in Kalkothi (1978), Coimbatore Range in Tamilnadu by laying out quadrats (10 each of 100 sq. m) in each plantations. Enumeration was also done in selected *Eucalyptus grandis* (Naduvattam range) and *Acacia mearnsii* (Pykara Range) plantations in Nilgiris. It was found that *Cestrum aurantacum* was the single dominant species on the ground flora in Nilgiris in *Acacia mearnsii* plantations. 32 species of ground flora were recorded from *Eucalyptus grandis* plantation in Naduvattam. Soil samples were collected from all these plantations for studying soil micro flora and physical and chemical properties. Details on population density of arbuscular mycorrhizal (AM) fungi, PGPR's and other fungi were recorded.

Structure, Diversity and Regeneration Studies in Permanent Preservation Plots in Moist and Evergreen forest of Western Ghats in Karnataka

Initial survey of Karka, Bhagavathi and Kulgi ppp of Dharwar Circle was carried out in the month of January and data recorded. Survey of Katlekan ppp of Sirsi Division was carried out in the month of February and the data recorded.

Seed Biology Studies

Fruits of shola species namely, *Michelia nilagirica*, *Mappia foetida*, *Viburnum erbuscens*, *Photonia notoniana*, *Michelia champaca*, *Berberis tinctoria*, *Syzygium cumini*, *Syzygium arnottianum*, *Dysoxylon malabaricum*, *Neolitsea zeylanica*, *Meliosma wightii*, *Hydnocarpus alpina*, *Litsea wightiana*, *Euodia Lunu-ankenda*, *Elaeocarpus oblongus* and *Symplocos cochinsinensis* were collected from Naduvattam, Glenmorgan, Kariamandhu, Kodanadu and Kotagiri areas of Nilgiris. Seed extraction and processing methods were standardized. Conducted germination studies and recorded seedling vigour parameters in the germinated seedlings, and transplanted. Parameters such as 100 fruit weight, Fruit moisture content, Seed moisture content, 100 Seed weight, Germination %, Shoot length, Root length, Collar diameter and Seedling vigour were found out. The transplanted seedlings were subjected to study on effect of microbial inoculation. Studies on germination of seeds inoculated with growth promoting microbes are in progress.

Monitoring of Changes in Flora and Fauna in the Reserved Forest along the Thellavagu Nallah

Data collection on monitoring changes of flora and fauna in the reserved forests along the Thellavagu nallah was done. Data were analyzed for IVI value and plant diversity.

Study on Impact of Podu Cultivation on Phytodiversity and Soil Factors in the Eastern Ghats of Andhra Pradesh

Surveyed the identified podu areas in Bhadarachalam Forest Division of Khammam District, Maredumilli range of Kakinada forest division and Palakonda Range of Srikakulam Forest Division.



Collected the data of phytodiversity of podu areas and control plots. Collected the soil samples from the respective areas and analyzed them for various prospects.

Investigation on Floristic Diversity in Teak Plantation of Various Age Groups in Barnawapara Project Division, Raipur, Chhattisgarh

Plantations promote understory regeneration by shading out grasses and other light-demanding species, changing understory microclimates, improving soil properties and increasing vegetation structural complexity. With this view the project has been started to determine the changing of plant diversity in different year old plantations, changing of soil properties in these teak plantations and the similarities between plant species in each of these teak plantations and plant species in natural forests of teak.

Quadrats have been laid out in 25 compartment of teak plantation of various age groups i.e. 1, 4, 7, 10, 13,

16, 19, 22, 25, 28, 31 years. Enumeration of vegetation was also carried out. Eighty four trees, 12 shrubs and 36 herbs species have been recorded other than teak. Soil samples were collected for estimation of soil nutrients.

Ecological Assessment of Diversity of Medicinal Plants in Conservation Areas of Chhattisgarh and Strategies for their Protection

In view of extremely rich bio-cultural diversity in the state and dependence of forest dwellers for their health requirements on medicinal plants, the Government has declared Chhattisgarh as a 'herbal state' in July 2001. Accordingly, the Chhattisgarh Forest Policy has specially provided for evolving a feasible mechanism for *in-situ* / *ex-situ* conservation, domestication, propagation and non-destructive harvest of medicinal plants with the active help and support from local people including traditional healers and vaidyas.

To document floral composition, taxonomic characteristics, listing of endemic and threatened species, regeneration of the important species and traditional uses, associated with medicinal plants being utilized by the local people/tribals; 7 conservation areas of medicinal plants of CGSMPB have been proposed for study in Chhattisgarh state.

Survey, identification and documentation of medicinal plants has been carried out at 7 MPCA i.e. Jabarra at Damtari, Keochi at Marvahi, Bandhatola at Kheragarh, Bhatwa at South Kondagaon, Machkot at



Team at Work With Forest Officials



Teak Plantation



Curculigo orchioides



Jagdarpur, Ghatpandari at North Sarguja and Patia at Jashpur Forest Division. 152 Plant species having medicinal importance have been identified from this region.



Gloriosa superba



Thespesia Lampas



Mitragyna parviflora



Ziziphus oenophila



Uraria lagopoides

Influence of Forest Canopy Cover on Ground Flora and Micro-climate in Western Ghats (Maharashtra)

Assessed change in ground flora including herbs and shrubs with change in canopy density in the selected sites of Raigad, Ratnagiri and Sindhudurg districts of western ghats (Maharashtra). Number of species in ground flora increased with decrease in canopy density.

Observed effect of canopy structure and density on natural regeneration and growth of ground flora including native and alien species.

Change in soil parameters was also observed due to change in organic matter, litter fall and decomposition, moisture conservation, light intensity, temperature and humidity which was attributed to varying canopy density.



Counterbalancing the Detrimental Effect of Sponge Iron Factory-emitted Particulate Matters (SIFPM) with the Protective Effect of Vesicular Arbuscular Mycorrhiza (VAM) on the Growth of Seedlings of Important Tree Species

The project was started to assess the protective effect of Vesicular Arbuscular Mycorrhiza (VAM) on the growth of seedlings of important tree species. The sites selected for the study are industrial areas of Ghugus (Maharashtra), Raigarh, Raipur (Chhattisgarh) and Bhopal (Madhya Pradesh). Innumerable Sponge Iron Factories have been established in Madhya Pradesh, Chhattisgarh and Maharashtra which emit pollutants mainly in the form of SO_2 , NO, NO_2 , N_2O_5 and Suspended Particulate Matters (SPM). SPM causes a huge loss to the environment on vegetations like closing of stomata in leaves and dispersal of several toxins in the environment. Around these factories, the average growth of the trees found to be stunted and deformed.

Six months old 1200 plants of ten tree species are presently under study of this project namely *Tectona grandis*, *Gmelina arborea*, *Dendrocalamus strictus*, *Dalbergia sissoo*, *Pongamia pinnata*, *Cassia siamea*, *Azadirachta indica*, *Emblica officinalis*, *Peltaforum ferrugineum*, *Schleichera oleosa* and *Butea monosperma* on a critical comparison with control data collected from least polluted areas. Physicochemical estimations in terms of biochemical estimations (Chlorophyll, Sugar, Ascorbic Acid and Phenol) of leaf and soil samples are in progress.

Experiments have been made with two sets at the nursery of TFR I; Soil + FYM (Control) and Soil + FYM + SPM (Experimental); the soil has been treated with the SPM collected from the industrial areas affected with the pollution from sponge iron factories. This is a model experiment which shall mimic the polluted condition and analysis of which along with growth data would tell us the magnitude of the loss or how much the plant is immune to pollution effects.

Soil around the feeder roots and feeder roots were collected from different tree species for VAM culture.

These soil and root samples were inoculated in different pots with maize seeds for VAM culture. For VAM culture, firstly the potting mixture was autoclaved (Soil + Sand + FYM) twice for sterility, and then transferred to earthen pots (10 kg capacity) in field. Then, soil and root samples collected from the affected sites were mixed with this pot-mix in 1:20 ratio, and immediately thereafter, 15 maize (*Zea mays*) seeds were sown at 2.5 inch depth. The maize plants were irrigated with sterile water to avoid any VAM contamination from other sources. The Mycorrhiza grew well in 3 months, and after that, the desired VAM was harvested.

It was observed that application of VAM for a particular species as collected from the affected area, cultured, harvested and when applied in pot-mix (mixed with environmentally toxic particulate matters) of nursery-grown seedlings, significantly confer physiological protection as reflected from general health, growth-data (Height, collar circumference, number of branches and number of leaves) and biochemical assays (soluble protein, phenol, carbohydrate, ascorbic acid, chlorophyll a & b). The same trend of improvement was noticed in all the species as mentioned.



Four Experimental Categories of *Gmelina arborea*

Four Experimental Categories of *Azadirachta indica*

Conservation, Management and Utilization of Selected Rattans of Assam

Field survey in Gibbon WLS, Karbi Anglong, in forest areas of Karimganj and Hailakandi District, Dibrusaikhowa NP, Jeypore RF, Poba RF and Nambor RF Garampani was carried out and phenological information and population dynamics data recorded. Samples, soil and plant samples for herbarium were



also collected and soil pH, bulk density, C, N, P and K etc determined.

2.1.5. Invasive Species

Investigations on Ecology of Mimosa Invasion in Kaziranga National Park, Assam

The work done till date under this project can be summarized as follows: Grid map of size '810m X 810m' of the study area was generated. Classification of course resolution satellite images (LISS 3) was completed. Questionnaire based appraisal survey for presence/absence of Mimosa in each range was also carried out. GPS based reconnaissance survey of the study area was carried out for collection of geo-coordinates of Mimosa invaded patches. A 'Potential invasion map' was prepared based on GPS information and the preliminary classified map. Vector layers like drainage, roads, camp locations, compartments and grids were integrated with Potential invasion map in GIS environment and base map prepared. Visual interpretation of higher resolution satellite images has been completed. GPS location (both polygons and points) of Mimosa patches were examined in the image thoroughly. A model was developed to integrate remote sensing, GPS and GIS data/information and weightage of each layer was provided using Analytical Hierarchy Process (AHP) to get the mimosa invasion map of Kaziranga National park.

It was found under the project, *Mimosa invisa* had been coming up in tall grass community, identified as *Erianthus ravanae-Imperata cylindrica-Saccharum spontaneum*, *Erianthus ravanae-Saccharum spontaneum-Imperata cylindrica*, *Veteveria zizanioides-Imperata cylindrica-Saccharum spontaneum*, *Veteveria zizanioides-Saccharum spontaneum-Imperata cylindrica* in Bagoroi and Kohora range, in Kaziranga National Park. 35 other plant species in association of *Mimosa invisa* were also identified viz. *Erianthus ravanae* (Ekora), *Imperata cylindrica* (Borota kher), *Saccharum spontaneum* (Kohua), *Imperata cylindrica* (Kher), *Veteveria*

zizanioides (Birina), *Alpinia allughas* (Tora) etc. Seedlings of 321.6 ± 56.2 no seedlings/sq m and 270.4 ± 52.6 no/sq m in *Mimosa invisa* infested site in Bagori and Kohora Range were recorded, respectively. In some sites, maximum 780 no seedlings/ sq m of *Mimosa invisa* were also recorded. It was observed initially that the infested weed was coming up in tall grass community particularly *Erianthus ravanae-Imperata cylindrica-Saccharum spontaneum*, *Erianthus ravanae - Saccharum spontaneum*, since weed required support to climb up. When the tall grass community were destroyed to some extent by wild animal and made space, the weed is able to exist within the tall grass community. Gradually, they grew up and by profuse branching, form a net like cover at the top of the tall grass. It reduces the regeneration and gradually disappear tall grass and ultimately weed gets dominance over to grass. It was observed some shrub species like *Alpinia allughas*, *Desmodium sp.*, *Ageratum conyzoides*, *Eupatorium odoratum*, *Litsaea monopetala*, *Bombax ceiba*, etc. are preserved in Mimosa infested site, which is an indication of transforming the site from grassland to tree dominated land.

Data recording on phenological events of Mimosa was completed and phenograms prepared with all events of life cycle which included Seed germination time, Inflorescence initiation, flowering, pod formation, seed setting and seed maturation periods. Seeds from healthy Mimosa plants identified in invaded areas were collected from Western, Central, Eastern and Burapahar ranges of KNP. Seeds were processed and stored for seed biology and germination studies. Viability and vigour of the seeds were studied following standard ISTA methods. Seed germination trials were laid out in laboratory and nursery conditions. Field trials for seedling emergence from soil seed bank were also completed. The seed burial effect (soil layer to 27 cm soil depth), biomass analysis at different environment gradient and seed soaking in water at different intervals experiments were completed. It showed the range of seed viability in different conditions as 90 – 95%. The control measures experiments showed good results when stem cut up to 12 cm from ground before seed



setting, all the selected stems died after three months. A Questionnaire (in vernacular language) was prepared and questionnaire based appraisal survey for existing Mimosa control measures was carried out.

Documentation and Distribution of Forest Invasive Species (FIS) of Jabalpur, Katni, Mandla and Seoni Districts of Madhya Pradesh

Alien species are non-native or exotic organisms that occur outside of their natural adapted ranges due to their dispersal potential. Many alien species support our farming and forestry systems. Alien species become invasive when they are introduced deliberately or unintentionally outside their natural habitats into new areas, where they express the capability to establish, invade and compete with native species. Many of the plant species intentionally introduced in various countries in the past have become major threat to the forest biodiversity and their control measures consume substantial financial resources. Preliminary survey has therefore been carried out in four districts i.e. Jabalpur, Mandla, Katni and Seoni of M.P.



Hyptis suaveolens in Mixed Forest



Lantana camara in Teak

Three sites at each district have been selected for the study and their details have been recorded. Thirty Nine



Carissa carandus



Hyptis suaveolens Infestation

invasive species so far been documented and identified from forest area of above four districts.

Ecological Impact Assessment of Invasion of *Lantana*, its Removal and Subsequent Restoration of Habitats in Rajaji National Park of Tropical Moist Deciduous Forest

Distinct changes in the dominance of understorey vegetation such as *Adhatoda zeylanica*, *Murraya koinigii* and *Clerodendrum viscosum* in mixed vegetation communities and *Ehretia laevis* a middle sized tree and *Clerodendrum viscosum* in Sal forest was recorded after removal of *Lantana* from the National Park. Besides, species diversity of herbs and shrubs also recorded higher in *Lantana* removal sites than *Lantana* invaded sites in both Sal and Mixed vegetation communities. Similarly the number of grasses was also recorded higher in *Lantana* removal sites than *Lantana* invaded sites.

2.1.6. Phytoremediation

Phytoremediation of Soil for Productivity Enhancement During Land Disposal of Effluent

A survey was conducted at Balotra, Salawas and Pali in January, 2011 and in the vicinity of effluent disposal area at Luni, Jojri and Bandi river, respectively studied. Plant and tree species like; *Acacia nilotica*, *Acacia tortilis*, *Prosopis juliflora* (Swartz.), *Aerva pseudotomentosa*, *Sacharum munja*, *Echinops echinatus* were observed at Salawas, whereas, *Prosopis cineraria* (Linn.), *Salvadora persica* Linn., *Aerva pseudotomentosa*, *Argemone mexicana* at Balotra and *Parkinsonia acculeata*, *Blumea oblique*, *Euphorbia hirta*, *Calotropis procera* and *Chenopodium album* were recorded at Pali.



Parkinsonia acculeata at Bandi River, Pali



Prosopis juliflora at CETP Plant, Balotra



Water and soil samples were collected from river basins and parameters like; pH, EC, Dissolved Oxygen, Chloride, Total Dissolved Solids (TDS), Suspended Solids, Soil Organic, Soil Inorganic and Soil Moisture Level etc were analysed in the laboratory. Water samples collected from Balotra showed high pH, very high Electrical Conductivity and Total Dissolved Solids. Water samples collected from river Jojri, Salawas also showed high pH, very high Electrical Conductivity, high Chloride, high Total Dissolved Solids and very low Dissolved Oxygen. Whereas, soil samples when analysed showed low pH and high Electrical Conductivity.



Affluent Water Sample Collected at Jojri River, Salawas

Many sites were considered for the study, but a favorable site for the field experimentation has been identified at Salawas village in vicinity of Salawas Treatment Plant (STP) Jodhpur. The proposal for the land has also been sent to Jodhpur Development Authority, which is under consideration.

2.1.7. Biodiversity

Grasses of Uttarakhand and Himachal Pradesh

The herbaria of Forest Research Institute and Botanical Survey of India are being scrutinized for collections of grass specimens from Uttarakhand and Himachal Pradesh. Libraries of both these organizations are also being consulted for references on grasses. Some of the books consulted included Grasses of Burma, Ceylon, India and Pakistan, Flora

Simlensis, Flowering Plants of Uttarakhand (A Check list), Herbaceous Flora of Dehradun, Flora of South Indian Grasses, The family Grasses in various Indian Floras, etc.

Exploration cum collection tours were conducted to collect the grass specimens. In Uttarakhand following places were covered – Chakrata, Dehradun, Mohand, Rajaji National Park, Pithoragarh, Lohaghat, Tanakpur, Uttarkashi, Nainital, Champawat, Narendranagar, Vikasnagar, Saiya, Tueni, Mussoorie, Rudraprayag, Chamoli, Gopeshwar, Haridwar, Rishikesh, Jaunsar & Chopta Mandal. Around 1500 specimens have been collected of which 600 specimens have been identified. Some of them are – *Apluda mutica*, *Andropogon monticola*, *Andropogon contortus*, *Arundinella hispida*, *Arundinella nepalensis*, *Cynodon dactylon*, *Typha angustifolia*, *Saccharum spontaneum*, *Sporobolus tremulus*, *Paspalum flavidum*, *Paspalum scorbiculatum*, *Digitaria sanguinalis*, *Panicum flavidum*, *Panicum colonum*, *Panicum ramosum*, *Panicum repens*, *Sporobolus diander*, *Cymbopogon martinii*, *Setaria tomentosa*, *Setaria homonyma*, *Setaria glauca*, *Ischaemum ciliare*, *Pennisetum purpureum*, *Echinochloa crusgalli*, *Erianthus sp.*, *Eriochloa polystachya*, *Poa pratensis*, *Chloris virgata*, *Pogonanthus sacchanoides*, *Bromus unioloides*, *Vetiveria zizanioides*, *Chloris barbata*, *Chloris burnei*. Unidentified specimens are in the process of identification.

Paonta Sahib, Dhaulta Ku-an and adjoining areas, Solan, Una, Hamirpur, Kandhaghat, Kumarhatti, Spathu, Simla highway and Parwanu and adjoining areas and boundaries of district Sirmour, Una, Hamirpur and Mandi have been covered in Himachal Pradesh. Around 500 specimens have been collected of which 300 specimens have been identified and remaining specimens are in the process of identification.

Bioecology and Management of the Gall Insect in Eucalyptus

Regular and extensive surveys were conducted and sites : Chidiyapur, Star Paper Mills, Shakumbhari Devi



Range, Roorkee and Kalesar (Yamunanagar) along with roadside plantations (Randomly at three sites during every tour) were finalized for regular collection of data on seasonal abundance, damage percent and bio-ecological aspects of the gall insect. Collection of data is in progress. Rearing of the insect is being carried out in the laboratory as well as in outdoor cages. Collection and procuring of clones of Eucalyptus is in progress from different sources for studying the resistance in eucalyptus.

Taxonomic Studies on Parasitoids Belonging to sub family Braconinae (Hymenoptera: Braconidae) of Uttarakhand

Survey and collection of parasitoids belonging to sub family Braconinae and their hosts / key insect pests have been carried out from Kaleswar, Kalsi, Timli, karwapani and New Forest campus. As a whole 21 parasitoids were collected. Sorting of parasitoids belonging to Braconinae was carried out and slides were prepared.

One Species of genus *Bracon* (4 specimens)
One Species of genus *Atanycolus* (9 specimens)
One Species of genus *Ipobracon* (8 specimens)
Detailed morphological studies of following two species have been carried out:

1. *Iphiaulax immsi* Cameron, emerged from wood borer of *Terminalia tomentosa* 2. *Iphiaulax spilocephalus* Cameron, emerged from the wood borer of *Calotropis procera*. Updating of the already present genera of NFIC: *Hypogaster xanthopsis* (Cameron, 1905) = *Iphiaulax spilocephalus* Cameron, 1905 *Stenobracon* (*Stenobracon*) *deesae* (Cameron 1902) = *Glyptomorpha deesae* Cameron 1902.

Studies on Taxonomy of the Family Eulophidae (Hymenoptera: Chalcidoidea) Present in National Forest Insect Collection (NFIC) Except Doon Valley

1. Literature on Eulophidae was collected (Hansson 2000, 2006).
2. Sorting and identification: Four hundred card mounted specimens of Eulophidae were sorted out from "Burma Collection", stored in NFIC.

Following species were identified:

- a) *Tetrastichus tunicus* : Four series of specimens collected from Naungkhangyi, Botanical Garden, Wet wan road Myamo, Myanmar; vi-x. 1940; MH Desai, from seeds of *Lantana camara*
 - b) *Euplectrus petiolatus* : Collected from Maymo; 08.vii.1940; MH Desai; undet pyralid on *Diospyros burmanica*.
 - c) *Oomyzus sokolowskii* Collected from Maymo; 28.iv.1940; MH Desai; undet. Host.
- 2) Slide preparation of two species of *Pleurotroppopsis* was done. They were dried and card mounted (HMDS). Species were macrophotographed. Morphometrics of species were also done.
 - 3) A total of 2774 specimens were identified from unidentified Eulophid collection, present in NFIC. All the specimens belong to species *Tetrastichus triozei* which were collected from the location Terah in Punjab.
 - 4) Studied and compared the following holotypes with identified eulophids at ZSI Western Ghat Regional Station, Calicut: 1. *Elachertus adimalicus*, 2. *Tetrastichus abatus*, 3. *Tetrastichus arucicus*, 4. *Tetrastichus chindakicus*, 5. *Tetrastichus cotesiae*, 6. *Tetrastichus dasi*, 7. *Tetrastichus dulciculus*, 8. *Tetrastichus flavilatus*, 9. *Tetrastichus girishi*, 10. *Tetrastichus heydoni*, 11. *Tetrastichus laparus*, 12. *Tetrastichus sumatus*, 13. *Tetrastichus thonicus* and 14. *Tetrastichus tunicus*.

Studies on Taxonomy of the Family Encyrtidae (Hymenoptera: Chalcidoidea) Present in National Forest Insect Collection (NFIC) Except Doon Valley

1. Card mounted specimens of Encyrtidae were sorted out from "Burma Collection" stored in NFIC. Following species were identified:
 - a) *Copidosoma indicum*
 - b) *Copidosoma floridanum*

Both were collected in Myanmar, Maymo; 10-11.v.1940; M.H. Desai; ex unknown host.



2. 1235 specimens stored in two Cabinet boxes and collected from different locations of Punjab during 1930s were identified as *Copidosoma varicorne*. Alcohol preserved encyrtids, collected from canopy fogging of *Vateria indica* Karnataka: Bannadapaare, Makuta near Virajpet (N 12°04' 39.2"; E 75°43'33.6") in the Western Ghat; 26.vi.2003; YB Srinivasa; were identified as: *Bothriothorax* sp. (2 specimens), *Copidosoma varicorne* (1 specimen), *Copidosoma subalbicorne* (4 specimens), *Adelencyrtus* sp. (6 specimens), *Adelencyrtus quadriguttus* (1 specimen), *Adelencyrtus* sp (14 specimens), *Epitetracnemus* sp (1 specimen), *Ooencyrtus agalmatus* (1 specimen) and *Trechnites* sp. (6 specimens).
3. Encyrtid specimens in alcohol were dried and mounted. They were identified as 3 undetermined species of *Ooencyrtus*, three species of *Adelencyrtus* and *Ooencyrtus corbetti*.
4. Alcohol preserved specimens from Karnataka were cleaned and dried with HMDS technique. Following species were identified: 1. *Adelencyrtus* sp1; 2. *A.* sp2; 3. *A.* sp3, 4. *Comperia indica*, 5. *Cheiloneurus zeyai*, 6. *Ooencyrtus uthesia* and 7. *Copidosoma indicum*. They were card mounted and some of their parts like wings and antennae were mounted in Canada balsam.

Psyllaephagus sp. parasitizing *Trioza fletcheri* minor leaf gall former of *Terminalia arjuna* was compared with *Psyllaephagus bengalensis* Hayat. Present species differs from it on the basis of antennal segments, body size and colorations. Morphometry for 75 different measurements each of female and male were taken from the HMDS dried and slide prepared specimens. *Psyllaephagus* sp. was macrophotographed.

Description of the new species *Neastymachus scutopunctilatus* was completed and paper submitted for publication.

Bioassay of Some Selected Plant Extracts against Major Defoliators of Poplar and Shisham.

Collection of *Clostera cupreata* and *Plecoptera reflexa* was done from the selected sites (Chichhrauli,

Haryana and Thanu, Uttarakhand). Rearing of defoliators was done in chimney as well as in wooden cages in the laboratory to maintain the culture for laying down a series of experiments. Collection of *Adina cordifolia* was done from the field, it was shed dried and ground to powder. Extraction of ground material of *A. cordifolia* was done in different solvents viz. petroleum ether, acetone, methanol and water sequentially in Chemistry Division, FRI. Moisture free yield was calculated which was 4.06, 4.91, 18.42 and 9.21 per cent in petroleum ether, acetone, methanol and water respectively. Different extractives were prepared by diluting in different solvents. Testing trials of different extracts was done at 1% concentration, to find out their



Cerapteroceroides anustifrons
(Head Dorsal View : Female)



Cerapteroceroides anustifrons



Cerapteroceroides anustifrons
(Head Frontal View : Female)



Scirtothrips dorsalis Hood



Plant of Solanaceae Family Attacked by *Scirtothrips dorsalis*



effectiveness against poplar and shisham defoliator but due to heavy rains, the breeding of larvae of poplar and shisham defoliators got affected by fungal infection. Laboratory testing work of *A. cordifolia* extract against *C. cupreata* and *P. reflexa* is in progress.

Orthopteran Diversity of the Nilgiri Biosphere Reserve (NBR)

Inventory of orthoptera in the selected habitats at respective sites has been made with regular interval. A total of 37 species have been observed in NBR. Population pattern of orthoptera in the selected sites has been studied in correlation with abiotic factors. Host preferences of selected orthopteran species namely *Xenoceatantops humilis*, *Conocephalus maculatus* and *Phlaeoba infumata* have been completed, and found most of them are monocot feeders. Scrub jungle, grass land, deciduous forest, ever green forest, and shola forest have been selected to study the impact of anthropogenic disturbance. The upland forests act as refuges for highly mobile polyphagous insects like grasshoppers. Extensive study on orthopteran diversity of high altitude shunted wet evergreen forests called shola is in progress, in order to understand the impact of landscape changes.



Orthacris maindroni Bol.
Ingrisch & Shishodia



Mirollia longipinna



Inventory of Orthoptera in Nilgiri Shola Forest – Avalanche
Elimaea (Orthelimaea) securigera (Brun.)

Biodiversity of Wood Inhabiting Fungi in the Rainforests of Makutta, Western Ghats

The study started with preliminary identification of site/transects for the sampling work at the LTI plot, Makutta, based on the observation and existence of fungal fruiting bodies. Line transect method was followed for the actual sampling work carried out in the study area. Regular visit to transects for documenting the macrofungi was carried out during all the quarters. Documentation was categorized based on the prevalence of fungi during monsoon, pre and post monsoon. The documentation was carried out through photographs collections and characterization of the macrofungi. A total of 30 species of macrofungi was identified. Substrates of the fungi were also recorded as fallen logs, twigs and snags. A manual is under preparation for field identification of macrofungi for the study area.

Pollination Entomology – Dynamics and Role of Insect Pollinators in Fruit-set of Species of Sonneratiaceae and Avicenniaceae in Mangroves of Karnataka

The project was started during December 2011. Recruitment of Research Fellows has been completed. The main objective of the project is the identification of insect pollinators responsible for fruit set of mangroves plants of family Sonneratiaceae and Aviceniaceae. The mangrove areas selected for the study are Mangalore, Kundapura, Karwar, Honnawar and Udipi in the West coast of Karnataka. Preliminary surveys were conducted to locate flowering plants of selected families in the study sites. Insects belong to Hymenoptera, Diptera, Lepidoptera were collected from different plants. Studies on pollination biology of plants in Sonneratiaceae and Avicenniaceae has also been initiated.

Studies on the Species Diversity of white flies (Aleyrodidae: Homoptera) and Their Natural Enemies in Mangrove Habitats of India

The project was started during December 2011. Surveys were conducted in Muthupet (Tamil Nadu) and Vypeen Island (Kerala) mangroves. The collected whiteflies were mounted and preserved. The host plants are identified.



Achanakmar-Amarkantak Biosphere Reserve

The continuous activities undertaken in the project include updating information on flora and fauna of Achanakmar-Amarkantak biosphere reserve by new additions to the already existing database. Collected references from recent literature on tropical moist/ dry deciduous type of **biosphere reserves** from web site and collated with the conditions of the Achanakmar-Amarkanatak biosphere reserve. Collected meteorological data of the core zone from the manual observatory.

Recorded regeneration status of trees from the permanent plots laid at core and buffer zones of biosphere reserve. Surveyed, collected, identified and preserved 300 specimens which includes 180 species of butterflies, 16 species of moths and two species of bugs among the 198 identified species. Recorded status of selected economically important threatened flora in biosphere reserve. Created web based information centre for Achanakmar-Amarkantak biosphere reserve and linked to the website of TFRI, Jabalpur (<http://tfri.icfre.gov.in/AABR/index.html>).

Ecological Studies on the Distribution Patterns and Food Plant Resources of Butterflies along Altitudinal Gradients In Different Forest Ecosystems of the Eastern Himalaya (Arunachal Pradesh)

Scientist of RFRI, Jorhat visited different places in Arunachal Pradesh for site selection and sampling were carried out in three selected sites including Namdapha and Pakke Tiger Reserve along with Eaglenest sanctuary in Arunachal Pradesh. Visited Namdapha Tiger Reserve for pilot study, transects laid for study in the visited sites. Data collection was done.

Exploration and Conservation of Genetic Resources of Selected Rare and Endemic Plants of Northeast India

A study was carried out on four different rare and endemic plant species- *Gnetum gnemon*, *Livistona jenkinsiana*, *Vanda coerulea* and *Renanthera imschootiana* at RFRI, Jorhat.

Socio-economic prospects on endemic gymnosperm- *Gnetum gnemon*, and indigenous and threatened palm- *Livistona jenkinsia* had been carried out. *Gnetum gnemon* is a gymnosperm which is shrubby in nature and endemic to this region. The leaves of this plant are hugely collected and used by different tribes as leafy vegetables. Roasted oily seeds are eaten as fruit.

The leaves of palm –*Livistona jenkinsiana* widely used in roofing of traditional hut. Besides, leaves are used in making of Jhapi- a traditional helmet in the North East India.

Population and regeneration status of *Livistona jenkinsiana*, and *Gnetum gnemon* had been assessed in the region. Multiplication and *ex-situ* conservation methods of *Vanda coerulea* and *Renanthera imschootiana* has also been studied.

Exploration of Diversity and Utilization Potential of *Sphagnum* species of Forestry Importance in N.E. India

Studies were conducted in Khasi, Jantia and Garo Hills of Meghalaya and Eastern and Western part of Sikkim. Taxonomical characterization of 6 species of *Sphagnum* have been completed viz. *S. khasianum pseudocymbifolium*, *S. cuspidatulam*, *S. papillosum*, *S. squarrosum*, and *S. palustre*. The physical and



Collection, Preservation and Documentation of *Sphagnum* species



Sphagnum pseudocymbifolium
West Khasi hills



Sphagnum squarrosom Sangmein
(near forest nursery) East Khasi hills



Sphagnum cuspidatum
Mawreng, East Khasi Hills



Sphagnum papillosum Laitlyntok
near Basti, East Khasi hills

Taxonomic Diversity among *Sphagnum* species



Wet Sphagnum



Girdling of Branch



65 Days Old



Detached from Mother Plant



Tag with Filled Sphagnum



40 Days Old



Transfer to Polybag



Detached from Mother Plant

Air Layering trials on *Cinnamomum zeylanicum* using *Sphagnum* as Substrate

chemical properties of all identified species of *Sphagnum* are under progress. The Trials on Air layering shows good results and the results have been transferred to end users. Three numbers of trainings were also given to farmers in different villages of Assam and more than 1000 branches air-layered through 2 *Sphagnum* species. More than 80% branches show very good results. The trials with orchids also show very good results in comparisons to control media. The *ex-situ* conservation of three

species of *Sphagnum* done in Low cost shade house in RFRI campus was also done.

Studies on Species Diversity of *Ganoderma* in Assam with Reference to Utilization and Cultivation of its Selected Species

Various host range of *Ganoderma* spp. as well the diversity of the fungi in Assam were studied. The estimation of polysaccharide (total soluble sugar), moisture content of different samples of *Ganoderma* spp. was also carried out.



Ganoderma lucidum



Ganoderma Sp.



Ganoderma multiplicatum



Ganoderma Sp.

Impact of *Prosopis juliflora* on Biodiversity, Rehabilitation of Degraded Community Lands and as a Source of Livelihood for People in Rajasthan State

Survey was carried out in and around Jodhpur, Pali and Bharatpur districts of Rajasthan and associated floral and faunal diversity were recorded of the selected sites in grazed and ungrazed areas. *P. juliflora* density was worked out in orans, gochars, protected areas, revenue lands, wastelands, wetlands, saline lands, agriculture fields and urban forestry models. The floral diversity was represented by 29 species of herbs, shrubs and trees belonging to 16 families. The most dominant family recorded was Fabaceae, followed by Salvadoraceae and Poaceae among the associated floral diversity.

Studies on dependant or associated faunal diversity revealed that 22 species were of soil arthropods and entomofaunal invertebrates. 42 species of vertebrates were also found directly or associated with *P. juliflora*. The inflorescence of *P. juliflora* attracts large number of bee species and numbers of bee-hives were also observed. One species of homoptera (*Cicada*) and two species of coleoptera (*Mylloceris*) were reported for the first time from *P. juliflora* from India.

Studies on utilization aspects revealed that *P. juliflora* tree has given a wide spread green cover to the xeric environment of the Indian Desert, besides providing fuel, fodder and food for the human, cattle and wildlife especially during severe summer and winter months. Studies on utilization of other exotic species associated with *P. juliflora* revealed that *Acacia auriculiformis* leaves were extensively used for amelioration of *mehandi* quality for commercial use and its bark for tanning purposes, whereas *Acacia tortilis* was used mainly as fuel wood and *Parkinsonia aculeata* as an ornamental tree.

Screening, Identification and Preparation of a Comprehensive Check- list of the Lepidopteran Fauna of Sasan Gir National Park of Gujarat State

Aim of the study was to study the Lepidopteron fauna of Sasan Gir Forest. The experimental sites have been selected viz; Chodiya Vistaar, Babulwala Chowk,



Dhadoria, Kamleshwar Dam, Valodra, Adodia, Ratanguna, Didarkri river, Peripite site and Kareli. The butterflies and moth species were collected from the Gir National Park, Junagarh, Gujarat, and identified, preserved and augmented in the insect collection boxes. All the specimens were photographed. The preparation of slides of wings and genitalia were carried out. The butterflies species, collected from the Gir National Park, Junagarh, Gujarat have been identified up to species level. The four species of Nymphalidae, two species of Danaidae, three species of Pieridae, two species of Papilionidae and one species of Sphingidae have been identified.

Ecological Assessment of Floristic Diversity in Kalatop Khajjiar Wild-life Sanctuary of District Chamba, Himachal Pradesh

The study sites were selected and the phytosociological studies conducted by laying out the quadrats of different sizes for tree, shrub and herbs randomly in different altitudes. In this sanctuary, total number of plant species recorded were 232 belonging to 76 families and 218 genera. In Talai-I beat, total number of plant species was 149 belonging to 55 families and 133 genera. In Khajrot beat, total number of plant species was 105 belonging to 60 families and 95 genera. In Khajjiar beat, total number of plant species was 101 belonging to 54 families and 95 genera. In Kangarrakh beat, total number of plant species was 127 belonging to 65 families and 119 genera. In Ala beat, total number of plant species was 93 belonging to 44 families and 87 genera. Dainkund beat revealed 102 plant species belonging to 54 families and 95 genera. Lakadmandi beat showed that the total number of plant species was 81 belonging to 52 families and 76 genera. Talai-II beat of the sanctuary revealed 109 plant species belonging to 58 families and 102 genera. In Kalatop beat, total number of plant species was 142 belonging to 71 families and 127 genera. Out of 100 medicinal plant species recorded from the Kalatop-Khajjiar wild life sanctuary, 7 species viz; *Cinnamomum tamala*, *Dioscorea deltoidea*, *Paris polyphylla*, *Podophyllum hexandrum*, *Polygonatum verticillatum*, *Taxus wallichiana*, *Zanthoxylum armatum* fall in the category of threatened plants. Conducted the ethnobotanical study in 14 villages and documented 45 plant species used for different purposes.



Junonia lemonias (L.)
Nymphalidae



Junonia orithya (L.)
Nymphalidae



Junonia almana (L.)
Nymphalidae



Male (ventral)
Hypolimnas missipus (L.)
Nymphalidae



Catopsilia crocale
Pieridae



Ixias pyrene evippe (Drury)
Pieridae

Butterfly species of Sasan Gir Forest

The permanent plots were also established in different forests in the Kalatop- Khajjiar wild life sanctuary for recording the time series data. In the plot established in alpine pasture, number of shrub and herb species was 5 and 44 with the dominance of *Viburnum erubescens* and *Geum elatum* respectively. The diversity index for shrub and herb species was 1.12 and 3.39 whereas dominance index was 0.42 and 0.04 respectively. In Ban oak and Rhododendron forest, number of tree, shrub and herb species was 2, 11 and 30



with the dominance of *Quercus leucotrichophora*, *Rhododendron arboretum* and *Trifolium repens* respectively. The diversity index for tree, shrub and herb species was 0.68, 2.02 and 3.06, whereas dominance index was 0.51, 0.16 and 0.06 respectively. In mixed forest of conifer and broad leaved, number of tree, shrub and herb species was 10, 11, 27 with the dominance of *Persea duthiei*, *Sarcococca saligna* and *Ptercanthus urticifolius* respectively. The diversity index for tree, shrub and herb species was 2.10, 1.58 and 2.69, whereas dominance index was 0.14, 0.32 and 0.10 respectively. In mixed conifer forest, number of tree, shrub and herb species was 4, 8 and 30 with the dominance of *Abies pindrow*, *Viburnum erubescens* and *Valeriana jatamansii* respectively. The diversity index for tree, shrub and herb species was 1.14, 1.62 and 2.83, whereas dominance index was 0.35, 0.30



Ban oak and Rhododendron Forest



View of Alpine Pasture

and 0.10 respectively. In pure deodar forest, number of tree, shrub and herb species was 1, 5, 21 with the dominance of *Cedrus deodara*, *Cedrus deodara* sapling and *Valeriana jatamansii* respectively. The diversity index for shrub and herb species was 1.47 and 2.36, whereas dominance index was 0.26 and 0.16 respectively.



Mixed Conifer Forest

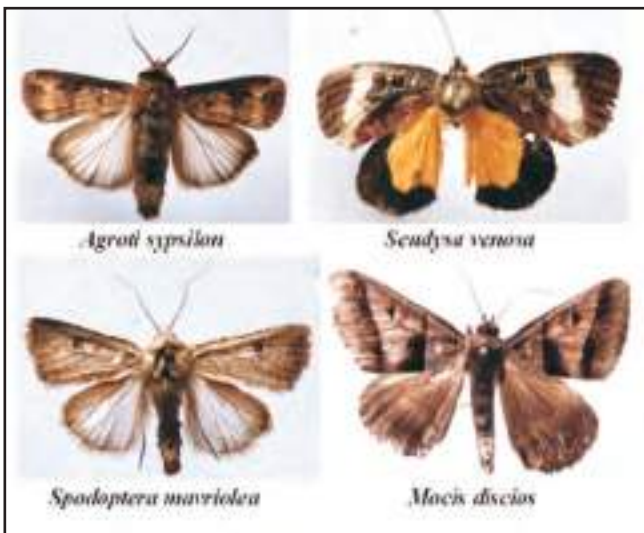
Taxonomy, Biodiversity and Habitat Association of Noctuid Moths (Lepidoptera: Noctuidae) in Various Conifer Forests of Himachal Pradesh

Total of 2740, 1360 and 1540 specimens of Lepidoptera moths have been collected from different conifer sites during 2009 and 2010 respectively. Out of these 663, 737 and 865 specimens belong to Noctuid moths collected during 2009, 2010 and 2011 respectively out of which 129 species have been identified. All species have been dissected to study wing venation and genitalia for taxonomic update. Data for biodiversity analysis has been recorded for the two years and third year data collection is in progress as per the methodology adopted to study the biodiversity of the Noctuid moths. During the field survey, some insect larvae were collected from the field and reared in the lab. It was also noted whether these species are causing the damage to the host (only selected conifers and associated vegetation) or are simply the host of the particular species. For example, during the present study, the following is the pest status of noctuid species of respective hosts given in parenthesis:

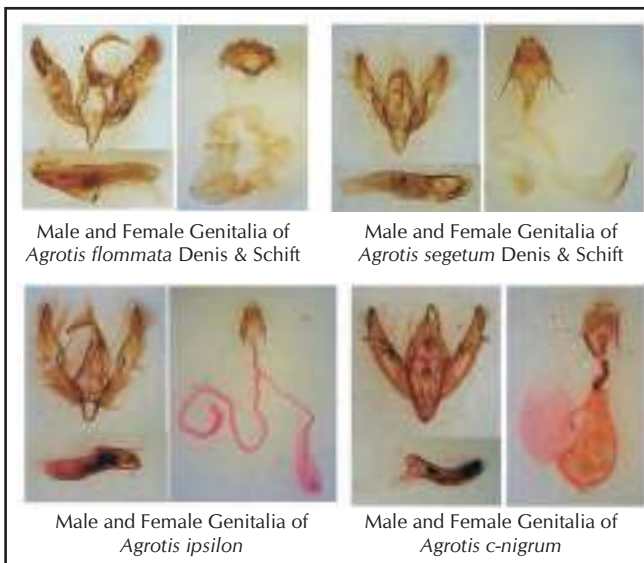


Major pests:

- *Trichoplusia orichalcea* Fabricius (Polyphagous, Herbs of the Deodar forests)
- *Agrotis segetum*, (cutworm of deodar and other conifers, polyphagous)
- *Agrotis ipsilon*, (cutworm of deodar and other conifers, polyphagous)
- *Spodoptera lituro* Fabricius (Polyphagous)
- *Spodoptera cilium* Guenee (Polyphagous)
- *Plecoptera reflexa* Guen. (Major pest of *Dalbergia sisso* in the zone of Chirpine)



Images of Noctuid Moths



Genitalia of Noctuid Moths

Ecological Dynamics of Vegetation Structure and Assessment of Morphological Adaptive Variation to Create Base-line Data in Selected Species in Dalma Wildlife Sanctuary”

A total of 68 Sample plots have been laid out in the sanctuary covering all ranges. Plant specimens are collected and herbaria are prepared. 186 nos. of plant species are identified and authenticated. Few species of elephant food like *Mallotus philippensis* is collected for bark and leaf nutrient estimation. Species identified were: *Kydia calycina*, *Mallotus philippensis*. These species were found extensively in the sanctuary and are third most preferred species for elephants. The variation studies revealed good amount of variation in fruit parameters. Morphological features such as leaf structure revealed five major types of leaf shapes. Bark is also preferred by elephants as food and exhibits three main types. The chemistry of bark content is being investigated through aqueous, petroleum ether or chloroform extraction. The leaves and bark have high water content and recalcitrant- it dries out with in 1 hour. Genetic stability of the species is being investigated under stressed and non-stressed conditions.

Assessment of Phytodiversity Dynamics for Conservation in Jeypore Reserve Forest

Data for phytosociological analysis was recorded from field as per standard methodology. Analysis has been done. Total 185 plant species has been observed. Plant specimens were identified. Herbarium was prepared. Natural regeneration potential of trees was studied. Climatic database, prepared for temperature and rainfall, was collected from different tea estates surrounding the study area, which can be used by researcher in future. Physical and chemical analysis of soil has been done. Training was imparted to target groups. Demonstration of sample plot was done. Targets have been achieved as per action plan of the project. Training on Biodiversity conservation and awareness was imparted to target group and demonstration of sample plots done before ecodevelopment committee members, forest department officials, students and farmers.



2.1.8. Forest Botany

Revision of Indian Woods – their Identification, Properties and uses- Volume – II

The objective of this project was to revise Indian Woods- Volume II by adding microstructure data and upgrading information on properties and uses.

Microstructure features of 23 families along with their microphotographs was studied. Literature on strength properties, uses, durability etc. collected. All the data collected shall be incorporated in writing the second volume of the reference book on 'Indian Woods – their Identification, Properties and uses'.

The project completion report has been submitted. Writing of book is underway.

Study on Wood Anatomy of Indian Shrubs for the Purpose of their Identification and Efficient Utilization.

Due to the ban on tree felling and scarcity of tree wood resources, wood from shrubs is being looked upon as alternate source for many end uses like tool handles, furniture, agriculture implements etc.

Also, stems of many shrubs are being used by pharmaceutical companies for preparation of various drugs. In India, so far, we do not have much information on wood anatomy of Indian shrubs. Thus, for academic purpose also wood anatomical data of Indian shrubs is required.

Since in India, the expertise of xylotomic (wood anatomical) studies is available mainly at FRI, Dehradun, therefore this work can be undertaken here only. Thus, the broad objective of the project is to study the wood anatomical structure of Indian shrubs. The species identification key for Indian shrubs that shall be developed towards the end of the study shall provide an authentic way of wood recognition, thus, leading to their efficient utilization, both in timber and in pharmaceutical industry.

In India, so far, we do not have much information on wood microstructure of Indian shrubs. Thus, the study shall be first of its kind with lot of academic importance. Since in India, the expertise of xylotomy studies is

available mainly at FRI, Dehradun therefore this work can be undertaken here only. The proposed work may bring out some interesting structural patterns present within a family with altogether different anatomy of shrub and trees. This shall reflect upon homogeneity and heterogeneity in taxonomic classification. So far, the studies have been carried out for *Abelia trifolia*, *Leycesteria formosa*, *Pentaphyxis stipulata*, *Solanum erianthum*, *Duboisia myoporoides*, *Ardisia humilis*, *Ardisia involurata*, *Ardisia paniculata*, *Embelia floribunda*, *Embelia ribes*, *Embelia robusta*, *Scleropyrum ridleyi*, *Osyris arborea*, *Melastoma malabathricum*, *Oxypora paniculata*, *Osbeckia crinita*, *Azima tetracantha*, *Salvadora persica*, *Rhodomyrtus tomentosa*, *Psidium guajava*, *Myricaria squamata*, *Woodfordia fruticosa*, *Rosa lechenaultiana*, *R. macrophylla*, *R. moschata*, *R. sericea*, *Rubus ellipticus* and *Rubus lineatus*.

Assessment of Wood Properties and Growth of the Progenies of Different Clones of *Populus deltoides* Bartr. ex. Marsh

The Experimental Site: Study site was located at Rudrapur (Udhamsingh Nagar), Uttarakhand, India. It is situated at around 28°N latitude; 78°E longitude and at the altitude of 200 M. The annual rainfall is 1200 mm; of which 88% occurs during June-August. The average maximum summer temperature (April-June) is 36.7°C and average minimum temperature (December-February) was 7.5°C (2005-06). The soil of the site is sandy loam.

The growth parameters namely tree height and DBH (diameter at breast height) were measured for each individual before the collection of wood samples. Study material was collected from the 130 progenies of *Populus deltoides* raised by WIMCO Plantations Ltd. at Rudrapur (Udhamsingh Nagar), India at the age of 6 years. The wood samples were collected from three, pith to periphery direction to cover radial variations. Each sample contain two growth rings so that it maintain the uniformity of age of the sample.

Cross, radial and tangential sections (15-20µm thick) were cut on Reichert microtome for microscopic examination. The sections were stained in



Heidenhain's haematoxylin and safranin, and mounted following standard laboratory procedure for making permanent slides. The data on vessel frequency (%), and proportion of tissue were taken from cross section.

Small radial chips were macerated for determination of fibre and vessel-length following Schultz's method (30% Nitric acid and a pinch of Potassium chlorate). Data on fibre-length, vessel-length, fibre-diameter and lumen-diameter were taken from macerated material.

Observation on microscopic features of various cell types (%) such as vessel, parenchyma, rays and fibres and vessel diameter were recorded from cross section. The frequency of vessels was determined from the average of 10 counts per mm^2 area. Twenty five counts were taken from macerated samples of each species for vessel, fibre-length, vessel and fibre-diameter.

Basic density of wood samples was determined as the ratio of oven dry weight vs. green volume. The green volume was determined by water displacement method.

The DBH (diameter at breast height) and height of each individual were recorded. Wood anatomical data for fiber length, diameter, wall thickness, vessel element length and diameter for and specific gravity for 88 progenies were determined. The fibre length (μm) ranged between 1077.11 ± 30.17 (progeny no. 173) to 1254.22 ± 47.96 (B-13); fibre diameter (μm) between 22.56 ± 0.19 (progeny no 25) to $(27.22 \pm 1.58$ (W-80); wall thickness (μm) between 3.55 ± 0.69 (B-20) to 7.54 ± 6.25 (progeny no 5); vessel element length (μm) between 461.44 ± 24.60 (progeny no. 129) to 596.22 ± 19.76 (progeny no. 102) and vessel element diameter (μm) between 95.56 ± 2.22 (progeny 173) to 121.22 ± 1.92 (progeny no. 37). The lowest specific gravity was in progeny B-20 (0.33 ± 0.01) and highest was in 125 (0.41 ± 0.01). The data of 21 progenies were analyzed for multivariate analysis. Variations due to replication were non-significant for all the wood traits. Intra-tree radial variations were significant for all the studied wood traits except for fibre diameter. Interaction between progeny replication was non-

significant for all the wood traits except for wall thickness. Multivariate analysis for 50 progenies in three replications were analysed for tissue proportion and fibril angle. MANOVA showed that inter-clonal (progeny of clones) variation in proportion of tissue was significant for fibre (%), ray (%), vessel frequency (mm^{-2}), and fibril angle, whereas, non-significant for vessel (%) and parenchyma (%). Inter-tree variations were non-significant for all the wood traits. Variations were also significant for DBH and tree height among the progenies of clones and non-significant due to replication. It showed that progenies were different for the wood traits. Radial variations indicated the impact of age on the wood properties.

Evaluation of Wood Properties and Growth Performance of *Eucalyptus* hybrids Raised in Multilocational Trials

The growth parameters namely tree height and DBH (diameter at breast height) were measured for each individual tree before the collection of wood samples from FRI 14 and FRI –EH001 hybrids. Wood samples were collected from 18 trees from FRI Campus.

Small radial chips were macerated for determination of fibre and vessel-length following Schultz's method (30% Nitric acid and a pinch of Potassium chlorate). Data on fibre-length, vessel-length, fibre-diameter and lumen-diameter were taken from macerated material. Basic density of wood samples was determined as the ratio of oven dry weight vs. green volume. The green volume was determined by water displacement method.

Anatomical data on fibre length, fibre diameter, wall thickness, vessel element diameter and length and specific gravity were collected from 10 trees of FRI campus. The preliminary analysis showed following results:

MANOVA revealed that both FRI 14 and FRI –EH001 hybrids were significantly different for wood traits.

Vertical variations were recorded for all the wood traits while horizontal radial variations were recorded for all the wood traits except for fibre diameter. Variation due to peripheral direction were non-significant.



FRI-14 showed better wood traits than FRI –Eh 001.

Digitization of FRI (Dehra Dun) Herbarium

- 4814 species details prepared and entered into the database;
- 8405 herbarium specimen details have been prepared
- 4638 have been entered into the database.
- 4638 herbarium specimen details have been incorporated into the database
- 6349 specimen photos have been taken
- 7691 photos have been edited

Study of Reproductive Biology of the Endangered Taxa *Trachycarpus takil* Becc. (Arecaceae), *Mahonia jaunsarensis* Ahrendt (Berberidaceae), *Pittosporum eriocarpum* Royle (Pittosporaceae) and *Eremostachys superba* Royle ex Benth. (Labiatae)

In this project, life cycles of four RET plant species *Trachycarpus takil* Becc., *Mahonia jaunsarensis* Ahrendt., *Cinnamomum glanduliferum* (Wall) Meissn., *Eremostachys superba* Royle ex Benth" are being critically examined in actual forest locations to find out the cause of their poor regeneration and distribution in nature. The four species selected for study are important forest species of India. These are known to show poor regeneration in their native habitat. To conserve these species, *in situ* or *ex situ*, thorough knowledge of their reproductive biology is necessary.

A hand on training was carried out in Delhi University for a month under the supervision of Prof. A. K. Bhatnager, Department of Botany, Delhi University where all the laboratory work and field work related to the project were studied. Several visits have been undertaken to different parts of Uttarakhand to exactly locate and monitor the species belonging to the project. Different tours were conducted for Pithoragarh, Chakrata, Mohand, Champawat, Chaubattiya in Uttarakhand and Jammu and Rajouri in J&K. Soil samples have been collected from all the sites for analysis. Tours were conducted to the above said places again in the flowering seasons from March to May

2012. All the samples such as flowers, buds and fruits have been collected and preserved. Analysis of these preserved specimens have been started.

Reproductive Biology of *Aquilaria malaccensis* Lamk. a Critically Endangered and Economically Important Species for Effective Conservation

Field survey in, Gibbon WLS (Assam); Dimapur, New Besumpuie (Nagaland); Nongpoh, Darugiri, Narengri, Tura, Baghmara, (Meghalaya); Imphal and Moreh (Manipur); Agartala, Trishna WLS (Tripura) were carried out; studies on pollen biology, seed biology from soil seed bank, growth and survivability of new seedlings etc were carried out and results recorded. Pollen and seed viability studies conducted and further monitoring of natural recruitment of seedlings is in progress. Floral samples were processed for embryological studies.

2.1.9. Tribal and Traditional Knowledge System

Ethnobotanical Studies of Northern Part of Eastern Ghats in Andhra Pradesh

During the period under report, extensive field tours were undertaken in the tribal areas of Srikakulam, Vizianagaram and Vishakhapatnam districts and ethnobotanically important plant species with relevant information was collected. Ethnobotanical data on 197 plant species were collected from Savara, Khond, Jatapu, Kondadora, Nukadora, Bagatha and Porja tribes from the study area. A total of 180 plant specimens were collected, made into herbarium and identified. The ethnobotanical data was scrutinized and screened with the help of available literature. During the period of study' lesser known medicinal plants used by the tribes for various ailments viz., *Careya arborea* (for snake bite and antidiarrhoea), *Crotalaria retusa* (for epilepsy), *Drynaria quercifolia* (for bone fracture), *Hygrophila auriculata* (for Jaundice), *Pueraria tuberosa* (for stomach pain) and *Wattakaka volubilis* (for Poisonous bites), were collected.



Ethno-medico-botanical Studies of Khasi, Garo and Karbi tribes

Seven villages i.e. Nongthymmai, Rangkasuna, Nongkhra, Marangr, Umdoh, Ronghona and Jorbil of Ri-Bhoi district, Meghalaya were surveyed and information on the use of medicinal plants by the targeted tribes (Khasi, Garo and Karbi) were collected. Cross cultural studies of targeted tribes were also done. Study revealed that there is decrease in use of medicinal plants for various ailments due to changing socio-economic situation and easily availability of modern medicines. It has been observed that younger generations are not so much interested to learn the traditional knowledge of medicinal plants from their elders. However, villagers use common medicinal plants which are found in nearby houses/ kitchen garden/road side for the treatment of various common ailments such as abdominal pain, burn injury, diarrhoea, dysentery, eczema, gastritis, headache, malaria, piles, toothache, urinary problem, jaundice, cut injury, cough, skin diseases etc. Interested villagers even planted the medicinal plants in their gardens for use. There are three categories of medicinal plants - i) easily available on the road side or in the village ii) planted by the villagers for their use and iii) medicinal plants found in forests. Preparation of detailed list of medicinal plants and their uses by the targeted tribes is in progress. One awareness programme on utilization and conservation of medicinal plants was organized at Umpher, Ri-Bhoi District, Meghalaya. 45 villagers including village headmen, ladies, old persons and young ones were present in the programme.

Studies on Ecological and Ethno-Mycological Aspects of Wild Mushroom of Nagaland

Ethnomycological survey and collection of wild edible mushrooms has been carried out from the selected areas of Kohima, Dimapur, Mon and Mokokchung districts of Nagaland. Till date 88 Nos. of mushroom samples were collected from the survey sites. The collected samples are being analyzed in laboratory for their taxonomic identification. Some of

identified mushrooms include the species of *Pleurotus* (edible), *Schizophyllum* (edible), *Ganoderma* (medicinal) Some saprophytes/ wood decaying fungi are identified as the species of *Polyporus*, *Phellinus*, *Xylaria*, *Pycnoporus*, *Clavaria*, *Auricularia*, *Russula*, Puffball, etc. All details of sites such as topography, forest type, habitat on which mushroom is growing, specific association of fruit body with surrounding trees, herbs and shrubs were documented at the time of collection.



Pleurotus species



Puffball



Xylaria species



Documentation and Inventorization of Indigenous Traditional Medicinal Knowledge of Jharkhand

Sadar, Churchu, Barkatha, Vishnugarh blocks of Hazaribagh district, Barwadih, Garus blocks in Latehar district, Chainpur block in Palamau district, Borio, Banhji and Mandro blocks of Sahibganj Dist. and Dalbhumgarh and Chakulia blocks of E. Singhbhum districts of Jharkhand were surveyed for collection of plant material from forests and herbal practitioners. Indigenous traditional knowledge of Kisan, Kharwar, Karmali, Birhor, Sourya Pahariya, Parhaiya, Manjhi and Sabar tribal groups of Jharkhand was also studied. Plants viz. *Vitex peduncularis* (Nagbael), *Helictres isora* (Aaintha), *Aristolochia indica* (Ishwarmul), *Hyptis suaveolens*, Hathi panjar, Kilo and koraya (*Holarrhena antidysentrica*), *Calotropis procera* (white variety), *Cyperus rotundus*, *Aeratum conizoides*, *Aristolochia*

indica have been collected and preserved as voucher specimens.

Nearly 90 herbal practitioners belonging to Bathudi, Birgia, Birhor, Chero, Karmali, Kharwar, Kissan, Parhaiya, Sourya Paharia and Sabar tribal communities have been interviewed so far regarding the use of medicinal herbs for curing their ailments. The tribes under this project viz. Banjara, Bedia, Bathudi, Bhumij, Chik, Baraik, Chero, Gorait, Karmali, Karma, Kissan, Lohra, Mahli and Sabar are scanty. In consonance with the NMPB's evaluator Sri V.K.Singh views during his visit to this Institute in the month of January 2012, the project has been proposed to be extended for a period of six months upto September 2012 for printing and publication of a book depicting the detailed medicinal habits of the ethnic communities in Jharkhand.

2.2 Forest Productivity

Overview

Productivity of our forests is one of the lowest in the world standing approximately at $1.0 \text{ m}^3 / \text{ha}/\text{year}$ compared to the global average of $3.0 \text{ m}^3 / \text{ha}/\text{year}$. Even, the forest plantations in India, constitute 17 per cent of global population but have the productivity as low as $1.0 \text{ m}^3 / \text{ha}/\text{year}$. At the same time output of the plantations under farm forestry and agroforestry is not high so as to match the productivity figures in other countries—major reason for it being the non-availability of quality planting material.

The proper scientific management of land and forest resources especially in the hills is quite important for achieving the long-term conservation and production needs of the forests. Government of India has declared a moratorium on the green felling and this issue of ban is always taking the back seat while the question of scientific management of the forest resources is discussed across, mainly because of the lack of scientific data behind. In addition to the number of parameters multiplying the problem, enormous congestion due to addition of new recruits and proper scientific management due to lack of data on the assessment of floral components always remains the concern. On the top of it, all these factors have got some bearing on the productivity of forest. Forests may reproduce more successfully when special efforts are made to encourage regeneration. Either artificial regeneration that involves planting seeds or seedlings, or natural regeneration that relies on existing seedlings or seed may be used.

Seeds although take up only a minor proportion of the overall cost of plantation and their management, yet their insufficient supply is often seen as a major bottleneck for carrying out various improvements in the production of planting stock. Even the survival in

various plantation programmes is quite poor owing to the number of factors including the quality of planting stock. The plantations in our country are generally driven by targets. Compromises made during selection of nursery stock for achieving plantation targets have significant effect on survival and growth of man made plantations. Though some morphological parameters have been fixed in case of important tree species for selecting nursery stock for planting, yet they are not adhered to while carrying out the plantations. Often nurserymen/managers get influenced by the targets and make compromises in nursery stock selection to accommodate all available planting material irrespective of its quality. Therefore, fixing up of minimum standards of seedling quality, culling of sub-standard stock in the nursery etc., will definitely result in higher survival and establishment and enhanced productivity.

The effective planning and implementation of afforestation programmes depends on the availability, at all times of sufficient quantities of seeds with right physiological stage and improved genetic quality. The seed must be collected from a genetically proven superior source. Secondly, there must be a continuous checking by testing the physical and physiological characteristics of the seeds. Finally, it is important that seed should be stored until required without losing its germinative capacity and viability. Gujarat state Forest Department has selected seed stands, established several seed production areas, seedling seed orchards and CSOs under planting stock improvement programme. The seeds, thus, obtained have not been tested so far and therefore, a study was undertaken in consultation with SFD, Gujarat to evaluate their established seed sources of important species.

Azadirachta indica, *Prosopis cineraria* and *Tecomella undulata* are very important species in arid



and semi arid regions of western India and play an important role in greening the vast areas of the region. However, seedling parameters viz seed germination, collar diameter, seedling length etc which not only determine the quality of seedlings, but also affect overall production is yet to be done. Similarly, standardization of biofertilizer requirements for several important forest tree species of arid and semi arid areas is lacking. The study therefore, has been undertaken to develop a complete protocol from seed collection to production of quality seedlings for the arid zone of India.

Total 365 seedlots of four species viz; *Acacia nilotica*, *A. catechu*, *Dalbergia sissoo* and *Tectona grandis* were collected for the seed trait studies. Variation in hundred seed weight and germination variation was observed in *Acacia nilotica*, *Acacia catechu* and *Dalbergia sissoo*, collected from the various sources from Gujarat. Seeds of SSO and CSO had higher (2-5%) seed weight and percentage of germination as compared to seed stand. Infrastructure facilities for raising quality seedling in nursery were developed.

Thirty numbers of Candidate Plus Trees (CPTs) have been selected in West Bengal, Bihar and Jharkhand. The photosynthetic efficiency using portable photosynthesis meter and estimation of chlorophyll content on role of seasonal variation and growth regulators has been assessed for clonal propagation. A clonal procedure for *Anthocephalus chinensis* through air layering of mature ortets employing auxin treatment has been evolved. VMG of *Anthocephalus chinensis* and *Bombax ceiba* has been established and its hedging regimes are being standardized.

Planting stock of *Bambusa nutans*, *Dendrocalamus asper* and *Dendrocalamus strictus* are being raised through Tissue Culture and clonal culm propagation at Ranchi, Lalgutwa and Mandar in Jharkhand and 0.50 ha plantation has been raised. About 67 villages and 45 markets were surveyed for

assessment of bamboo shoot producing species, production period and consumption in Jharkhand.

Interactive meetings were held with senior functionaries of HP State Forest Department on various issues pertaining to quality parameters of Nursery Stock of Deodar and Ban Oak in Shimla and Rampur Forest Circles of H.P. Physiological assessment of Deodar and Ban Oak nursery stock, particularly with Root Growth Potential (RGP), was taken up for standardization of parameters for identification of their quality planting stock. The plantation success through wildlings of *Cedrus deodara* has been found to be a critical issue and results are not encouraging till date even after detailed investigations.

The experimental sites established for assessing the various morphological parameters of the nursery stock of deodar and ban oak, in Shimla and Solan districts of Himachal Pradesh (HP) could not perform well because of the less snow fall/rains, resulting in large scale mortality in their experimental plantations –indicating moisture as the triggering factor for mortality.

Increase in the population and over-exploitation, especially of the forest resources for meeting the requirements of the growing populace, the demand for fuel-wood, fodder etc., can no longer be met with from the existing resources. Accordingly, practice of agro-forestry in its true sense is further required to be popularized. No doubt, such practices in India have been known and recognized since time immemorial and are being followed traditionally in different manners all across the country but need to be documented and understood with reference to its ecological, bio-physical and socio-economic aspects. However, agroforestry is gaining importance as land use practice in different parts of the country. In farmlands, the farmers intercrop tree species with many agricultural crops like cotton, soybean, maize, ground nut and many other food plants. The agro-forestry models with *Wrightia tinctoria* R.Br and *Gmelina arborea* Roxb. as tree species with Red gram and



Sorghum as agricultural crops, are being developed in Karnataka.

Ailanthus excelsa, *Ziziphus mauritiana*, *Colophospermum mopane* and *Prosopis cineraria* were planted in agroforestry trials at Bilara, Jodhpur. *A. excelsa* attained maximum height (318 cm) and collar diameter (10.86 cm), whereas *Z. mauritiana* exhibited minimum height (184 cm) and *P. cineraria* minimum collar diameter (6.54 cm). Total dry weight biomass was maximum in *P. cineraria* (14.0 kg/tree) and minimum in *Z. mauritiana* (2.0 kg/tree), whereas root biomass was highest in *C. mopane* (3.87 kg) and lowest in *Z. mauritiana* (0.97 kg/tree). The fodder production was highest in *C. mopane* (3.0 kg/tree) and minimum in *A. excelsa* (1.0 kg/tree).

The establishment of multitier cropping system by raising Aonla intercropped with Arhar and Adrak is in progress at OSR experimental area of Tropical Forest Research Institute Jabalpur and OFR in farmer's field at Neemkheda village, Jabalpur district.

In order to introduce selected genotypes of Karanj, Kusum and Bamboo as tree components in Agroforestry models in lateritic belt of eastern India, 2-year old seedlings of Karanj and Kusum were planted at Lalgutwa and Mandar and a seven-year old bamboo plantation was selected at Mandar in Jharkhand. Five agricultural crops viz., ginger, turmeric, colocasia, black gram and ragi were sown/ transplanted under trees from May to July. Soil samples were collection for analysis. The study is in progress.

In sandy hill pediment land at Bhuj in Gujarat, *Cordia gharaf* and *Cenchrus ciliaris* based silvipastoral system produced maximum biomass, followed by *Zizyphus mauritiana* with *C. ciliaris* after 38 months of planting. Dense grass sowing adversely influenced the tree growth, while scattered grass promoted growth.

Two species of bamboos viz. *Bambusa nutans* and *Dendrocalamus strictus* were selected to establish the bamboo based agroforestry system at experimental area of TFRI Jabalpur and to create the awareness among the

farmers of different villages of M.P. and Chhattisgarh state for the adoption of bamboo in their field.

Assessment of land use practices in jhum areas and investigation of different production related parameters were carried out. Productivity enhancement in abandoned jhum land through agroforestry management and value addition was done. Quality and yield improvement in agroforestry based food product under integrated nutrient management were analysed. Rehabilitation of jhum land through potential bamboo species with reference to carbon sequestration and livelihood development was carried out.

While agroforestry models have been developed for several agricultural crops however, the research on development of agroforestry system with medicinal plants is not adequate. In the context of growing interests among the farmers for cultivating tree species in farmlands, particularly *Casuarina* and *Eucalyptus* and existing potential market for medicinal plants, the study has been initiated to develop suitable agroforestry systems with medicinal plants in Tamil Nadu. Studies on cultivation of the medicinal plants with *Casuarina* and *Eucalyptus* and their compatibility in agroforestry system will open up a new vista and encourage the farmers to practice the system and get more remuneration than intercropping with any other agricultural crop.

Industrially important medicinal plants such as *Asparagus racemosus*, *Cassia senna*, *Decalepis hamiltonii*, *Gloriosa superba*, *Hemidesmus indicus*, *Plectranthus barbatus*, *Withania obtusifolia* and *W. somnifera* were sown in four locations in Tamil Nadu. The seeds of medicinal plants were collected annually and analysed for their properties. The growth parameters of medicinal plants and tree species were recorded and the soil attributes were also estimated. All these medicinal plants have compatibility and suitability under the industrial tree species. The result showed that colchicine content in *Gloriosa superba*, was higher under *Eucalyptus* than other tree species, although colchicine content was high in *Gloriosa*



superba under other species also. Such a medicinal plants based agroforestry project may help to increase the soil fertility and recover the perennial medicinal plants like *Hemidesmus indicus*, *Decalepis hamiltonii*.

Studies on sustainable management of medicinal plants in JFM areas in two agroclimatic zone of Madhya Pradesh were conducted. Germination percentage was improved by pretreatments on *Schleichera trijuga*, *Terminalia arjuna*, *Sapindus laurifolia*, *Terminalia chebula*, *Abelmoschus moschatus*, *Rauvolfia serpentina*, *Embllica officinalis* and *Mimusops elengi*, out of 12 target species.

In the plantation trial on highly saline black silty clay soil of little Ran of kuchchh, *Salvadora persica* proved to be the best species with 83.7% survival after 50 months, followed by *Acacia ampliceps*. Application of FYM and wheat husk favoured better survival and growth.

Preliminary growth data indicated that *Gmelina arborea* performed well on all the study sites in Shimla and Solan districts and has attained an average height of about 250 cm within three years of its establishment. Though very early to predict, yet, it can be a potential species for carrying out future plantations in the lower hills.

Keeping all the above aspects in view, ICFRE is making all out efforts through some research projects so as to suggest specific strategy to the stake-holders.

Projects under the Theme			
Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	10	23	12
Externally Aided	04	06	04
Total	14	29	16

2.2.2 Silviculture

Enhancement of Seed Longevity of *Diploknema butyracea*

Fruits/seeds of *Diploknema butyracea* were collected from four locations viz. Gurna, Jadapani, Harkante and Matela in Pithoragarh FD (Uttarakhand), seed parameters, initial germination, viability, vigour, studies on desiccation sensitivity of seeds done. For storage studies, seeds were desiccated to two moisture levels i.e. 30% and 25%, and desiccated seeds were stored at two temperatures viz. ambient room temperature and 15°C. Seed longevity enhanced to 30 days in undesiccated seeds stored at ambient room temperature. Seeds of *D. butyracea* were categorized as Tropical recalcitrant seeds with lowest safe moisture content of 30%. Seeds sown in nursery in different media and containers and observations on seedlings growth, taken periodically. Better growth (height, collar diameter, vigour index) was observed in seedlings in polybags. Potting media of soil: sand in 2:1 was found to be best for the growth of the seedlings.

Developing Seed Technology and Propagation Techniques for Germplasm Conservation of *Buxus wallichiana*

Fruits/seeds of *Buxus wallichiana* were collected from Matkangra block (Chakrata Forest Division) and also from Mandal forest in Kedarnath Wild Life Sanctuary. Seeds were subjected to stratification, Gibberellic acid, KNO₃ pretreatments for enhancing the germination. Highest germination was 50% in seeds from Chakrata treated with GA₃ (0.01%) for 48 hours. For Mandal seeds it was 77% in GA₃ (0.02%) for 48 hours, treatment. Seed stored at 15°C for one year yielded 26% germination, ones stored at 5°C resulted in 10% germination while seeds at RT did not germinate at all. Thus, seeds of *B. wallichiana* were short lived and orthodox. Propagation experiments for *B. wallichiana* conducted in Deoban nursery (Chakrata). Stem cuttings, treated with 12 combinations



of different concentrations of rooting hormones (IBA and NAA), were kept in mist chamber for rooting. 70% rooting observed in stem cuttings treated with 1000 ppm IBA.

Enhancement of Seed Germination in *Anogeissus latifolia* through Various Seed Technological Inputs.

Seed Maturity indices of *Anogeissus latifolia* have been quantified. Seed handling, germination and storage protocol have been developed. More than 90% emptiness was observed in the seeds of this species. Sucking of sap by insect from fruits during developing stage seems to be one of the causes of the emptiness. Systemic insecticides have been applied in the trees to control the disease during August 2011 with the help of Entomology Division of FRI and seeds were collected from these trees during March 2012. It seems that some insects were responsible for the emptiness of seeds in *A. latifolia*, as more half filled seeds were found in seed collection from treated trees. More intensive study is required to control the fruit sucking insect in the species and should be carried out in Entomology Division of FRI.

Biodiversity Conservation and ecological security: Establishing Germplasm Garden of Some Rare and Endangered Plants

Locations of five species viz. *Catamixis baccharoides*, *Ulmus wallichiana*, *Rauvolfia serpentina*, *Berberis aristata* and *Mahonia jaunsarensis* were identified and collection of propagation material (seeds/ cuttings/wildlings) was done from Chakrata, Hardiwar and Dehradun area for their multiplication and conservation. Wildings of *Catamixis baccharoides* have been successfully established in germplasm garden. Germplasm of *Mahonia jaunsarensis* and *Berberis aristata* have been propagated through cuttings. Accessions from CIMAP have been received and added to the garden. Germplasm of *Ulmus wallichiana* has been collected from Chakrata and Kashmir and plants have been produced successfully through cutting.

Variability Studies on Seed Quality Parameters and Seed Mycoflora of *Bauhinia purpurea*, *Bauhinia semla* and *Bauhinia variegata* for their ex-situ Conservation

In April/May 2011 pods/seeds of *B. purpurea* collected from Saharanpur, Muzaffarnagar and Kanpur in UP, Roorkee, Vikasnagar, Dehradun in Uttarakhand; that of *B. retusa* collected from Tehri and pods of *B. variegata* collected from different locations in Uttarkashi district. Seeds of *B. purpurea* and *B. variegata* from all sources in UP and few from Uttarakhand had high viability while *B. variegata* from Uttarkashi exhibited low germinability and high fungal infection. Variability in pod and seed morphological parameters, moisture content, germination and storability studied. Viability and vigour of seed collections of the year 2009 and the year 2010 also assessed quarterly. Seeds are gradually losing viability and rate is faster in *Bauhinia retusa* seeds. Seeds of *B. purpurea* have maintained 45 – 85% viability after 2 years in storage. Seeds of different species of *Bauhinia* (2010 and 2011 collection) were grown on blotter paper for identifying the fungal isolates. All the sources of *B. purpurea* had *Penicillium* (24) infection followed by *Aspergillus* (23) and *Rhizopus* (8). Most of the fungal isolates belonged to *Aspergillus* sp. and *Penicillium* sp. *Trichoderma* was only present in *B. variegata* from FRI source. Sub culturing of different isolates of fungi was done and maintained on PDA slants.

Influences in Regeneration of Silver Fir (*Abies pindrow*) and Spruce (*Picea smithiana*) Forests -Effect of Natural Leachates on Seedling Growth in Nursery.

Litter, humus and soil samples have been collected from fir and spruce forests in Deoban, Chakarata on monthly basis and soil samples have been analyzed for Total Nitrogen, Available N and Organic Carbon. Leachates of litter, humus, soil and of under-storey plants have been prepared. Seeds of fir and spruce has been collected from Chakrata and sown in nursery at Deoban forest nursery for further experimentation. Application of leachates on fir and spruce seedlings and data recording is continuing.



Allelopathic Potential in Regeneration of Sal (*Shorea robusta*) forests .

Litter, humus and soil samples collected from Sal forests, Dehradun on monthly basis and soil samples analyzed for Total Nitrogen, Available N and Organic Carbon. Leachates of litter, humus, soil and of under-storey plants prepared. Seeds of sal collected and sown in nursery at FRI, Dehradun for further experimentation.

Forest Genetics Resources

Genetic Improvement of *Jatropha curcas* for Adaptability and Oil Yield (Funded by CSIR, New Delhi)

Performance of different accessions of *Jatropha curcas* in unreclaimed sodic soils was found unsatisfactory. At five and half years of age, the plants exhibited poor survival and growth. None of the accessions could record growth rate comparable to plantation of this species on a good site. Seed yield has been negligible. In Dehradun valley, at four years of plantation age, maximum seed yield of 244.80 kg/ha was obtained with application of 2kg FYM+ N10 g+ P20 g +K10 g/Pit, F4/2kg FYM+ N10 g+ P20 g +K10 g/Pit. Pruning at 30, 45 or 60 cm height resulted in production of more number of branches and greater canopy diameter than control. Plants fertilized with 2kg FYM+ N10 g+ P20 g +K10 g/Pit/F4/2kg FYM+ N10 g+ P20 g +K10 g/pit possessed greatest height, number of branches and canopy diameter. Effect of fertilizer irrigation frequency interaction was not significant.

Field Evaluation of Superior Germplasm of *Jatropha curcas* in Uttarakhand as a Part of Multilocation Trial (Funded by DBT, New Delhi)

Trials are being maintained. Growth parameters of different accessions were recorded. Seed production has not yet started at the age of three years.

Establishment of Multilocation Clonal Trial and Study of Wood Anatomical Properties and Cellulose Content of Promising Clones of *Populus deltoides* .

Field trials of 30 clones have been established at four sites i.e. Saharanpur, Ambala, Ludhiana and Udham Singh Nagar districts. Nursery of selected clones has been established again for next year's field trials. Germplasm bank was maintained. Cellulose content of 30 clones have been estimated and wood anatomical studies on 20 clones completed.

Vegetative Propagation of Some Difficult-To-Root Commercially Important Tree Species.

Rooting has been achieved in branch cuttings of *Diploknema butyracea*, *Lagerstroemia parviflora* and *Adina cordifolia*. *Anogeissus latifolia* has not responded to air layering or propagation through cuttings.

Evaluation of *Bombax ceiba* for Seed Sources in Northern India.

Experiment on rooting of branch cutting has been established. Literature is being collected from published sources. Growth and form behaviour of the species has been examined and criteria for selection of trees and stands have been worked out. 10 CPTs have been selected and their cuttings planted.

Nursery Techniques of *Stereospermum suaveolens*

Screening of two provenances of Uttar Pradesh and Uttarakhand of *S. Suaveolens*, where naturally available trees were found, and genetic resources was carried out to elucidate the genetic variation and relationship of pod and seed traits on germination percentage, to select the best planting material for higher productivity. From all seed sources, eight traits viz. pod length, Pod width, 100-pod weight, Seed width, 100 seed weight, seeds per pods and maximum seed length with wings and without wings were studied. Pods and seeds traits correlation studies revealed that irrespective of the pod



characteristics, the seed characteristics, especially the length remained more or less the same. Thus, the seed length and width look to be fairly independent of the pod size for this species.

Also tested germination of seeds with different pre-treatments and vegetative propagation studies with different hormonal concentration.

Conservation and Cultivation of Economically Valuable Lesser Known/Less Utilized Fruits Tree Species and to Determine Possible Chemical Components Present in Fruits

Survey was done of *Spondias pinnata* and *Artocarpus lakoocha* trees/localities in Allahabad district and collection of its fruits done during different months and drying. Fruit and seed parameters studied. Seed germination under nursery conditions with different treatments studied. Vegetative experiments in *Artocarpus lakoocha* and *Spondias pinnata* with different hormonal treatments were carried out. Chemical analysis of *S. pinnata* fruits to determine possible chemical component present in it fruits was also done.

Development of Models for Conversion of Plantations into Secondary Forests in Andaman

Conducted the plantation surveys in North Andaman, Middle Andaman, Baratang and South Andaman and sample plots of 5 ha each in Teak plantations, Padauk plantations and mixed plantations, located adjacent to moist deciduous forests, semi evergreen forests and evergreen forests selected. A total of 12 sample plots of 5 ha each were selected. Each sample plot was further subdivided into 5 plots of 1 ha each for various treatments and control. The species diversity present in sample plots of Padauk, Teak and Mixed plantations has been assessed. Similarly the species diversity in the adjoining forests is being assessed to convert the plantations into secondary forests close to natural profile. The Department nurseries at Mannarghat in South Andaman, Nilambur in

Baratang, Bakultala in Middle Andaman, Tugapur in Mayabunder Division, Aerial Bay in Diglipur Division have been identified for raising the seedlings.

Developing Yield Tables for Short Rotation Tree Crops in Kerala (funded by the Kerala Forest Development Corporation)

The present project aims to develop regional prediction models for constructing yield tables for five fast growing tree crops viz. *Acacia auriculiformis*, *A. mangium*, *Albizia falcataria*, *Eucalyptus pellita*, and *E. grandis* in Kerala. Sample plots were laid out in plantations of *Acacia auriculiformis*, *A. mangium*, *Albizia falcataria*, and *E. grandis* and trees were measured for girth at breast height. The measured trees were grouped into different girth classes. Mean trees for each girth class were felled for actual volume estimation. The parameters like basal girth, gbh, total height, commercial height (height up to 5 cm diameter), and clean bole height were also recorded. The data set on growth parameters will be used for calculating actual volume for both over and under bark volume. The best-fit regression models will be developed for all the five species using easily measurable parameter – girth at breast height and then finally regional yield table will be prepared for future yield estimation of plantations.

Standardization of Pruning Practices and Optimum Doses of Organic and Inorganic Fertilizers to Increase Leaf Surface Area of Tendu

Surveyed and selected sites in Morga, Kotadol and Litipara in Chhattisgarh state, having good quality and high production of tendu, as suggested by M.D. Chhattisgarh State MFP Federation.

Experiments on foliar spray of chemical fertilizers were conducted in Morga to observe the effect of different doses of fertilizers, either individually or in combination, on increment in size of tendu leaves using RBD statistical design. Maximum increase



(16.19%) in surface area of tendu leaves was observed when a combination of 2% nitrogen and 1% phosphorus was applied through foliar spray, which was followed by 1% phosphorus treatment when compared with control.

Experiments on chemical and biofertilizers viz. urea, single super phosphate, vermicompost and neem based biofertilizer on enhancement of quality and sustainable production of tendu leaves were conducted at Morga using RBD factorial design.

Experiments on pruning practices of tendu with treatments including time interval of pruning, height of pruning and girth classes were conducted at Morga using RBD Factorial design.



Conducting Experiment on Foliar Spray of Chemicals at Morga



Collecting Tendu Leaves from Experimental Site

Reclamation of Fly Ash Dykes with Suitable Amendments at NTPC Korba, Chhattisgarh

Surveyed and selected fly ash dykes at NTPC Korba and conducted vegetation survey by Quadrat method in the surrounding forest area for the assessment of native species. The following species communities were found Trees - *Eucalyptus*, *Cassia siamea*, *Cassia fistula* Shrubs - *Lantana camara*, *Phoenix sylvestris*, *Xanthium strumarium* Herbs- *Hyptis suaveolens*, *Cassia tora*, *Triumfetta rhomboidea* Collected fly ash samples and analyzed them for their physio-chemical parameters.

Studies on the Effect of Different Level of Seed Collection on Natural Regeneration of Sal (*Shorea robusta*) in Chhattisgarh

Three sites, Bastar, Raipur and Bilaspur agro-climatic zone were selected and sample plots were laid out to study the effect of different level of seed collection, fire and grazing in pure, mixed and degraded sal forests of Bastar, Raipur and Bilaspur agro-climatic zone. Phyto-sociological studies including regeneration survey of newly recruited seedlings of seed and coppice origin and samplings of sal of all the experiments laid out in pure, mixed and degraded sal forests of Bastar, Raipur and Bilaspur agro-climatic zone had been completed. The experimental results showed that different level of seed collection had positive impact on overall regeneration and recruitments. After eleven months of observations, very low percentage of recruits were observed to survive (6.64%) on uncontrolled grazing site and fire affected sites.

Best recruits status (17.06%) was found to be at the sites with cleaning and loosening of soil practices followed. It was followed by 12.98% at loosened soil site and 11.24% at the sites where undesirable herbs were cleaned.

Studies on Seed Traits of Seeds Collected from Seed Stands / SPAs / SSOs / CSOs of Important Species of Gujarat State

Seeds of *Azadirachta indica* (15kg), *Prosopis cineraria* (10kg), *Acacia nilotica* (5kg), *Acacia*



nilotica var. *cupressiformis* (2kg), *A. tortilis* (2kg), *Ailanthus excelsa* (15kg), *Tecomella undulata* (1kg), *Pongamia pinnata* (2kg), *Salvadora oleoides* (2kg), *Cassia fistula* (5kg), *Capparis decidua* (0.2kg), *Acacia senegal* (5kg), *Lasirus indicus* (100g), *Cenchrus ciliaris* (4kg) and *C. setigerus* (1kg) were collected for seed bank and supply to AFRI-Model Nursery for raising seedlings to be used in research projects and supply to end users. Seeds of *Tectona grandis* (95), *Acacia nilotica* (2), *Acacia catechu* (10), *Dalbergia sissoo* (34) sources were collected during 2011-12 from Gujarat.

A total of 365 seedlots of four target species (*Acacia nilotica*, 14, *A. catechu*, 50, *Dalbergia sissoo*, 83 and *Tectona grandis* 200 seedlots) have been collected over five year period and significant differences observed in 100 seed weight/stone weight and percent germination studies. Seeds collected from seed production area, SSOs and CSOs have higher (2-5%) seed weight/per cent germination in comparison to seed stands. In *A. nilotica*, 100 seed weight varied from 12.60-16.70g and per cent germination from 80-96%. In *A. catechu* it varied from 3.79-5.66 g and 25-84%. In *D. sissoo*, it varied from 1.81-3.75 g and from nil to 63% germination. In teak 100 stone weight varied from 17-60g.

Refinement of Modern Nursery Practices for Raising Quality Seedlings of Selected Important Forest Tree Species of Arid and Semi Arid Areas

Surveyed and selected morphological superior seed trees of *Azadirachta indica* (Neem) and *Prosopis cineraria* (Khejri) in and around Jodhpur. Seeds were collected from the selected trees of *P. cineraria* and *A. indica* and depulped and dried for nursery studies. 100 seed weight of Neem and Khejri varied from 11.80g to 19.88 g and 4.47 to 4.66 g, respectively. Different potting mixtures were prepared. Seed sowing of *P. cineraria* was carried out in the mother beds. Infra-structures (Root trainers/shade house with sprinkler facilities) were also developed.

Determination of Morphological and Physiological Quality Parameters of Nursery Stock of Deodar (*Cedrus deodara*) and Ban oak (*Quercus leucotrichophora*)

Raised and maintained nursery stock of Deodar and Ban Oak at Model Nursery, Shimla and Shilly nursery, Solan respectively. Experimental plantations, as carried out as per the morphological parameters of these species during August 2008 & 2009 in Shimla and Solan districts of Himachal Pradesh, were maintained. To achieve first objective of the project, survey was done through interview and a structured questionnaire was developed for that purpose. It was found that only one physical parameter was adopted in the SFD's nurseries for measuring the quality of Deodar and Ban Oak nursery stock *i.e.* height (shoot length) of the nursery stock. Owing to very less snow fall/rains during 2008 and 2009 followed by continuous drought like conditions during summer resulted in large scale mortality in experimental plantations of these species. Initiated studies for judging quality of Deodar & Ban Oak nursery stock based on Root Growth Potential (RGP).

During the year, the quality planting stock of Deodar (5,000 no.) and Ban Oak (20,000 no.) was maintained at Model Nursery Shimla and Shilly nursery Solan respectively. Work on physiological assessment of Deodar and Ban Oak nursery stock continued, particularly with Root Growth Potential (RGP) trials and also fresh trials, laid out in the nursery pertaining to physiological parameters. Experimental plantations done during 2008 and 2009 in Shimla and Solan districts maintained and data pertaining to survival and growth recorded. The trails repeated in gunny bags also, maintained and data recorded regularly.

For achieving one of the major objective of the project successfully, organized 2 no. interactive meetings with senior functionaries of HP State Forest Department on various issues pertaining to quality parameters of Nursery Stock of Deodar and Ban Oak in Shimla and Rampur Forest Circles of the state.



Out Planting of Deodar in Gunny bags

during August 2010. Tall plants were raised in the nursery in big containers such as gunny bags, plastic containers etc and subsequently maintained.

During the year 2011, finalized one additional site for pilot scale experiments near Shillaru in Shimla district. Field and nursery trial as established earlier were maintained properly, including carrying out the out planting of tall plants raised in gunny bags/ plastic containers, carried during August 2011. Nursery studies continued for raising tall plants of Deodar. Survival data recorded on regular basis for both nursery and field trials. The plantation success through wildling



Interactive Meeting on Quality Parameters of Nursery Stock of Deodar and Ban Oak



Raising of Deodar Tall Plants in Nursery

Development of Techniques for Raising Deodar (*Cedrus deodara*) Plantations through Tall Plants

Pilot scale experimental plantations of Deodar planted on the basis of height and root collar diameter classes, as established during August 2008, February 2009 and repeated again during August 2009 and August 2010 were maintained in the field intensively. Experiments were also carried out as per Root Exposure Time and Root Dessication Protecting Substances, while extracting and planting wildling directly in the field as well as in the nursery in gunny bags. The data pertaining to field survival recorded regularly and the initial results recorded were not found encouraging except for the experiments with the wildling repeated



Out Planting of Deodar Tall Plants in the Field



is still a critical issue and results are not encouraging till date. Nursery experiments for raising tall plants in gunny bags and plastic containers are still continuing at Model Nursery Shimla and Shillaru nursery.

Studies on Seed Germination and Longevity of *Abies spectabilis* (D. Don) Spach

This project was initiated from April, 2011 only and during this period, extensive surveys were conducted for identifying the natural population of *Abies spectabilis* in five Forest Divisions in the state of Himachal Pradesh. As a result of the survey, identified nine natural populations of *Abies spectabilis* in Churdhar area of Sarpet Beat in Nohradhar Range of Shimla Wild Life Division, Budhavan and Chowagor area of Tosh Beat in Kasol Range of Parvati Forest Division, Rahla area of Kothi Beat in Manali Range of Kullu Forest Division, Ula kanda area of Ula Beat in Kalpa Range and Chot Kanda area of Nichar Beat in Nichar Range of Kinnaur Forest Division, Uchpago area of Chhitkul Beat and Barda Kanda area of Rakchham Beat in Sangla Range of Sarahan Wild Life Division, Dangiabe area of Yangpa Beat in Katgaon Range of Sarahan Wild Life Division. The data pertaining to geographical coordinates of the identified sites i.e., altitude, latitude and longitude along with associated species of *Abies spectabilis* recorded. The soil samples were collected from the identified sites and analyzed in the laboratory for soil pH, organic carbon, moisture content, electrical conductivity, nitrogen and potassium content to know the site characteristics of the identified locations. The cones of *Abies spectabilis* were collected from the two identified locations i.e., Chhitkul and Churdhar forest and seeds were extracted from the cones. The morphological data of the cones and seeds i.e., cone length, cone width, cone weight, specific gravity of the cones and seed length, seed breadth, 100 seed weight and moisture content of seeds collected during the period, recorded. The nursery beds prepared and seed germination trials laid out in the laboratory and nursery.

The seed storage trials also initiated by using different storage containers and storage environment and germination and viability data recorded.



Churdhar, Shimla
Wild Life Division



Rakchham, Sarahan
Wild Life Division



Yula, Kinnaur
Forest Division



Chhitkul, Sarahan
Wild Life Division

Natural Populations of *Abies spectabilis* in Himachal Pradesh

Integrated Strategy for Evaluation of Indigenous Fast-growing Multipurpose Trees of Eastern India for Plantation Forestry

Selection and screening of kadamb and semul seed sources in Bihar, Jharkhand and West Bengal; and standardization of propagation packages for mass production of superior planting stock is significant for employment of these species in plantation forestry.



Air layering protocol for clonal multiplication of mature ortets has been standardized in *Anthocephalus chinensis* and *Bombax ceiba*.

Edible Shoot Production of Selected Bamboo Species and Extension of Shoot Production Period Through Cultural Practices

A total of 67 villages and 45 markets have been surveyed in Jharkhand and information on quantity of edible shoot consumed by villagers, species used, persons engaged in collection, self bamboo utilization, quantity marketed, persons involved in shoot trade, average quantity sold and earnings etc. have been collected. Conducted field trials on shoot production period and yield of the species by improving soil health through soil working, mulching, irrigation and organic and inorganic amendments and also through clump management. Effect of shoot removal at different intensities have also been studied on quality and quantity of edible shoot production and on the general health of the clumps of the said species so as to standardize shoot extraction method.

One day Workshop (30.08.11) on 'Cultivation of Bamboos for Edible Shoot Production and Processing' and a Five days' Training (25.07.11 to 29.07. 11) on 'Bamboo Propagation, Cultivation and Management for sustainable Livelihood' for farmers were organized at IFP Ranchi.

2.2.3 Social Forestry, Agro-forestry/ Farm Forestry

Development of Model of Some Important Medicinal Plants with *Melia composita* and *Emblca officinalis* in Degraded Land of Punjab and Uttarakhand

Review of literature work has been done from the library on Agri-Silvi-medico agroforestry systems. Surveyed and selected the sites at Handesra, district Mohali of Punjab and Naukra grant (Buggawala), district Haridwar of Uttarakhand and discussed with the

farmers for site preparation and Agri-Silvi-Medico agroforestry research activities in their farm land in Punjab and Uttarakhand. Developed both the sites at Handesra (Punjab) and Naukra grant (Buggawala), Uttarakhand. Raising and maintenance was done of *Melia composita* seedlings in central nursery and medicinal plants procured. Soil samples were collected from both the sites and their analysis is in progress. Data were also recorded on village profile from Handesra (Mohali) and Naukra grant, Buggawala (Haridwar). The work is in progress.

To Study the Timber Markets of Important Agro forestry Species in Eastern Uttar Pradesh

The survey has been done in identified villages of the districts of Bahraich and Barabanki and market places as saw mills, industries, contractors and middlemen for providing information to traders and growers on selected agroforestry species. The preparation of database is in progress. The data compilation has already been done for two districts- Raebareilly and Allahabad for traders and growers information having marketable timber under agro forestry for selected species.

Development of Site Specific Medicinal Plant Based Agro-forestry Models for Existing Plantations in Eastern Uttar Pradesh and Establishment of Demonstration Model

Site has been selected at experimental trials of medicinal plants with the tree crops of mango, Aonla, Mahua, Bamboo and Eucalyptus in Allahabad district. Procurement of propagules of Sarpagandha, Pachauli and Satawar and Kalmegh was got done from CIMAP, Lucknow. A nursery for propagation of medicinal plants has been established and agroforestry experiment has been laid out.

Evaluation of Potentials and Constraints of Agroforestry Development of Uttarakhand, based on Econometric Analysis

Collection of literature is in progress. Development of data collection tools/questionnaire has been



completed and their testing in the field is in progress. Locations of agro forestry trials were identified with the help of secondary data/information. Data were collected from Haridwar district.

Introduction and Evaluation of Fast Growing Tree Species under Agroforestry Systems in Different Agro-climatic Zones of Tamil Nadu

Agroforestry systems with fast growing tree species were established, over 15 ha farm land in three agroclimatic zones (Northeastern, Cauvery delta and Southern zones) of Tamil Nadu with tree species viz., *Melia dubia*, *Gmelina arborea*, *Neolamarckia cadamba* and *Sweitenia macrophylla* over 5 ha each in three zones.

Intercropping activities carried out and the biomass and yield of annuals of various species (as intercrops) has been assessed. From the intercropping activities carried out in the first year, *M. dubia* with Turmeric registered highest net annual returns of ₹ 1,25,700 followed by *G. arborea* with Banana (₹ 41,550), *M. dubia* with Tapioca (₹ 32,468) on per ha basis. Allelopathic study has been conducted with the exudates prepared from the fast growing tree species leaf, stem and root and study completed in Maize, Sorghum and Black-gram. One training has been conducted on 'Capacity building on agroforestry



Establishment of Agroforestry System with *Melia dubia* and Sorghum under Farmers' Field in Northeastern Zone of Tamil Nadu



Establishment of Agroforestry System with *Melia dubia* with Castor under Farmers' Field in Northeastern Zone of Tamil Nadu.

Establishment of Agroforestry System with *Melia Dubia* with Groundnut under Farmers' Field in Northeastern Zone of Tamil Nadu.

plantation establishment and management' to farmers' of Pudukottai district.

Improving Productivity of Bamboo Cultivation in Farmlands of Tamil Nadu (funded by National Bamboo Mission (NBM), Government of India)

Nine bamboo field trials have been established over three ha, each spread over 3 agroclimatic zones of Tamil Nadu, to standardize the silvicultural practice. During 2011–12, maintenance of these trials were carried out. In addition, 10 ha. of bamboo germplasm bank with 33 species and 85 accessions and bamboo multiplication garden with 23 species and 57 accessions were established under the project at IFGTB Field Station, Kurichi, Coimbatore.

Development of Elite Planting Material and model Plantation (funded by NOVOD board)

The project aims at raising 50 ha of Neem and Pungam model plantations. Around 12,500 Neem and 12,600 Pungam seedlings were raised during 2010-11 under the project. During 2010-11, 10 ha of model plantations were established at Salem (4ha) and Coimbatore (6 ha) During 2011-12, 15 ha of Pungam plantations have been established in 40 ha land offered by Tamil Nadu Magnesite Limited (TANMAG), Salem – a Government of Tamil Nadu undertaking. In principle,



approval for a sum of Rs. 3.55 lakhs has been granted by M/S Tamil Nadu Magnesite Limited (TANMAG), Salem towards the maintenance of model plantations of Neem and Pungam.

A Value Chain on Industrial Agroforestry In Tamil Nadu (funded by ICAR)

In order to demonstrate the potential of the genetically improved planting materials, demonstration plots of Eucalyptus over 20 ha and Casuarina over 15 ha have been raised. 16 high yielding clones of Eucalyptus developed by IFGTB have been used. In Casuarina, superior seedlots from seed orchards and clones of *Casuarina junghuhniana* and Casuarina hybrids have been used. In order to develop new generation planting material and to increase the use of genetically diverse material in the planting programmes, 9 clonal trials have been laid with 70 clones of *Casuarina junghuhniana* and 4 hybrid clonal trials have been laid with 26 *Casuarina equisetifolia* x *C. junghuhniana* hybrids. One hybrid of *Eucalyptus tereticornis* x *E. grandis* has also been identified for mass propagation and planting.

Development of Agroforestry Models in *Wrightia tinctoria* R.Br and *Gmelina arborea* Roxb. as Tree Species in Semi-arid Tropics of Andhra Pradesh.

Most of the physical targets set out for the project were met during the period under report. Cultivated the Redgram and Sorghum crops and recorded the yield data. *Wrightia tinctoria* and *Gmelina arborea* tree crops are maintained. Meanwhile pot culture and bioassay experiment is being conducted in the FRC nursery to see allelopathic interactions.

Development of Multitier Cropping (Silvi-Agri-Spice) system

Identified and selected two study sites as an OSR experimental area of TFRI and as an OFR in farmer's field, Neemkheda village, Jabalpur district to establish the multitier cropping system by raising Aonla intercropped with Arhar and Adrak. Preliminary

cultural operations like clearing, weeding, ploughing, levelling of field, basal dressing with Farm Yard Manure were done. Procured and transplanted two varieties of *Phyllanthus emblica* (Aonla) viz. NA7 & NA 10 at the spacing of 10m x 8m and 10m x 6m intercropped with *Cajanus cajan* (Arhar) in Factorial RBD. The data on nutrients study revealed that Organic matter, available macro nutrients (N, P, K) were in medium range except available phosphorus which was very low in both the field i.e. Farmer's field as well as in research station. The growth parameter of NA-7 Aonla plants (one year old) shows a regular increase in mean height (minimum 86 cm to maximum 114.30 cm at 10m x 8m, whereas, NA10 is performed minimum 93.60cm and maximum 172.10 cm along with agriculture crop in the study sites.

Development of Lac Based Agroforestry (Silvi-Agri-Lac) System

Surveyed the local area for the selection of farmer's field to establish the OFR under the project. Saplings of two species of Lac host viz. *Flemingia semialata* and *Flemingia macrophylla* were procured from the Natural Resin and Gum Research Institute (Jharkhand) Namkum, Ranchi and transplanted in the OSR and OFR, selected as two study sites under the project. For the estimation of physical properties and nutrient status of land, soil samples were collected and analysed. Observation on growth and survival of both the species were recorded. Data on growth parameter were recorded and *F. macrophylla* shows better maximum (250cm and minimum 90 cm), whereas, *F. semialata* shows maximum height 150cm and minimum 60 cm after one year of its plantation. The soil samples were collected and analysed for the estimation of Macro nutrients and physical properties (pH; 6.9 - 7.4, EC; 0.049 – 0.062 and OM; 0.28 - 0.39) of the sites. Data showed that the macro nutrient like Nitrogen 94.08 to 188.16kg/ha, Phosphorus 7.74 - 10.32 kg/ha and Potassium 79.21 – 130.40kg/ha, Ca^{++} - 10.02-26.8 and Mg^{++} - ranged 8.8 - 20.0 after one year of plantation.



Assessment of Land Use Practices in Jhum Areas and Investigation of Different Production Related Parameters

Geo- coordinate of the land Use System were collected and mapping was done for Tipi watershed (Arunachal Pradesh) with use of different GIS tools. Data sheets were prepared for information regarding prevalent Land use systems in Tipi watershed. The different types of existing LUs were identified i.e. home garden, fisheries, settled cultivation areas. Yield parameters for the prevalent seasonal crops



Socio-economic Survey



Estimation of Crop Production

were studied through quadrat methods. The soil samples of the Watershed area were also collected and analyzed.

Productivity Enhancement in Abandoned Jhum Land through Agroforestry Management and Value Addition

The trials were maintained for second year experimentation in the two sites in Kawnpui (Mizoram) and Baljek Aduma (Garo hills, Meghalaya). Market Survey was conducted and data collected from farmers as well as from local markets for exploring pattern of demand and supply for important farm products. Designing and layout of site specific agroforestry models under existing land use types were laid out in three types i.e. traditional, participatory and scientific patterns. The farmers have shown their preferences and motivation towards the scientific method of practices which is also positively correlated with the direct and indirect benefits out of it. In support of scientific interventions, a low cost vermicompost unit and water harvesting pond were also set up at the two sites. First rotation of *Jhum* produce was collected (Snake guard, *Solanum* spp (local breed), Pumpkin, Cowpea etc. and under progress paddy) and their yields estimated accordingly. The site-specific on-farm trials – appropriation of suitable plantation geometry and tree – crop association studies are under progress.



Application of Organic fertilizer: Scientific Approach



Rain Water Harvesting for Irrigation Purpose at Trial Site



Bamboo Check Gate for Soil Conservation



Jhum Produce Participatory Approach

Quality and Yield Improvement in Agroforestry Based Food Product under Integrated Nutrient Management

Several soil samples have been collected from different agro-climatic zone of Assam (Total 9 places) with plant samples like Lady's finger, Bitter gourd, Cucumber, Spine gourd etc. for iodine estimation. Field trail for iodine bio-fortification in bamboo based agro-forestry crops (Lady's finger & Radish) has been established in Satra, Jorhat while two Arecanut based agro-forestry trial site in Dharapur (Kamrup district) and Khanikor gaon, Sarupathar (Golaghat district) also established. The Chemical treatment of KIO_3 & KI (1,2,3,4,5 mg/kg) has been done on the vegetables as foliar and soil. Simultaneously, a pot experiment has also been established in RFRI on spinach plant. The analysis of pot experiment is under progress. The Iodine content of some collected vegetables and soil samples have been analyzed. The physico-chemical properties of soil samples like moisture content, Organic carbon, pH have also been analyzed. Comparing the control, the Iodine value of Lady's finger has increased after treatment of 3,4,5 ppm but it was not significant in case of 1 and 2 ppm. When the vegetable was treated with KIO_3 , the value of Iodine increased as compared to the value of KI . Both the soil and foliar application, the Iodine value varied.



Trial Field at Dharapur, (Kamrup District)



Trial of Rabi Crops (Raddish) at Satra, Jorhat

Development of Economically Viable and Integrated Agroforestry Models for Arid Region

Agroforestry model was maintained at farmer's field at village Harsh, Bilara, District - Jodhpur. *Sesbania aculeata* (Dhaincha) was grown during the year in the field for green manuring. Survival, growth and biomass production data were recorded, compiled and analysed. Performance of *Cordia mixa* was found the best out of horticultural species and *Prosopis cineraria* of silvicultural species.

Ailanthus excelsa plants attained maximum height (318 cm), followed by *Colophospermum mopane* (293 cm), *P. cineraria* (256 cm) and *Cordia mixa* (251 cm), whereas, *Z. mauritiana* attained minimum height (184 cm). Similarly, collar diameter was found maximum in *A. excelsa* (10.86 cm), followed by *C. mixa* (8.39 cm), *C. mopane* (7.22 cm) and *P. cineraria* (6.54 cm). The plant height and collar diameter of *C. mopane* and *P. cineraria* and height of *Ailanthus excelsa* and *Cordia mixa* were significantly ($P < 0.05$) higher in agroforestry plots as compared to the control (without crop). Wheat crop could not be grown by farmers due to lack of irrigation water at site.

One tree of the each species in agroforestry and control plots were felled and uprooted for biomass and root study at the age of six years. *P. cineraria* tree exhibited highest total dry biomass (14.018 kg per tree),

followed by *C. mopane* (13.277 kg per tree), *A. excelsa* (11.378 kg per tree) and *C. mixa* (7.114 kg per tree) in the agroforestry plot. The lowest biomass production was obtained in *Z. mauritiana* (2.067 kg per tree), in the agroforestry plot. The total biomass was reduced by 51%, 78%, 91%, 52% and 64% in *P. cineraria*, *C. mopane*, *A. excelsa*, *Z. mauritiana* and *C. mixa*, respectively in control plots as compared to agroforestry plots. Fodder production (leaf dry biomass) was highest in *C. mopane* (3.046 kg per tree), followed by *P. cineraria* (1.077 kg per tree) and *A. excelsa* (1.038 kg per tree) in agroforestry plots, whereas, fodder production of these species in control plots was reduced.

Root dry biomass was highest in *C. mopane* (3.875 kg per tree) and lowest in *Z. mauritiana* (0.957 kg per tree) in agroforestry plot. Root biomass was less in control plot of each species as compared to agroforestry plots. The primary and secondary roots of *P. cineraria*, penetrated vertically deep in soil. In *P. cineraria* an interesting and prominent feature was that secondary roots were initiated below 50 cm depth as compared with just below the soil surface in other species. The primary and secondary root of *A. excelsa* and *Z. mauritiana* extended in umbrella shape, whereas, roots of *C. mixa* and *C. mopane* expanded on the long distance around each direction below the soil surface of 25 cm in agroforestry plots as well as control plots. Large variation in rooting depth was observed in various species.

Identification of Extent of Forest Lands in Forest Fringe Villages (Funded by NRAA)

This NRAA funded project started in the month of October, 2011 with the objective of Socio-economic survey and ecological studies in forest fringe villages situated within 1 km range of forest. Complete survey work was to be carried out in 24 districts of Rajasthan and Gujarat (12+12) and in each district, 61 villages and within each village, 12 households were to be surveyed. To carry out this survey work, a questionnaire was made and printed. Tours for survey work



Forest Near Khachan Village in Kotra Tehsil, Udaipur



Dob Village in Jhadol Tehsil Central Udaipur



Bitta Village in Jhadol Tehsil



Khachan Village in Kotra Tehsil



Boslathi Village in Kherwara Tehsil

Socio-economic Survey and Vegetation Studies in Udaipur District of Rajasthan

started in January, 2012 and 61 villages of Udaipur district and 14 villages of Pali district were surveyed. For the selection of household in a village, three different categories were made; affluent, medium affluent and non-affluent on the basis of income of family, number of livestock, agriculture land holding, type of house etc. and from each category household were surveyed in a fixed ratio and for vegetation study, three different sizes of square plots (31.62 × 31.62m, 3 × 3m, 1 × 1m) were laid out in forest. Its GPS location were noted and observation on trees, shrubs, and sapling and herbs and seeding were recorded. Following observations were coming from the survey work: majority of farmers have approx 0.25 ha land holding, grow wheat, maize and chick pea as major crop, source of irrigation is rainfall or well, having approx 4-5 livestock, majority of villages have primary school. Regarding ecological study mainly; *Butea monosperma*, *T. grandis*, *P. juliflora*, *P. sylvestris* were

found whereas, among understorey plants, *Cassia tora*, *Euphorbia caducifolia* and *Zizyphus numularia* were observed commonly.

Introduction and Performance Trials of *Gmelina arborea* for Agroforestry in Lower Hills of Himachal Pradesh and Jammu & Kashmir

Procurement of seeds from five different locations was accomplished through Institute of Forest Productivity, Ranchi. Field Research Stations of the Institute at Johron (Paonta Sahib) and Bir Palasi (Nalagarh) representing the Low Hill Zone had been used for planting stock production. After field survey, four sites in lower hill zone at Puruwala and Kot in HP and Nudh and Basanterbella in J&K measuring, 0.5 ha each had been identified and experimental trials, following RBD design with three replications were established. Preliminary growth data indicated that the *G. arborea* was performing well on all the study sites.



Though quite early to predict, yet *G. arborea* may be a future planting species for the lower hills keeping in view its short rotation period.

Keeping this important factor in view, two trainings cum demonstration programme on, "Nursery and Plantation techniques of *Gmelina arborea*" for the ultimate benefit of front line staff of the State Forest Department, farmers, Mahila Mandals, members of VFDCs etc were organized at Sambha in district Kathua (J&K) and at Kayarda in district Sirmour of Himachal Pradesh.

Enhancement of Soil Carbon and Nitrogen Sequestration Potential of Mined/Overburden Soils in Jharkhand through Management Practices

Two coal mine overburden sites, viz., Khilaris Coal mines (CCL, Ranchi) and Sikini Coal Mines (owned by private licensee) were selected for the study. Nursery established for seedlings production for planting at overburdens.

Soil samples were collected from the overburden soils and physio-chemical properties were analysed. Pot trial experiment is in progress with four tree species in the Khilari overburden soil, which is reclaimed by vermicompost and green manuring. As bulk density of the overburden soil is high, 50% of sand was added to the overburden soils. Performance of species with respect to germination and growth are being recorded.

Introduction of Selected Genotypes of Karanj, Kusum and Bamboo as Tree Components in Agroforestry Models in Lateritic Belt of Eastern India

Two-years old seedlings of Karanj and Kusum were used for tree plantation. Seedlings of Kusum & Karanj were planted at Lalgutwa and Mandar, respectively in the month of May. Seven-year old plantation of bamboo was selected for agroforestry at Mandar. Five agricultural crops viz., ginger, turmeric, colocasia, black gram & ragi were sown/ transplanted under three tree components from May to July. Analysis of soil samples is in progress.

2.2.4 Forest Soils & Land Reclamation

Bioremediation of Bauxite Residue through BGA/ bio-inoculants

Bioremediation is a low cost and environmental friendly technique which uses plants and microbes to clean up moderately contaminated areas and problematic soil. Bauxite residue (Red mud) is an industrial waste by-product of Aluminium industry. Under this project, HINDALCO was visited for surveying the Red Mud Production. Red Mud is being produced as by - product during the Alumina extraction through Bayer Process. HINDALCO dumps red mud after drying process called dry stacking of Red Mud in nearby area close to the forest. Red Mud Samples were collected from HINDALCO and analyzed. Effect of bioinoculant in the bioremediation of red mud has been studied. Promising cyanobacterial species were identified for bioremediation of Red Mud. The effect of these promising cyanobacterial species in combination with other bioinoculant amendments was also studied. The effect of these combinations on the growth performance of selected plant species has been studied in pot experiment and suitable species were identified as per their growth performance on Red Mud medium, amended with promising cyanobacterial species and other bioinoculants. A field trial of seedlings of selected species inoculated with promising cyanobacteria and bioinoculants was established at artificial Red Mud pond at Research Nursery, Padilla, Allahabad and performance was recorded. Methodology for bioremediation of Red Mud pond was developed. The developed methodology may be used to solve the ever increasing environmental problems related to Red Mud storage and disposal and facilitate the revegetation of red mud ponds as well.

Phytoremediation of Water Logged Waste Land through Biodrainage and Soil Amendments

Irrigation potential has been increased in recent years for the increased and sustained yield of agricultural products. The introduction of canal



irrigation has caused a rise in ground water table leading to water logging and secondary salinisation. Presently, about one-third of the world's irrigated area is facing the threat of water-logging. About 4981.43 sq Km area in Uttar Pradesh is suffering from water-logging resulting in reduced productivity. The present study is aimed to phytoremediate the waterlogged/high water table area through plantation of Biodrainage Species. Water logged site of eastern U.P. has been surveyed and nursery of selected species viz. *Acacia nilotica*, *Terminalia arjuna*, *Syzygium cuminii*, *Eucalyptus sp.* and *Trewia nudiflora* has been raised. Maintenance and management of the nursery carried out. Survey and selection of suitable waterlogged site near Sharda Sahayak Khand canal side for experimental trial and SWOT analysis was done at the selected site. Suitable observation wells near selected waterlogged sites were selected and marked for monitoring of water table. Regular monitoring of water table in observation well was done. Collection of soil samples of selected site was also done for analysis. Soil analysis is in progress along with preparation for establishment of experimental trial at selected site.

Relative Effect of Geology, Vegetation and Climate on soil Formation of Uttarakhand

Uttarakhand forest of North Western Himalaya is a confluence of all the rock formations resulting in different soil and vegetation types on different climatic zones. The importance of geology in forestry research is of great significance in evaluating the soil fertility status and in managing the soil for greater production.

Surveyed the area and collected the soil and rocks samples from Dehradun, Tehri Garhwal, Pauri Garhwal, Uttarkashi, Chamoli, Rudraprayag and Nainatal districts of Uttarakhand under different natural forests. The soils are generally acidic to neutral in nature with pH increasing with depth. It has been observed that *Spruce/Fir* flourishes very well on schist, gneiss, phyllite and slate under mountain soils and brown hill soils. *Cedrus deodara* grows very well on

limestone, dolomite, quartzite, slate, schist and phyllite under forest brown hill soil group. *Quercus leucotrichophora* grows very well on limestone, slate, shale, quartzite and phyllite.

The major soil groups found in these locations are sub montane and brown hill soil occurring on different parent material. It has been observed that *Pinus roxburghii* flourishes very well on limestone, dolomite, quartzite, shale and slate. The major soil groups found in these locations are forest brown hill soil. It has been observed that *Shorea robusta* flourishes well on limestone, dolomite, sandstone conglomerates and shale and the major soil group found in these locations are brown hill soil. Miscellaneous forest grows well on limestone, shale, slate, quartzite parent material and soil group found in these locations under these species are brown hill soil and skeletal soil.

Present study 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 completion report is under preparation.

Soil Organic Carbon Store under Different Land Uses in Haryana

Intergovernmental Panel on Climate Change has recognized soil organic carbon pool as one of the five major carbon pools for LULUCF sector. It is mandatory to all nations to provide soil organic carbon stock and changes in the stock of their forests in LULUCF sector under Nation Communications to the UNFCCC.

No systematic study has been undertaken to estimate the soil organic carbon in Haryana by following uniform methodology for field and laboratory work as per IPCC. This project will generate the authentic and scientific information on the assessment of soil organic carbon stock under different land uses in Haryana and which will serve as benchmark information for the future investigations to



ascertain the changes over a period of time on this very important aspect of climate change.

During this year, field work in Jind, Fatehabad, Sirsa, Kaithal, Kurukshetra, Karnal, Panipat and Yamunanagar district of Haryana was carried out. Sites were selected in different forest ranges in forest divisions of above said districts and in different blocks and collected soil samples. Selected the sites at different locations in all the above districts and soil samples were also collected from other various land uses *i.e.* block plantations, horticulture and agroforestry. Overall, 1246 soil samples were collected which include 378 samples from forests, 336 samples from block plantations, 280 samples from horticulture land use and 252 samples from different models of agroforestry.

All the collected soil samples were processed in laboratory for carbon, bulk density and coarse fragment and analysed for soil organic carbon during this period. Estimation of bulk density and coarse fragment were completed in all collected samples. In this project, up to field work in Bhiwani, Fatehabad, Jhajjar, Jind, Kaithal, Kurukshetra, Mahendragarh, Rohtak, Sirsa, Karnal and Yamunanagar districts of Haryana, has been completed.

Assessment of Soil Quality Indicators for Different Forest Stands in Uttarkashi District

Soil quality assessment is invaluable in determining the sustainability of soil management practices. It identifies problem areas and assesses differences between management systems and is valuable to measure the sustainability of land and soil management systems at present and in the future. Maintenance and improvement of soil quality is also a prime concern.

The study will provide information on the distribution of nutrient status, organic carbon content, soil physical and chemical properties. Poor sites will be identified which will help the local people as well as scientific researchers in identifying the new sites for plantation development. Soil quality index may be

inferred from various soil indices derived from physical, chemical or biological attributes that reflect its condition and response.

Literature has been collected on the relevant subject for the project. Reconnaissance survey of the study site has been made. Visit to Naugaon, Barkot, Radi, Silkyara, Hanuman Chatti, Janki Chatti, Uttarkashi and Yamunotri (Upper Yamuna and Uttarkashi Forest Division), Uttarkashi district made and soil samples collected from Chir, Oak, Deodar & Spruce and Fir forest stands from three sampling points at pre determined depth *i.e.* 0-15, 15-30, 30-60, 60-90 and 90-120 cm with the help of auger. Soil samples collected from the field were prepared being analyzed for different physical and chemical attributes.

Assessment of Soil Microbial Community and Soil Quality under Poplar and Eucalyptus Plantations in Haryana

Government of Haryana has framed its own forest policy in 2006. The policy has fixed the goal of achieving 10% forest and tree cover by 2010 and eventually 20% in the State. The indiscriminate use of water, fertilizer and pesticides over the years led to soil and environmental degradation and affected yield sustainability. Microorganisms play an important role in nutritional chains that are an important part of the biological balance in the life on our planet. Soil bacteria remain in constant dynamic state in soil and their community structure is greatly influenced by the change in climate, physico-chemical and biological factors.

Over-use of chemical fertilizers and pesticides have adverse effects on soil organisms that are similar to over-using antibiotics, with continued use, resistant organisms developed, and other organisms that compete with the disease-causing organisms are lost. The present study will help to assess the change in activity of soil microbial health (bacteria and fungi) with the application of fertilizer and biofertilizer (if any) in



poplar and eucalyptus plantations. Soil quality under fertilizer treated plots and biofertilizer treated plots will be assessed. This study will lead to characterize and identify various types of bacterial and fungal species which have growth promotory or inhibitory effect on poplar and eucalyptus plantations.

Survey of the area in Haryana where poplar and eucalyptus plantation were present adjacently, was done. Samples were collected from various villages like Kheda Powerhouse, Manakpur farms, Sug, Jaroda, Harnoli, Panjanto, Issapur, Narangabad of Yamunanagar and Kurukshetra district of Haryana. Soil samples so far collected are being analysed in the laboratory.

Ecology and Species Recovery Studies in Tsunami Impacted Mangroves of Andaman Islands

Conducted survey in mangrove areas affected due to Tsunami in South Andaman, Baratang, Middle and North Andamans. The affected areas were classified as heavily, moderately and least damaged based on Stratified random sampling. A total of 12 sample plots of 2 ha each have been selected in North Andaman, Middle Andaman, Baratang and South Andaman. The vegetation survey in adjoining mangrove areas have been undertaken. Species composition, abundance and size of mangrove stands, have been documented. Life history traits such as patterns of reproduction, propagule distribution and successful seedling establishment are being documented. Mangrove nurseries have been established in two locations. The following mangroves have been recorded during the survey. *Acanthus ebracteatus*, *Acanthus ilicifolius*, *Aegialitis rotundifolia*, *Acrostichum aureum*, *Acrostichum speciosum*, *Aegiceras corniculatum*, *Avicennia marina*, *Avicennia officinalis*, *Bruguiera cylindrica*, *Bruguiera gymnorrhiza*, *Bruguiera parviflora*, *Ceriops tagal*, *Cynometra iripa*, *Excoecaria agallocha*, *Heritiera littoralis*, *Lumnitzera racemosa*, *Lumnitzera littorea*, *Nypa fruticans*, *Pemphis acidula*, *Phoenix paludosa*, *Rhizophora mucronata*, *Rhizophora stylosa*, *Rhizophora apiculata*,

Rhizophora hybrid, *Sonneraria apetala*, *Sonneratia caseolaris*, *Sonneratia griffithii*, *Scyphiphora hydrophyllacea*, *Sonneratia alba*, *Sonneratia ovata*, *Xylocarpus granatum* and *Xylocarpus mekongensis*. *Sonneratia ovata* is a threatened mangrove species as per IUCN.

Identification of Suitable Tree Species and other vegetation for bio-drainage in Bargi command area

The study was conducted with the objective to drain out excess water of the soil in water logged/canal seepage areas through vegetative means and to enhance the site productivity along the left bank canal of Bargi command area, Jabalpur. The study has been concluded and final draft report has been submitted to the funding agency. Following conclusions can be drawn from the study :

In the experiments simulated in lysimeters, most of the selected species performed better under water logged conditions as compared to control, which could be due to their high water requirement. *Eucalyptus hybrid*, *Pongamia pinnata*, *Albizia procera* and *Terminalia arjuna* exhibited their maximum growth values under 0-0.25m water regime.

Maximum water use on per day basis was found in *Eucalyptus hybrid*, followed by *Pongamia pinnata* under different depths of water logging in lysimeters. Water use by the species decreased with increase in depth of water logging, which could be due to more surface area of roots in contact with soil water. Significant monthly variation in water use was observed in the species under test, which was directly related to the climatic conditions.

The transpiration rate was found maximum in *E. hybrid*, followed by *P. pinnata* and *T. arjuna*. The results showed that with the increase in water logging, transpiration rate increased in all seven species. Peak transpiration was observed at 12 hour during the period for most of the species, but for some species the peak period shifted to 11 hour or 13 hour.



Eucalyptus hybrid, followed by *P. pinnata* and *T. arjuna* was found to have significant effect on lowering down the water table in the canal command area. Monthly variation in water table due to tree plantations was found directly related to temperature, humidity and rainfall. Depth of water table, in plantations of all the tree species gradually increased from January to mid June, with the increase in maximum and minimum temperature. After this period, water table suddenly increased due to decrease in temperature and onset of rainfall in the second half of June. In July, August and September the water table continued increasing in all the plantations due to high

rainfall. Maximum decline in water table in *E.* hybrid plantation was observed at 14:00 – 16:00 hours in summer.

Integrated Nutrient Management for Improved growth of Trees on Overburden Dumps

Survey was conducted in Kanhan region of Western Coal Fields Limited, Junnardeo and PENCH area of Western Coal Fields Limited, Shivpuri area, for selection of coal mine overburden site for laying out experiment. Shivpuri open cast coalmine at Haranbhata has been selected for taking up the experiment. Overburden samples were collected from the selected site and the samples were analyzed for its physico-chemical properties viz, texture, bulk density, pH, EC, organic carbon, available N. P. K. Cation Exchange Capacity, exchangeable Ca, Mg, available micronutrients viz. iron, manganese, zinc and copper. Plantation has been done with ten species. Initial reading recorded and overburden dump samples analyzed. Further work is in progress.

Rehabilitation of Jhum Land through Potential Bamboo Species with Reference to Carbon Sequestration and Livelihood Development

Bambusa balcooa (Bhaluka), *Bambusa nutans* (Mokal) and *Oxytenanthera parviflora* (Hill Jati) raised from both rhizome and seedling following standard statistical design in the experimental plots at Johnar Sinar Village (Silonjan) and Jilangso village (Kohora) Karbi Anglong, Assam were properly maintained. Survival data were recorded and gap filling was done by replanting the seedlings as per layout. Progressive growth rate of 22 months old bamboos showed maximum length and GBH in *B. balcooa* followed by *O. parviflora* and *B. nutans* in both sites. Above ground and below ground biomass of three species were recorded and observed same trend as in growth. Composite soil samples were collected randomly from the experimental sites and estimated for Organic Carbon, bulk density and pH. Percentage of both plant carbon



Plantations of different tree species raised along left bank canal of Bargi command area



and OC in soil showed comparatively high value in *B. balcooa* followed by *B nutans* and *O. parviflora*.



Plantation of Rhizome in 7x7 plot



Jilangso (Kohra) Experimental Plot



Recording Growth Data in Bamboo Trial

Enhancing Productivity of Saline Wastelands in Kachchh-through Improved Tree Planting Techniques and Silvopastoral Study (Gujarat SFD sponsored project)

Sub Project-A: improved tree planting techniques

The Little Rann (5,300 sq km/2,045 sq mile) of Kachchh is a flat, saline waste land having extensive saline mudflats and lies in the hinterland of the Kathiawar Peninsula, between the gulfs of kachchh and Khambat in Gujarat. Much of the Little Rann is a wild ass sanctuary (WAS). *Prosopis juliflora* has invaded areas of WAS. Research trials were laid in July, 2007 to find out suitable exotic and indigenous fodder plant species with appropriate planting practice.

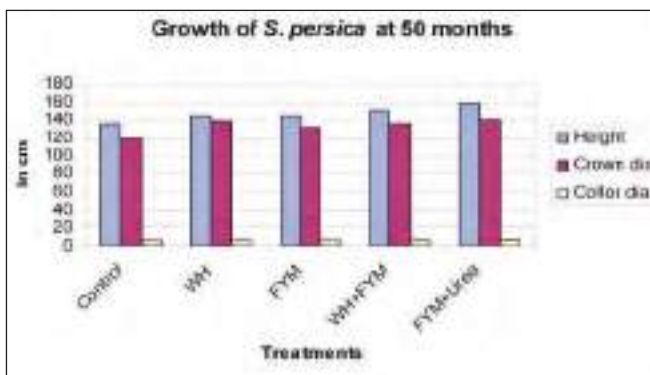
Research trials were laid with *Acacia ampliceps*, *Acacia bivenosa* (exotic) and *Salvadora persica* (indigenous) on black highly saline silty clay (medium), soil depth: 40-75 cm at Kordha, Sami Range in Patan, Gujarat. Trials of *Acacia ampliceps* and *A. bivenosa* were laid with control, Wheat Husk (1/2 kg), FYM (5kg), WH + FYM, Bajara Husk (250g) and FYM + BH treatments. *A. ampliceps*, called the salt wattle, is a very fast growing shrub/small tree from North-Western Australia that has considerable importance as fodder on alkaline/saline soils, especially where its roots have access to a shallow brackish water table. *A. bivenosa* (two nerved wattle) makes a complex with *A. ampliceps* (salt wattle). Trial of *S. persica* was laid with control, Wheat Husk (1/2 kg), FYM (5kg), WH + FYM and FYM + Urea (20g). Randomised block design with three replication was followed for all the trials. Spacing was 4 m X 4 m for *A. bivenosa* (12 plants/ treatment) and *S. persica* (16 plants/treatment) and 3m x 3m for *A.ampliceps* (16 plants/treatment).

S. persica proved to be the best plant with 83.7% mean survival after 50 months in the extremely harsh conditions of high salinity, heat stress after two consecutive summers (2009 & 2010) and one drought year (2009) and erratic monsoon afterwards.

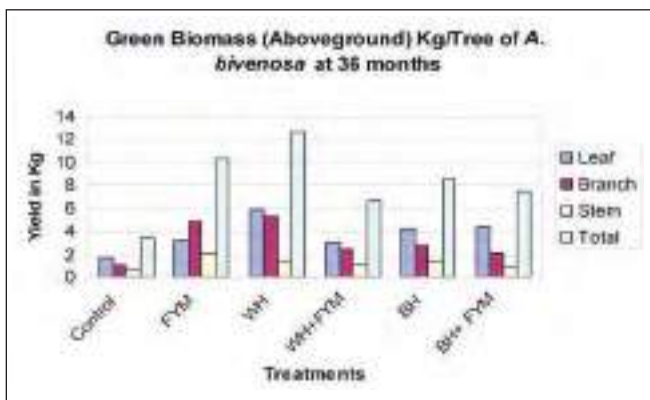


Treatments improved the growth; height, crown and collar diameter after 50 months. Treatment consisted of FYM+Urea was the best for maximum height 158.5 cm, crown dia 140.3 cm and collar dia 7.0 cm as compared to control 136, 118.5 and 5.6 cm for height ,crown and collar dia, respectively.

Above ground biomass study was done on the basis of the mean height, crown and collar diameter. As selection criteria, one tree was selected from each treatment for destructive sampling in all the three replications at the age of 50 months. Thus, a total of 15 trees were felled for biomass study. Above ground green biomass as 2.5 kg/tree in control to 7.1 kg/tree in T5 (FYM + urea) treatment. Although, all the treatments enhanced the biomass growth, but increment was maximum (2.5 fold) for T5, followed by 2.4 fold in T3 treatment indicating the positive influence of FYM application.



Growth Parameters (cm) of *S. persica* with Different Fertilizer Treatments at Age of 50 Months



Above Ground Green Biomass Yield (gm/tree) of *A. bivenosa* at 36 Months of Age

A. bivenosa was at second place, survived in one summer and one drought year with 10.2 % decrease in mean survival, 77.3% at 30 months compared to 12 months (86.1%). However, second consecutive summer effected the species and the survival was significantly reduced (40.0%) in summer 2010 and recorded as 46.3 % at 36 months. It attained significantly high growth and biomass estimation.

Treatment influenced the biomass yield and all the treatments recorded higher biomass as compared to control (3.43 Kg). Maximum 12.68 kg biomass yield was obtained for T₃ (wheat straw) treatment, followed by 10.22 kg for T₂ (FYM) treatment. A combination of FYM and wheat straw did not yield much.

Acacia ampliceps suffered the maximum damage in summer of 2009 and after the second successive hot summer, mean survival was further reduced to only 12.7% ranging from 6.0% in control to 18.7% in T3 (wheat husk) in different treatment and, thus, survival of *A. ampliceps* was poor. However, some of the surviving trees attained good growth. Based on average growth (height and crown diameter) one tree per treatment was cut and aboveground green biomass was estimated in field, it was ranging from 5.5 kg to 13.01 kg per tree in different treatments.

Results indicate that all the three plant species have the potential to revegetate the bare salt affected soils. They maintain good survival, attained significantly higher growth than sandy soils. Management practices enhanced the growth of all the three species under arid conditions on black soils. *A. ampliceps* and *A. bivenosa* flowered and produced viable seeds within a year, while on sandy soil, they took three to five years. *S. persica* also flowered and produced fruits in second year. Plantation activities have improved the soil conditions and reduction in pH and EC and improvement in percent SOC inside the plantation area. Weed biomass estimated every year indicated that



rainfall influenced the number of species and in high rainfall year, even glycophytes appeared in significant number.

Thus, it can be concluded that *S. persica* is the best plant with maximum survival, but due to halophytic nature, its fodder acceptability is less. However, *A. ampliceps* and *A. bivenosa* can be introduced in Wild Ass sanctuary and with management practices which will enhance fodder yield.

Sub Project B : Silvipastoral Study

Trials with four tree species, namely, *Cordia gharaf*, *Prosopis cineraria*, *Zizyphus mauritiana* and *Colophospermum mopane* and three grass species, namely; *Cenchrus ciliaris* and *C. setigerus* were laid in RBD in three replication at Mochirai, Bhuj in July, 2006. The area was undulating, and soils were loamy sand textured. Soil pH and EC was 7.3 to 7.5 and 0.49 to 0.89 dSm⁻¹ for 0-25, 25-50 50-75 cm soil layers, respectively. Organic carbon in 0-25 cm, 25-50 and 50-75 cm soil layer was 0.34, 39 and 0.36 %, respectively. Area is hilly pediment. Soil depth is less and an underlying rocky impermeable calcium carbonate layer was found at 25-75 cm depth at different places. Area was deep ploughed in summer to facilitate moisture conservation. In summer, temperature goes up to 47° C and in winter around 4°C. The rainfall during the experimental period was 596 mm in 2006, 663 mm in 2007, 247 mm in 2008, 419 mm in 2009, 896 mm in 2010 and 742 mm in 2011.

Cenchrus setigerus based Silvipastoral trial

In this experiment, *C. setigerus* seed was sown manually at high seed rate 8-10 kg /ha (very dense) where soil depth was medium 40 -75 cm. After 64 months, the mean survival was 96.3%, for control and 90.6% with grass treatment. Although, control trees recorded higher mean percent survival than control throughout the study period, however, the difference was not significant. Species wise, all the species recorded more than 90% survival, *Cordia gharaf* recorded maximum 96.3% survival, followed by

Z. mauritiana (93.5%) and *P. cineraria* (91.6%). Survival of *C. mopane* was less than 50%.

In this experiment, initially *C. gharaf* was the best performing species, but after 52 months, *Z. mauritiana* took over in height and crown diameter. *P. cineraria* was at third place and *C. mopane* did not perform and discontinued from experiment. Dense grass sowing adversely influenced the growth and biomass of tree species, treatment wise, the mean height was 202.8 cm, crown diameter 176.5cm and collar diameter 7.1 cm for control as compared to 162.3 cm height, 153.7cm crown diameter and 5.5 cm collar diameter with grass treatment. Species wise, the mean height and crown diameter for *Z. mauritiana* was 237.5 cm & 210.9, followed by *C. gharaf* 208.4 & 197.9 cm and *P. cineraria* 102.0 cm & 86.5 cm respectively at 64 months of age.

Effect of grass growth was more adverse on collar girth and control trees (without grass) attained 30.7% more collar girth (7.15cm) as compared to grass treatment (5.47cm). Species difference continued to be highly significant (p=0.00) and now with 9.67cm mean collar diameter, *C. gharaf* attained 1.89 and 2.42 times more collar dia as compared to *Z. mauritiana* (5.3cm) and *P. cineraria* (4.0cm), respectively.

Biomass

Based on mean height and crown diameter, component wise above ground biomass estimation was done for *Z. mauritiana* and *C. gharaf* in control and with grass treatments at 38 months. Control trees recorded significantly higher biomass for both the species. It was 1.6 fold more for *C. gharaf* (7.5 kg) in control to 4.8 kg with grass treatments for green biomass. For *Z. Mauritiana*, the yield was 2.5 fold high (4.0kg to 1.9kg). Same trend continued in dry mass, where *C. gharaf* recorded 1.7 and *Z. mauritiana* 2.3 times more in control trees. Green biomass of *P. cineraria* was estimated at 64 months and it was 4.28 kg /plant in control treatment as compared to 2.27 kg/plant in with grass treatment.



Cenchrus ciliaris based Silvipastoral trial

In this experiment, grass sowing was done at low seed rate (1.0 m strip at a distance of 3 m), where soil depth was shallow 25-40 cm only. Survival at 64 months for control treatment was 87.6%, while with grass it recorded 97.5%. There was no change between 52-64 months growth period. Contrary to *C. setigerus*, mean percent survival with grass was higher in case of *C. ciliaris* as compared to control trees throughout the study period however, the difference was not significant.

At 64 months, both control and with grass treatment, same mean height recorded (173.8 cm), which is less than mean height at 52 months. Between 52 to 64 months, many *Z. mauritiana* trees fell down due to poor root development, failing to support the tree in shallow soil depth, resulting in 7.1% decrease of mean height (from 225.2 to 209.2 cm) indicating that in shallow soil depth, pruning should be done to maintain the plants in shrubby form. Height difference among species was significantly different, but it was due to very less height for *P. cineraria* (58.1 cm). The difference between *C. gharaf* (257.2 cm) and *Z. mauritiana* (209.1 cm) was also significant at this stage. Same is the trend for crown diameter.

Biomass was estimated at 38 months. Green biomass yield was 4.5 to 5.3 kg/tree for *Z. mauritiana* and 8.0 to 8.6 kg/tree and 1.76 to 1.89 kg/tree for *C. gharaf* with grass and control treatments respectively, suggesting that at low seed rate, grass sowing promote tree growth. Here, *P. cineraria* did not attain enough growth to estimate biomass.

Thus, it can be concluded that in shallow soil, grass sowing in scattered manner promotes tree growth due to better moisture availability but dense grass sowing adversely affect the tree growth. *C. gharaf* : *C. ciliaris* was the best silvipastoral system, followed by *Z. mauritiana*: *C. ciliaris*. Growth of *P. cineraria* was slow in medium soil and poor in shallow soil. *C. mopane* did not survive due to site conditions.

Among grass species, *C. ciliaris* was the best, closely followed by *C. setigerus*. *D. annulatum* took time for establishment, but spreads fast after establishment. Rainfall influenced the grass yield and in a well distributed monsoon year, *C. ciliaris* recorded 1.94 kg/m² yield, followed by *C. setigerus* 1.51 kg/m².

Identification of Soil-vegetation Relations and Indicator Species for Assessment and Rehabilitation in Lower Aravalli of Rajasthan

A study was carried out at five different locations with varying rainfall of 988 mm, 961 mm, 950 mm, 568mm and 424 mm in Banaskantaha (Trisulia), Motimori (Sabarkantha), Banswara (Bara Nandra kho), Rajasmand (Sabalia) and Pali (Borvad forest block), respectively (i) to study on physical properties and nutrient status of soil derived from different parent material, and (ii) to study on vegetation structure and indicator species on dominant soil types. Based on IVI values, these sites were dominated by *Wrightia tinctoria*, *Tectona grandis*, *Lanea coromadelica* and *Anogeissus pendula* tree species, respectively. Among the shrubs, *Nyctanthes arbor-tristis* at first two sites of Gujarat, whereas, *Lantana camara* was dominated at Banswara, *Rhus mysorensis* at Rajasamand and *Euphorbia caudicifloia* at Pali sites. Among herbs and grasses, *H. suaveolense*, *A. lanceolatus*, *Aristida mutabilis* and *Apluda mutica* dominated the respective site. Total numbers of species (tree, shrubs, herbs and grasses) were 85, 100, 109, 95 and 87 numbers at the sites in Banaskantha, Sabarkantha, Banswara, Rajasamand and Pali, respectively in 2011. Height of the herbaceous vegetation was in the order of Rajsamand > Sendra > Banswara > Sabarkantha > Banaskantha, where number of herbaceous species were 8.6, 8.4, 9.9, 18.2 and 10.1 number, respectively. Production of herbaceous biomass was highest at Sabalia site of Rajasamand and the lowest at Pali site. The order of sites in terms of herbaceous biomass production was Rajsamand > Banswara > Sabarkantha > Pali > Banaskantha. Soil water content (SWC) was lowest at Pali site throughout the year. SWC



Observation Recording on Vegetation in Sabalia Forest Block in Rajasamand



Vegetation Growth in Baranandra Kho Forest Block in Banswara



Vegetation Growth in Motimori Forest Block in Sabarkantha



Vegetation Growth in Borwav Forest Block in Pali

was highest at Banswara in June, 2011 and February, 2012 and at Sabarkantha site in October, 2011. In October, 2011, soil pH was lowest at Sabarkantha and was associated with the lowest electrical conductivity, $\text{NO}_3\text{-N}$ and highest SWC, number of species and their populations. Concentration of $\text{NH}_4\text{-N}$ was highest at Trisulia forest in Banaskantha, whereas, it was lowest in Motimori Forest in Sabarkantha Division. The highest $\text{NO}_3\text{-N}$ concentration at

Rajasamand was related to lowest number of species and highest quantity of herbaceous biomass.

Characterization and Classification of Forest Soils of Rajasthan

The project was initiated in September, 2007 with the objective to characterize and classify forest soils of Rajasthan following the USDA classification system. During the reporting period, soil and vegetation survey was conducted in Bundi, Jhalawar, Kota, Karauli, Swai



Very Deep Soil at Taranagar Range, Churu



Shallow Gravelly Soil at Kurabad, Udaipur



Prosopis juliflora in Bandra Forest Block, Barmer Having High CaCO_3 Content in Deeper Soil Layer (380mg kg^{-1})



GIS Lab

Madhopur, Udaipur, Churu and Jodhpur districts. 146 soil profiles in 146 forest blocks were studied and field observations recorded on vegetation status, regeneration, litter, aspect, drainage, soil structure, consistency and colour. Physico-chemical characterization of the soils has been done in the field as well as in laboratory. Soil samples were collected and analysed for soil texture, structure, consistency, colour, pH, electrical conductivity, organic carbon, NO_3 and NH_4 – nitrogen and phosphorus.

Soils were moderately deep to very deep at most of the sites in Jodhpur, however, 30% sites have shallow soil with calcareous hard pan. Soils in Churu district are deep to very deep in nature with sandy texture. In Udaipur, soil depth varied from 60 to 180 cm in different blocks. Colour of soils showed a wide range of

variation too. Whereas, most of the soils were dark brown to brown in colour, at some places soils were pink and yellowish red in Udaipur. Soils were mostly gravelly. Only 10% soil samples had $< 20\%$ gravels. Among the soils tested, soils of Barmer district have high CaCO_3 (380 mg kg^{-1} at Bandra forest block).

Carbon Stock and Soil Classification Mapping for Rajasthan Forests

The project was initiated in November, 2011 with the aim to develop digitized maps of forest carbon stock, forest soil types and soil nutrient status for Rajasthan and to determine relationships (if any) between *in-situ* biomass density, soil parameters and remote sensing characteristics. GIS laboratory has also been fabricated using one-time grant.

2.3 Genetic Improvement

2.3.1 Overview

Genetic improvement through traditional breeding methods is absolutely essential and important for improving productivity of plantations and quality of timber. However, because of long life cycles of many trees and low genetic gains per generation of breeding, it takes many years to achieve major genetic gains. Productivity of tree crops on agricultural lands in India is much lower than in many other countries (like Brazil and Indonesia). This seriously undermines the real potential of agro-forestry/tree farming in India. While productivity of a tree crop is determined by a variety of factors, the most basic determinant is quality of planting stock availability. Clonal plantations exploit existing natural variation for fast and immediate genetic gains, taking full advantage of superior genetic qualities of field tested clones. Field tested genetically superior clones of Eucalyptus and poplars have revolutionized the productivity and profitability of plantations in many countries and results from Indian endeavors are quite encouraging.

Indian Council of Forestry Research and Education is working on the genetic improvement of different forest tree species including economically important species required by the farmers, forest department and industries across the country. Basic and applied research in the field of genetics, clonal forestry and biotechnology is being carried out to as per the requirement of the stakeholders. Realizing the importance of strategic activities for Forest Genetic Resources (FGR) evaluation and improvement presently being undertaken by various Institutions, a long term research program and species specific tree improvement and tree breeding strategy to be adopted across the country has been taken up by ICFRE. Accordingly a National Coordinated Research Programme has been developed on 'Forest Genetic

Resource Management and Tree Improvement' aiming to improve the productivity of plantation forest through, use of quality seeds and seedlings obtained through tree improvement & breeding programme for meeting the demands of farmers, industries and forest department. This will also help in networking of activities by various forestry research institutes, state forest departments, universities, and putting their efforts in place for the benefit of stakeholders.

Eucalyptus

Artificial hybridization between *E. pellita* and *E. urophylla* was carried out and inter-specific F1 hybrids were also developed and planted in the field for their evaluation.

Dalbergia sissoo

Eleven populations of shisham were analysed for genetic variation and it was observed that the populations of Jammu & Kashmir (J&K) and Himachal Pradesh (HP) have more genetic diversity compared to the populations from Uttarakhand. A highly productive and resistant (against wilt disease) clone of *Dalbergia sissoo* (FRI-14) has been released for commercial cultivation by the Variety Releasing Committee of Ministry of Environment and Forest, Government of India.

Melia composita

Selection and characterization of 230 candidate plus trees was carried out using index method and plus trees were identified. Genetic evaluation of 21 families is being carried out in six geographical locations to analyze stability and adaptability in different eco-climatic conditions.

Bamboo

An efficient protocol for micro propagation was developed for *Thamnocalamus falconeri* (Dev Ringal).



In-vitro Rooting

Rooted Culm Cutting

The propagules for Dev Ringal developed through various path ways were planted in the field at Magra (1834 amsi) Mussoorie and evaluated for growth and adaptability for one year.

Tecomella undulata

The progeny trial of *Tecomella undulata* established in 2008 with 40 Candidate Plus Trees (CPTs) of Bikaner and Jodhpur, revealed better growth performance of progenies in Jodhpur.

Prosopis cineraria

The genetic improvement programme of *Prosopis cineraria* was executed and 21 new Candidate Plus Trees were selected from different locations in Rajasthan. The variation in pod parameters from various plus trees was also studied.

Tectona grandis

- Two orchards, one each in Karnataka (Janganamatti, Dharwad) and Andhra Pradesh (Achuthapuram, Rajamundry) were selected to standardize flower induction schedule in clonal seed orchards of *Tectona grandis*.
- Three ramets each of 97 plus trees of *Tectona grandis* maintained at National Teak Germplasm Bank, Chandrapur representing 12 teak growing states and 15-31 progenies (half sib families) of nine

plus trees were validated using AFLP and STMS markers

- 15 phenotypically superior trees of Teak selected and genetic variation among half sib families was studied, genetic gains were computed and inheritance of growth traits investigated.

Pterocarpus santalinus

Progeny trials of Red sanders have been established at Hyderabad and Bangalore. Early growth performance evaluation of the progenies shows the superiority of CPT's collected from Karnataka esp. Kushalnagar, Kodagu.

Azadirachta indica

- Evaluation of 8 years old Neem progeny trial established targeting high azadirachtin at Govindpura, Jaipur revealed superior growth performance of Progenies of CPT 7, CPT 4, CPT 11 & CPT12. Progenies of CPT 3, 4, 5, 6 and 7 were frost tolerant. Whereas, progenies of CPT 4 and 7 were superior in growth parameters as well as frost tolerant.
- *In vitro*, aseptic cultures of *Azadirachta indica* were established from five populations of Madhya Pradesh. Significant increase in shoot length (2.28 cm) was obtained on 0.5 μM BA and 125 mg l⁻¹ casein hydrolysate. Shoot regeneration with leaf pieces resulted in maximum number of shoots (3.56) on 0.44 μM BA and 162.86 μM Ads. HPLC method was standardized for quantification of azadirachtin from seeds.

Pinus gerardiana

Survey of Chilgoza pine populations in Kinnaur and Bharmour areas of Himachal Pradesh revealed that due to the biotic pressure, rights of the local people for seed collection, the regeneration has been negligible. The isoenzyme protocols were developed for three populations for genetic variation studies in *P. gerardiana*.



Forest Genetic Resource Evaluation & Conservation

Calophyllum inophyllum is an important tree borne oilseed used for biofuels and medicinal purpose. Selection of high fruit yielding trees of *Calophyllum* carried out. Germplasm bank has been established at Panampally research station.

- *Sapindus emarginatus* is another potential NTFP species of Tamil Nadu which is in high demand. Established germplasm bank with high fruit yielding trees and saponin content.
- Field germplasm banks of the important indigenous fodder tree species viz. *Grewia optiva* (2.0 ha at Dudhli Lachiwala Range, Dehradun Forest Division) and *Quercus leucotrichophora* (1.50 ha at Magra, Jhonpur Range, Mussoorie Forest Division) were established.
- In order to develop germplasm bank of a fodder tree species *Bauhinia variegata*, selection of the promising genotypes was made in the states of Uttarakhand & Himachal Pradesh.
- The germplasm of *Diospyros melanoxylon* was collected from four locations in three agroclimatic zones of Chhattisgarh.
- A germplasm bank consisting of 50 progenies of *Aquilaria malaccensis* was established in RFRI Jorhat campus.
- 29 districts were surveyed covering 10294 ha for the mapping distribution and density of *Commiphora wightii* (Guggal) and collected germplasm from 105 superior plants for *ex situ* conservation.
- For domestication, mass multiplication and popularization of *Moringa oleifera*, having higher leaf nutritive and cytokinin content', CPTs/ superior seed sources were identified in Jharkhand, West Bengal, Bihar and Orissa. Superior genotypes were clonally multiplied and maintained in germplasm bank.
- Laboratory protocols are being developed for extraction of dyes from *Mallotus philippensis* and *Wrightia tinctoria*.

- For conducting studies on pollarding and propagation in Kusum (*S. oleosa*) for lac cultivation., collection of stem cuttings and scion of plus trees of Kusum from Basia, Simdega, Bano etc was carried out and air layering procedure was successfully standardized

Molecular Characterization for Breeding Programme

- A programme initiated on timber forensics for applications of molecular markers in tracing origin of the stolen timber or log back succeeded in isolating DNA from the wood of *Cedrus deodara*.
- Germplasm of *Eucalyptus citriodora*, *E. pallida*, *E. hybrid* and three commercially used clones of eucalyptus was collected and analyzed for determination of marker constituents conferring CLSB resistance to the foliage.
- Molecular taxonomy facilities for the molecular characterization of selected bamboo species, established at FRI Dehradun. Initially the work has been started in five bamboo species.

Micro and Macropropagation

- Success has been achieved in the development of clonal propagation technique for *Saraca asoca*, a commercially important medicinal plant species using different rooting media, growth hormones and season of rooting.
- Shoot multiplication medium for *Dalbergia latifolia* and *Pterocarpus santalinus* has been standardized.
- Endogenous levels of auxin on Indole Acetic Acid (IAA) in selected trees of *Dalbergia latifolia* from Jabalpur, Chandrapur and Jagdalpur showed significant seasonal and genotypic variation. Juvenile and mature shoot cuttings of *Dalbergia latifolia* had 36% and 11% rooting response, respectively.
- Vegetative propagation protocol of selected bamboo species was developed. Methods have been developed for shoot multiplication and root induction in *Dendrocalamus hamiltonii*.



- Under *in vitro* conditions, the best shoot multiplication in *Salvadora persica* was 2.5 fold on MS medium supplemented with BAP (5.0 mg/l) and IAA (0.1 mg/l).
- In *Capparis decidua*, the best shoot multiplication was on MS media supplemented with BAP (2.0 mg/l) and IAA (0.5 mg/l).
- Somatic embryo derived plants were produced from 3 years old (long term maintained) cultures of *Commiphora wightii* and were found genetically uniform based on six RAPD markers found genetic stability.
- For the standardization of propagation method and germplasm conservation of *Machilus villosa* (Roxb.) and *Quercus lineata*, 10 plus trees of *M. villosa* and 9 of *Q. lineata* has been selected and marked.
- For conducting studies on variability in rooting proficiency in selected genotypes of *Pongamia pinnata*, scions were collected from 23 trees and variability in grafting success among plus trees was observed.
- For optimization of protocol for *in vitro* propagation and conservation of *Embelia ribes*, germplasm was collected from Nagpur, Maharashtra, Lower Subansiri, Arunachal Pradesh. Explants were collected from this source and cultures were established at tissue culture laboratory.

Distinct Uniform and Stability (DUS) Testing

Five populations of *Pinus roxburghii* viz. Chabbal forest, Banethi, Nurpur forest, Nerva and Dibkan forests and five populations of *Cedrus deodara* viz. Chopal, Cheog, Chail and Kinnaur were surveyed for distinct traits. The observations with regard to needle length and colour were found to vary considerably. The distinctness in traits for cone size and crown shape in both the species are also being looked into to identify distinct genotypes. The genotype of deodar in Chopal Forest division has been identified with distinct drooping branches.

Seed Science and Technology

Studies on seed viability in three recalcitrant species *Dipterocarpus retusus* Bl. (Hollong), *Shorea assamica* Dyer (Makai) and *Aquilaria malaccensis* Lamk. (Agar) has been carried out. Seed biology of *Abroma augusta* L.f. has also been undertaken.

Project under the Theme			
Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	21	62	19
Externally Aided	06	16	04
Total	27	78	23

2.3.2 Conservation of Forest Genetic Resources

NTFP species

At FRIs field research station, Khirsu (Pauri Garhwal) some medicinal plants namely Atees (*Aconitum heterophyllum* wall ex Royle), Brahmi (*Bacopa monnieri* L. Pennell), Chirata (*Swertia chirata* Buch – Ham), Dalchini (*Cinnamomum verum* Presl.) and Daruhaldi (*Berberis asiatica* Dc.) are being conserved.



Conservation of Medicinal Plants at Khirsu



Methodology and parameters for selection of superior genotypes of five NTFP species viz. *Pongamia pinnata*, *Aegle marmelos*; *Pterocarpus marsupium*, *Strychnos Nux-vomica* and *Sloanea suaveolens* have been developed.



TFRI Staff along with Maharashtra Forest Official During Field Visit



Superior Plant of *S. Suaveolens* (Padal) in Chandrapur

Quercus leucotrichophora

Banj oak (*Quercus leucotrichophora*) is the most common broadleaf tree in the mid-elevational central Himalaya in India. It is the most preferred tree species in the temperate region, mainly used for fodder, fuel, and small timber. *Q. leucotrichophora* forms an extensive belt along the middle elevation (1200–2200 m) facing excessive pressure for existence. In order to study the genetic diversity and population structure of Himalyan Ban Oak forests, ten populations each with 30 individual trees covering Himachal Pradesh and Uttarakhand have been sampled for DNA marker based study. DNA extraction techniques from oak leaves have been standardized. Polymorphic ISSR/RAPD markers screened for molecular characterization of populations.



Trees Selected for Sample Collection in Ban Oak Forests of Gadach (Jhungi)



Dalbergia sissoo

Genetic diversity analysis of eighty six clones of *Dalbergia sissoo* was carried out using randomly amplified polymorphic DNA (RAPD) markers by selecting 10 decamer primers. The maximum similarity was found between clone 218, 1003, 10 and 12 and the most dissimilar clones were 7006, 59, 9032 and 5030 with minimum similarity coefficient. The average genetic diversity was recorded 0.21. Clone 5022 was found to be the most divergent clones which could be used for number of combinations to be established in the seed orchards and as a parent in hybridization programme.

Mangroves

Mangroves are fast disappearing assets of our country. The species *Bruguiera sexangula* grows landward and is very rare in India. It occurs in only three restricted patches of India namely South Andamans, Ernakulam region of West Coast and in Bhitarkanika, Odisha. In the Ernakulam region of West Coast, it was presumed to be extinct and was rediscovered only during 2004. The species is obligatorily ornithophilous and becoming globally rare. Considering the urgent need for conservation of this species the project is undertaken. Current achievement of the project is

reconnaissance survey of *Bruguiera sexangula* Populations, molecular characterization and control pollination. Reconnaissance survey was carried out in Panangad and Kumbalangi at Ernakulam region. 30 individuals were GP documented. Control pollination was attempted in Panangad and Kumbalangi. About 400 individuals were transplanted in the month of June, 2011. Two populations are being quantified for diversity estimation using DNA markers. Reproductive biology of the species is studied.

The CPT selections of *Calophyllum* have been conserved as field germplasm bank at Panampally Research Station as clone bank and half-sib progeny trial. Seedlings raised from *Sapindus* CPTs are maintained in the nursery for assembling in germplasm bank.

Pterocarpus santalinus

Population genetics and phylogeography of *Pterocarpus santalinus* and its *ex situ* conservation is being investigated through biotechnological interventions. DNA was extracted and purified from the collected population samples for the population genetic analysis work. For the development of the germplasm bank, land preparation has been taken up.

Tectona grandis

Molecular assessment of breeding patterns in clonal seed orchards of Teak in Andhra Pradesh is being investigated. Seeds were collected from the short listed clones and were put for germination and nursery being raised.

Boswellia serrata

In order to study the genetic diversity and population structure of *Boswellia serrata* through RAPD and ISSR markers, genomic DNA extraction procedure from the leaf samples has been standardized. Polymorphic ISSR primers were screened for genetic analysis. Phenological data revealed 100% leaf fall in this species. Similarly immature fruit fall is 11.3% and fruit fall is 23.8%.



Bruguiera sexangula Fruits



Raising of Seedlings for Re-introduction



Planting of *Bruguiera sexangula* in Degraded Areas



Established *Bruguiera sexangula*



Rauvolfia serpentina

Variation in reserpine content in some high yielding genotypes of *in vitro* and seedling raised *Rauvolfia serpentina* was studied for the effect of genotypes on culture establishment, effect of basal media and growth hormones on shoot multiplication. The results revealed the genotypes sensitivity to hormones. A significant effect of different levels of BA and NAA on the rate of shoot multiplication was recorded. Best and rapid multiple shoot potentiality was observed on MS medium, in which highest number of shoot (6.10) was observed within six weeks.

Azadirachta indica

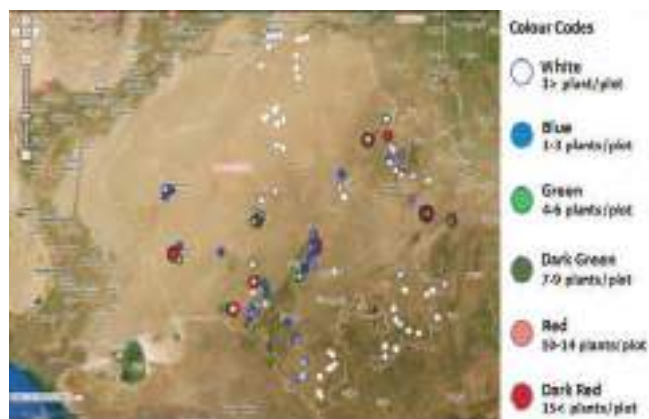
Variation with respect to *in vitro* azadirachtin production in selected high yielding populations of *Azadirachta indica* was studied. Isolation of azadirachtin from seeds and shoot cultures of different populations was carried out and quantified. Azadirachtin content was found to vary within and between populations of the species.

Bamboos

For inventorization and *ex-situ* conservation of Bamboo and Rattan resources of Mizoram, Tripura and Barak Valley of Assam, germplasm of *Calamus flagellum*, *Dendrocalamus hamiltonii*, *Dendrocalamus asper*, *Phyllostachys aurea* was raised. Besides, the germplasm of *Dendrocalamus hamiltonii*, *Phyllostachys manii*, *Dendrocalamus asper*, *Teinostachyum dullooa*, *Bambusa balcooa*, *Bambusa nutans* and *Bambusa wamin* was maintained in the nursery. Fifteen species of different bamboo species were collected from RFRI and multiplied through macro-proliferation technique in the Advanced Research Centre for Bamboo and Rattan (ARCBR) nursery for further plantation and establishment of Germplasm bank. Survey carried out and recorded the distribution of bamboo and rattan species in Lakhimpur.

***Commiphora wightii* (Guggul)**

For investigating the population density and diversity for *in situ* and *ex situ* conservation of *Commiphora wightii* (Guggul) in Rajasthan, surveys were conducted in 29 districts of Rajasthan namely; Ajmer, Banswara, Baran, Barmer, Bharatpur, Bhilwara, Bikaner, Bundi, Chittorgarh, Churu, Dungarpur, Hanumangarh, Jaipur, Jaisalmer, Jalor, Jhalawar, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Pratapgarh, Rajsamand, Sawai Madhopur, Sikar, Sirohi, Sri Ganganagar and Udaipur. A total of 2660 sample plots in 141 sites in 29 districts were surveyed covering 10294 hectare where Guggul occurrence has been recorded. GPS data were loaded on Rajasthan map using software with colour codes for population densities.



Population Density of Guggul Plants Shown by Colour Code on Rajasthan map

Madhuca longifolia

For quantitative and qualitative improvement in flower seed and oil yield of *Madhuca longifolia*, field surveys were conducted for selection of CPTs at Allahabad, Pratapgarh, Jaunpur, Azamgarh, Mirzapur, Kaushambi, Kanpur, Unnao, Rai Bareilly, Varanasi, Sultanpur and Faizabad districts and 52 CPTs selected for screening. Collected corolla from selected CPTs, for qualitative analysis. Chemical screening of flower for total soluble sugars and protein has been analyzed and oil content from seed estimated.



Seed Storage

Seed water relation was studied and optimum storage conditions were standardized for seeds of *Bambusa bambos* and *Jatropha curcas*. Sorption isotherms were analysed by applying Brunauer Emmett and Teller (BET) theory, and status of water in the form of monolayer, primary and secondary water molecule was determined. The monolayer moisture content decreased with increase in temperature indicating that hygroscopic characteristics fall at high temperatures. In *J. curcas* seeds, the monolayer value was less than *B. bambos* at all the temperature. A strong agreement between experimentally obtained EMC and that obtained using BET theory validated the use of BET theory in elucidating the adsorption mechanism in seeds. The ideal RH for storing seeds of *J. curcas* is between 43 to 33.5% and for *B. bambos* it is between 33.5 to 23.5%. Best storage condition for *J. curcas* is 4.6% moisture content at 15°C temperature and for *B. bambos* is 6.5 % at 5°C temperature. The loss in viability was correlated with biochemical changes by using Fourier Transform Infrared (FTIR) Spectroscopy.

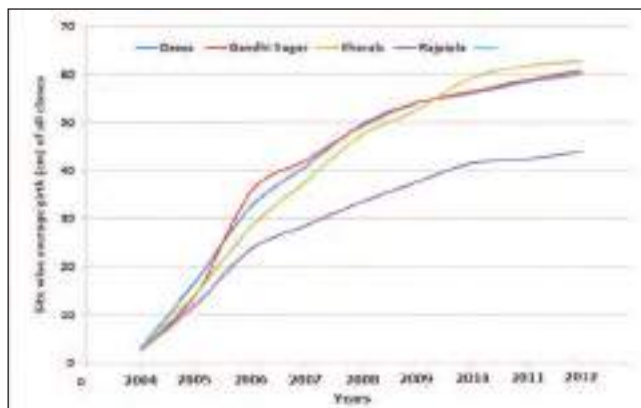
Tree Improvement

Dalbergia sissoo

Forest Research Institute, Dehradun has been working on the genetic improvement programme of *Dalbergia sissoo* since 1990. Though this species has a number of promising attributes, it exhibits poor stem form (crooked stem), forking, ramicorn branching and susceptibility to the dieback. In genetic improvement programme of the species, a number of plus trees from various locations have been selected and assembled in the gene/clone bank. Initially the selection of promising trees was carried out in the states of undivided Uttar Pradesh, Rajasthan, Bihar, Nepal and other shisham growing regions, the genetic worth of these genotypes is being tested in the field. The field trial consisting of 49 clones has been established at three locations each at Bithmeda (Haryana), Pantnagar (Uttarakhand) and Hoshiarpur (Punjab). The evaluation of earlier trials

consisting of 36 clones planted at Hoshiarpur, Ludhiana and Bithmeda were evaluated on various morphological and wood traits. A highly productive and resistant (against wilt disease) clone of *Dalbergia sissoo* (FRI-14) developed by FRI Dehradun was released for commercial cultivation by the Variety Releasing Committee of Ministry of Environment and Forests, Government of India.

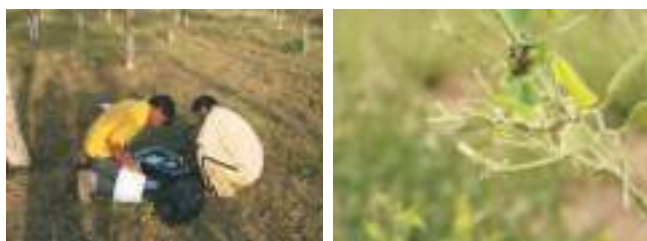
Multilocal trials of *D. sissoo* clones established in 2003 at four locations in Gujarat namely; Deesa, Gandhinagar, Kheralu and Rajpipala revealed a stable performance of the clones G2, 15 and 35 across the sites as demonstrated by their better growth (height and girth parameters).



Effect of Site on Girth Parameter of *D. sissoo* Clones

Natural populations and old plantations of the species have been surveyed and screened in Jharkhand and Odisha for selection of candidate plus trees on the basis of morphological characteristics, physiology and health.

HFRI Shimla studied the selected clones of shisham for genetic variation through isozymes analysis and also for stress resistance and insect-pest tolerance. Isozyme analysis revealed considerable genetic variation in clones which was also confirmed by their growth data at two sites. The tolerance of clones against stress and insect-pests showed difference in the resistance pattern. The advance generation orchards of shisham are maintained and growth data being recorded periodically.



Studies on Stress and Insect Resistance in the Field

Melia composita

The natural forests and the plantations of *Melia* were surveyed in different states. A total of 230 candidate plus trees (CPTs) were selected by FRI from different geographical regions and analyzed for index value based on height, diameter at breast height, straightness, clear bole height, crown diameter and knots. Evaluation trials of 21 most suitable families were established applying lattice design in six geographical locations of Haryana, Punjab, Uttar Pradesh and Uttarakhand. Genetic evaluation trials have also been established in different locations with 42 families to analyze stability and adaptability and screening of suitability of genotypes for arid and semi-arid regions. Early results have demonstrated absolutely remarkable progress for straightness, growth and diameter as well as disease and insect incidences. In fact, few of the progenies have touched a height of 9 m and circumference of 0.60 m in less than two years of age. Some of the progenies show high degree of tolerance to high temperature of around 49°C and have survived for three years under drought conditions.

Thirty plus trees, each of *Melia dubia* and *Melia azedarach* respectively were selected by IFGTB in the southern part of the country based on the morphometric traits to identify suitable seed sources with high oil content.

- The seed of *Melia azedarach* collected from plus tree number PAK-9 of Dharwad sources was estimated to have the higher oil content as compared to other sources.
- The seed of *Melia dubia* collected from plus tree number PDT-12 of Thalamalai sources was

estimated to have the higher oil content as compared to other sources.

- Seed germination study also revealed that de-pulping the fruits and soaked in normal water for 168 hr significantly enhanced seed germination percentage.
- Seed germination study also revealed that the seeds collected in the month of January to February gave the best results in *Melia dubia*.
- The progeny traits were established using seeds of plus trees from Karnataka, Tamil Nadu and Andhra Pradesh at Forest Research Centre, Hyderabad and Nallal Field Research Station, Bangalore. The survival percentage was not found to be 100% in both the species.
- Under field evaluation studies, growth parameters were recorded and many analyses of variance indicated significant difference among the seed sources for all the characters studied.
- RAPD studies for both the species provided the basic information that there is variation among the plus trees population. This will be used as a base to initiate the advanced studies in tree improvement programme.

Evaluation of growth performance of progeny trial has been carried out at FRC, Hyderabad and Nallal, Bangalore. Coppicing was done to carry out vegetative propagation in *Melia dubia* and it was found that it is a good coppicer and further experiment are being carried out for rooting in stem cuttings. Among various auxins tested for rooting in *M. dubia*, IBA at 3000ppm found best to induce rooting.

Pongamia pinnata

The plantations of *Pongamia pinnata* were surveyed in the states of Punjab, Uttarakhand, Uttar Pradesh and Haryana and promising genotypes for higher seed productivity and oil content identified. Field trials have been raised with 49 selected families at Jhumpa (Haryana) and Pantnagar (Uttarakhand) for testing stability, adaptability and growth performance.



Candidate plus trees of *P. pinnata* screened for phenotypic characters in different states, and progeny trails conducted. Oil content ranged from 27.89 to 41.43 %, and 33 progenies profiled for fatty acids.



Selected Superior Tree of *Pongamia pinnata* at Bhavanisagar, Tamil Nadu



Rooted Cuttings of Selected Tree



Hardened Clones of *Pongamia*

A total of 74 candidate plus trees of *Pongamia pinnata* were selected from 23 districts in different agro-climatic zones of Tamil Nadu and being multiplied clonally. Flowering and fruit production in selected trees were recorded. Seeds were collected from 10 selected trees for analysis of oil content.

Eucalyptus

Controlled crossing was done in *E. pellita* and *E. urophylla* for production of F1 hybrids. Hybrid seeds were collected, raised and established in the field for their evaluation. *E. pellita* is a frost resistant and moderately resistance to stem cankers due to *Cryphonectria cubensis* and has fast growth. *E. urophylla* has higher productivity and adaptability but is susceptible to *Cryphonectria cubensis*. Both the species are used for pulp and paper. Few ramets of F1 hybrids of *E. pellita* x *E. urophylla* have been produced through rooting of branch cuttings. The ramets have been planted in vegetative multiplication garden for production of coppice shoots for mass propagation.

- The Potted Seed Orchards (PSO) were established using top 5 clones of *E. camaldulensis*. The early flowering in PSOs was induced through the treatment of Paclobutrazol. This will help in inter clonal hybridization and will save resources in seed production.



Mapping Population Trial at Sathyavedu

- IFGTB Coimbatore identified best performing 50 clones based on three clonal trials in Karunya Nagar, Coimbatore and Sathyavedu . The poor 25 clones present in the trials were culled and seeds were collected from the best performing 50 clones and progeny trials were established in Puthukottai (2 Ha) and ANGRAU, Hyderabad (2 Ha). At the same time, the same clones were mass multiplied



Progeny Trail of Eucalyptus



Application of Paclobutrazol to Enhance Flowering

and were established in CSOs at Salem (2 Ha) and Nellore (9 Ha). Seedling Seed Orchards at Coimbatore (2 Ha) and Chennai (3 Ha) are also established.

- A VMG of a hybrid of *E. tereticornis* x *E. grandis* has been established at Pugalur TNPL campus premises.

- For characterization of eucalyptus clones for physiological and nutritional parameters, field trials have been established in four locations viz., Pudukottai, Tirunelveli, Sivagangai and Coimbatore. For the short-listed 30 Eucalyptus clones, parameters like chlorophyll a, chlorophyll b, total chlorophyll and total leaf area were worked out. Observations on physiological parameters and growth parameters are being made at regular intervals in four locations.
- For assessing the suitability of *Eucalyptus tereticornis* and *E. camaldulensis* clones for various agroclimatic zones of Southern India, twelve clonal trials have been established at Karaikkal (Puducherry), four locations in Andhra Pradesh viz., Warangal (Jakaram), Rajmundhry, Hyderabad (Mulug) and Tirupathi (Sreevarimetta), three in Karnataka viz., Badami, Gangargatti (Dharwad), Halbhavi (Belgaum), four in Tamil Nadu viz., Nachiarpettai (Ariyalur), Amaravatipudur (Karaikudi), Thyagadurgam (Kallakurichi), Marakkanam. From the data on height and girth from the trials raised in Andhra Pradesh at Hyderabad, Tirupathi, Warangal, Rajamundhry and (PAJANCOA) Karaikal, six clones viz., 9, 10, 66, 123, 124, 196, are maintaining superiority over other clones. Maximum height is 4.61m and maximum girth is 11.72 cm.
- Multilocational trials of *E. camaldulensis* clones established in 2003 at four locations in Gujarat namely; Deesa, Gandhinagar, Kheralu and Rajpipala revealed a stable performance of the clones A3, 10 and 105 across the sites as demonstrated by their better growth (height and girth parameters).

Gmelina arborea

Candidate plus trees of *Gmelina arborea* identified from North East India, West Bengal and other areas of Southern India with less knots and straight boles. Evaluation of the CPTs will reveal their worth in further breeding programmes and productivity enhancement.



Selected CPT of *Gmelina arborea*

A progeny trial was established at Gudalur Research Station, Kancheepuram District, Tamilnadu.

Also intensive surveys were conducted in the natural forests of Siruvani, Anaikatti, Anthiyur, Sathiyamangalam, Dindugal, Kodaikanal, Sirumalai, Theni and farmers plantation in Pudhukottai. Selected 50 CPTs based on growth superiority, clear bole and freedom from pest and diseases. The reproductive traits like flowering phenology, pollen fertility, pollen germination on stigma and pollinator interaction of *Gmelina arborea* have been studied on the selected CPTs. Wood samples (core) were collected and analyzed for wood parameters

Calophyllum inophyllum

Identified populations of *Calophyllum inophyllum* in Tamil Nadu, Kerala, Puducherry and Andamans.

Trees with high fruit count per foot length branch was taken as selection criteria. Stem cuttings and raised clones of CPTs for establishing germplasm bank collected. Tree-wise oil content quantified to rank the clones.

Sapindus emarginatus

Populations of soapnut in Tamil Nadu were identified in Mettupalayam, Pillur, Palani, Dhimbham, Thengumarada, Thalavadi, Sarkarpathy, Hogenakkal, Aliyar, Srivilliputtur and Rajapalayam. Collected seeds from Pillur and Thengumarada, processed and conducted germination test. The number of fruits per meter length of branch was taken as selection criteria. Measured seedling parameters in the germinated seedlings. Raised stock in nursery and maintenance done for field establishment. Quantified tree-wise saponin content, to rank the CPTs.

Casuarina sp.

The major work done in *Casuarina* improvement is establishment of second generation seed orchards of *Casuarina equisetifolia* and *C. junghuhniana* to increase seed production and genetic gain. So far 16 ha of progeny tests have been established in various locations including 2 ha established near Chennai during the current year.

All the test plots are intensively managed and data on growth, tree form and flowering have been recorded



A Wind-hardy and Fast-growing *Casuarina* hybrid Clone under On-farm Testing in Cuddalore Dt, Tamil Nadu



periodically. Ranking of all trees through index selection method has been carried out for two test plots which have attained the age of 3 years (mid-point of 6-years' breeding cycle). Inferior families and individuals have been marked for culling for conversion into second generation seed orchards.

For evaluation and characterization of clones of *Casuarina* with reference to yield, tree form, biomass, pulping characteristics and key nursery pests; 95 clones were shortlisted for field testing and prepared their planting stock. Established field trials in Tamil Nadu at Mayiladumparai, Karur district, in a sodic site at Pugalur and in a casuarina belt at Sirugramam, Cuddalore district. Biometric / qualitative observations are being recorded from these trials at regular intervals. The top 10 ranking genotypes are Clone 01, Clone 12, Clone 11, Clone 31, Seed lot 01, Seed lot 02, Clone 83, Clone 21, Clone 49 and Clone 29. At Sirugramam, the better performers were CE 2003/5, CE 9, S 88, CE 268, S 90, CE 224, TN 111, CE 219, S89, CH 3001, CE 332, CE 73, CE 2002/1, TNCS 1 and TCR 060101.

A total of 220 clones of *Casuarina* were maintained in a nursery trial. The trial was screened for natural incidence of the targeted pests, *Icerya purchasi* and *Eumeta crameri*. Observations on the incidence and intensity of attack of these pests on the clones, recorded at 15 days intervals revealed variations among the clones for tolerance. Clones free from attack were shortlisted. Analysis of biochemical parameters such as Phenol and Tannin was completed for 10 short listed clones showing different levels of tolerance for *Eumeta crameri* and for 3 clones showing high susceptibility for the scale insect, *Icerya purchasi*.

Study was undertaken to select phenotypes of *Casuarina* which are suitable for developing a windbreak agroforestry system in western zone of Tamil Nadu. Twenty five superior trees have been selected by adopting 'Point Grading Method' of selection by giving greater scores for more branchiness. All the selected phenotypes have been assembled in germplasm bank at IFGTB. These selected phenotypes

were further multiplied and 4 replicated field trials have been established in farmers' field for evaluation of selected phenotypes for their efficacy in minimizing wind speed. Superior clones will be popularized for establishing windbreak agroforestry systems.

Acacia mangium

The advanced generation seed orchards of *Acacia mangium* were created based on biomass and wood density at Mundur (Palakkad). Maintenance works were carried out in the planted trials.



Six Month Old Progeny Trial of *A. mangium* at Palode

Acacia auriculiformis

In order to select promising clones of *Acacia auriculiformis* with desirable stem form and wood properties for short rotation timber production, superior trees of *A. auriculiformis* based on stem form and growth have been selected in Wadkkancherry (15), Panampally (30) and Nilambur (17) Palode (25). Trees have been initially coppiced in Panampally for young shoot production for further rooting. Superior trees (61) selected in Wadkkancherry, Panampally and Nilambur Palode, based on stem form and growth have been multiplied vegetatively and 7000 rooted cuttings made ready for planting in clonal trial and VMG.

Pterocarpus santalinus

A project was undertaken to study variation in *Pterocarpus santalinus* for growth and heartwood content according to edaphic and climatic factors in



A Selected CPT of *Pterocarpus santalinus* (Red Sanders) in Vellore Division, Tamil Nadu

Tamil Nadu. Soil samples were collected and analyzed from five plantations in Ammoor in Vellore Forest Division. Growth data were also recorded from these plantations and core wood samples were collected. Heartwood presence was observed in all the trees sampled. Thirty two CPTs were selected based on heartwood presence and other growth characters.

Study was undertaken for collection of quantitative field data through rapid assessment of population, growing stock and natural regeneration status. Around 400 stratified random sample plots of 0.1 ha were laid out in natural red sander forest areas and data on population structure of red sanders, regeneration were collected, compiled and analyzed. Data on Removals and level of regeneration were also recorded. Threat factors to natural populations have been identified. An



Visit to Red Sanders Depot in Rajampet

NDF report based on CITES guidelines was prepared and submitted to MoEF during February 2012.

Ailanthus excelsa* and *Ailanthus triphysa

In order to study the reproductive biology and breeding systems in *Ailanthus excelsa* and *Ailanthus triphysa*, germplasm bank of *A. triphysa* has been established at Panampalli Field Research Station. Karyotyping work was initiated with root tips. Pollen viability and male and female structural variation in *Ailanthus triphysa* has been studied. Key pollinator have been identified as Indian Honey bee (*Apis cerena indica*) and Dammar bee (*Trigona iridipennis*). Long term pollen storage is being standardized.

For developing clonal technology for raising clonal plantation of indigenous species viz. *Ailanthus excelsa* and *Ailanthus triphysa* in Tamilnadu and Kerala, 170



A Plus Tree of *Ailanthus excelsa*



CPT's of *Ailanthus excelsa* and 120 CPT's of *Ailanthus triphyssa* have been identified. Standardization of the vegetative propagation of *Ailanthus excelsa* is in progress.

Tamarindus indica

For evaluation and identification of optimal parameters for flowering and fruit set in Tamarind (*Tamarindus indica* L.), orchards located at Neyveli, Thoppur, Theni and Mullangaddu were evaluated for flowering and fruiting. Soil samples were analyzed for micro and macro nutrients. Analyzed phenol, carbohydrates, protein and CN ratio from non-flowering and flowering trees. The tamarind orchards were imposed with 30 different treatments for improving flowering and fruiting. Among different treatment soil drenching of Cultar @3000 ppm and spraying of 2% KNO₃ found positive implication on enhancing fruit productivity.



Application of Flower Inducing Plant Growth Regulator in an Unproductive Tamarind Orchards

Thespesia populnea

A study was undertaken to select and screen germplasm of *Thespesia populnea* for improving productivity. Extensive field surveys were undertaken in the Western, North Western, Cauvery Delta and Southern Zones of Tamil Nadu and selected 80 CPTs of *Thespesia populnea* for further improvement. Clonal accessions of 80 CPTs selected mainly based on growth and tree form and assembled at IFGTB.

Community Seed Orchards

A new concept of establishing "Community Seed Orchards" was developed through which farmers and self-help group members were encouraged to establish their own seed orchard in government / village land with inputs from IFGTB in the form of planting material and technical support. The cost of maintaining the orchards for two years is taken care of by the Institute in addition to capacity building of farmers in orchard management. The seeds produced is used by the farmers themselves and any surplus will be sold to others like wood-based industries with quality assurance from IFGTB. Three model orchards have been established in Tamil Nadu and Puducherry which are at present producing seeds.

Tectona grandis

Study was undertaken for realizing genetic gain from teak seed orchards and enhancing seed production through cultural and ecological interventions. Two teak seed orchards (one SSO and a CSO) were evaluated for flowering, fruit and seed production. Organized seed collection with individual tree identity and studied for morphological, germination and seedling characteristics. Studied the impact of flower-inducing and seed-set promoting treatments like paclobutrazol application and introduction of apiaries on the orchard output. Studies initiated for estimation crossing rates in seed orchard in comparison to seed production area. These investigations are expected to yield precise information on the current status of teak seed orchards in terms of seed production and the extent of genetic gain possible through use of orchard seeds.

Identified more than 200 outstanding trees in different teak-growing areas of Kerala and Tamil Nadu and undertook open-pollinated seed collection with individual tree identity. These seedlots will be utilized to raise broad-based breeding populations. The Walayar Teak CSO has been systematically studied for annual flowering and seed production dynamics. Successfully produced fullsibs through control



pollination, involving clones with high general combining ability observed in a 20-year old progeny test. Plus trees were selected and coppices were collected. The selected clones were planted in the Vegetative Multiplication Garden and being multiplied for establishing clonal trials. The rooting performance of different clones was studied. A clonal trial of teak has been established at Salem (TN) which showed outstanding growth performance.

Two orchards one each in Karnataka (Janganamatti, Dharwad) and Andhra Pradesh (Achuthapuram, Rajamundry) were selected to standardize flower induction schedule in clonal seed orchards. Six chemicals like Paclobutrazol, Salicylic Acid, Succinic acid 2, 2-Dimethyl Hydrazide (ALAR-85), Potassium Nitrate, Poly Ethylene Glycol 6000 (PEG) were used in 12 different treatments to study their effect on flower induction. New method for stem injection of chemicals was devised during the experiment wherein ALAR, stem injection along with combination of paclobutrazol and salicylic acid showed encouraging results in both the CSOs.

Genetic variation and inheritance pattern of Western Indian Teak was investigated. The materials for this investigation came from three progeny trials established with 16, 28 and nine half-sib families of teak at Shivrajpur, Sajjangarh and Jodhpur, respectively. The Shivrajpur trial was established in 2008, under the jurisdiction of Silviculture Division, Rajpipla by the SFD, Gujrat, while the other two trials were established in 2010. Analysis of variance of these trials revealed that variation due to families was highly significant for height and collar girth indicating scope for family selection, except in case of Jodhpur trial, where these differences were non significant at one year, but was significant at nine month growth. Height and collar girth exhibited high to moderate estimates of narrow sense heritability, respectively at individual as well as family level.

Family heritability values were considerably higher for both the traits suggesting effectiveness for

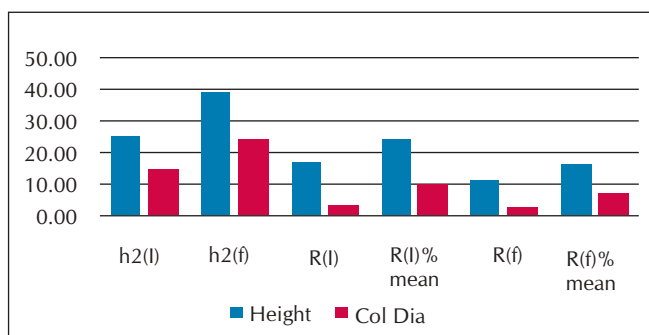
family selection. Genetic advance estimates for these traits also followed similar trend and ranged from 6.41 to 24.32 percent. In addition to this, 15 new phenotypically superior trees were selected from different locations of Rajasthan and Gujarat. Open pollinated seeds from 70 trees from Gujarat and other areas of the country were collected, weathered and seedlings were raised in the nursery.



General View and Close Up view of Sajjangarh Prognny Trial of Teak



CPT of Teak Selected in Gujarat



Heritability and Genetic gain estimate Sajjagarh Trail (1st year)

Validation of DUS Testing Guidelines for Casuarinas and Eucalyptus

The Protection of Plant Varieties and Farmers' Rights Authority entrusted the Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore with the responsibility of developing DUS test guidelines for two widely cultivated forestry crops viz., Casuarina and Eucalyptus. IFGTB has brought out a draft set of guidelines in 2009 followed by its validation with varieties of these two species available with different stakeholders like industries, forest departments, Universities and Research Institutions. A stakeholders meeting on Validation of Descriptors of Casuarinas and Eucalyptus was organized on 15.6.2012 with the funding support of the PPVFR Authority to complete the validation process of the draft DUS guidelines. Stake holders representing paper mills, forest departments, research organizations and universities attended the meeting. After the completion of the validation process, the draft guidelines will be submitted to PPVFR Authority for examination by a Task Force followed by notification in the Plant Variety Journal of India.

Neolamarkia cadamba

Neolamarkia cadamba is being viewed as an alternative species for Pencil, Match Wood and ply wood industries. A project was undertaken to improve *Neolamarckia cadamba* through selection and mass multiplication of superior genotypes. Selection of candidate plus trees has been done in two plantations of



Coppice Shoots of *Neolamarkia cadamba*
Get Rooted through IBA Treatment

Tamil Nadu (Narasipuram and Devarayapuram) and in natural forest at Konni, Parambikulam, and Nilambur forest divisions of Kerala and in South and Middle Andaman. Till date, 72 Candidate Plus Trees have been identified. Standardization of Seed handling technique is in progress.

Hardwickia binata

Survey has been carried out in different parts of Karnataka, Andhra Pradesh and Tamil Nadu to identify the populations of *Hardwickia binata*. Preliminary morphological observations have been recorded and core samples have been collected from different aged plantations. Considerable variations have been recorded with reference to girth, height, bark, sapwood, heartwood and specific gravity.

Diospyros melanoxylon

For selection and cloning of superior germplasm of *Diospyros melanoxylon*, sites were selected and marked for collection of plant materials. These sites were Lohattar (Bhanupratappur), Litipara (Gariaband), Kotadol (Korea) and Madanpur (Katghora) in Chhatisgarh. The germplasm collected from the above sites were maintained. The leaf area and total dry weight of the leaves collected from these localities were measured in order to screen superior germplasm. Significant differences were also observed between localities and sites for dry weight (mg) of leaves.



Collection of Germplasm of *Diospyros melanoxylon* (a) Demarcation of Area for Germplasm Collection (b) collection of Leaf Samples from the Field (c) Collection of Root Suckers from the Field (d) Pretreatment of Root Suckers in the Nursery of TFR I (e) Planted Root Suckers in the Polythene Bags (f) Sprouted Root Suckers.

Seed Testing

Studies were undertaken on seed viability in three recalcitrant species viz. *Dipterocarpus retusus*, *Shorea assamica* and *Aquilaria malaccensis*. Results revealed that the seed size effects seed germination and moisture content in Dipterocarps, and temperature affects the storage of seeds for longer period. In Agar, the storage period of seeds can be increased by storing the seeds at 7°C with 25% moisture content. Study was also undertaken on the Seed biology of *Abroma augusta*.

Aquilaria malaccensis

An Extensive survey was carried out in the North Eastern states to select Agar (*Aquilaria malaccensis*) trees from its natural habitats and also in home

gardens/plantations. 91 trees were selected from Assam, Tripura, Arunachal Pradesh, Nagaland, Manipur and Mizoram. Fruits were collected from the selected trees and progeny of 55 trees was raised. A germplasm bank consisting of 50 progenies of *Aquilaria malaccensis* was established in RFR I campus and preparations are underway to establish another germplasm bank in Arunachal Pradesh. The genetic relationship between the selected trees was analysed by using RAPD technology.

Bamboo

Studies were undertaken for the development of DUS descriptors on *Bambusa balcooa* and *Dendrocalamus hamiltonii*. Extensive field surveys were done to ascertain the availability of *B. balcooa* and *D. hamiltonii* in different parts of North East. Thirty two accessions were collected and multiplied in the nursery. Different morphological characters were studied, such as, Clump Characters, Culm Characters, Branching Characters, Leaf Characters and Culm Sheath.

Tecomella undulata

Candidate plus trees (47 nos.) were selected from various district of Rajasthan based on the quantitative traits (height, girth, clear bole and crown diameter) and qualitative traits (straightness, roundness and health). Progeny trials were established using seedling of 40 CPT's at Bikaner and Jodhpur in August, 2008. The progenies of CPT-23 from Chohtan (Barmer) exhibited best growth at Jodhpur, attaining height of 143 cm and minimum in progenies of CPT-4 (Mohangarh) of 87 cm (at Jodhpur). At family level, highest survival (97.2%) was found in progenies of the CPT-15 (Daichu) and minimum (75%) in progenies of CPT-23 (Chohtan) at Jodhpur, whereas, at Bikaner progenies of CPT-3 (Mohangarh) exhibited highest survival rate of 73% and minimum (36%) in progenies of CPT-4 (Mohangarh). At Bikaner, highest collar diameter was 1.09 cm in progenies of CPT-24 (Chohtan) and least collar diameter (0.70 cm) was of progenies of CPT-2



Overview of Progeny Trial of *Tecomella undulata* at the age of 3½ years at Jodhpur



Close up View of Progeny Trial of *Tecomella undulata* at the age of 3½ years at Jodhpur

(Mohangarh). In general, growth performance was poor at Bikaner as compared to that at Jodhpur.

Azadirachta indica

Studies were undertaken to screen oil and Azadirachtin content in progeny trial established in the year 2002 at Govindpura, Jaipur with seedlings of selected 17 CPTs. This trial is almost, now, 9 year old and significant variation in flowering and fruiting has been recorded. Seed collected from 33 trees belonging to 10 families showed high oil content (above 40%).

Prosopis cineraria

A coordinated project on integrated management of Khejri mortality for socio-economic upliftment in Rajasthan was undertaken by AFRI Jodhpur. Surveys

were conducted in Nagaur, Sikar, Churu and Jhunjhunu districts of Rajasthan and 21 candidate plus trees (CPTs) were selected. Pods collected from selected CPTs and parameters from individual pods of these CPTs like; length, width and weight have been recorded. Cutting and layering experiments were conducted on mature trees of *Prosopis cineraria* for their clonal propagation.



Selected CPTs of Khejri in farmer's field

Pinus gerardiana

A project was undertaken on isozyme variation in natural populations of *Pinus gerardiana*. Survey of chilgoza populations in Kinnaur and Bharmour areas of Himachal Pradesh was carried out for regeneration studies and selection of Plus Trees. It was observed that owing to biotic pressure and local people enjoying the rights of seed collection, the regeneration in these areas has been very negligible. There was very poor cones/seed production during the year 2010-2011. For



conducting genetic diversity studies in the dwindling populations of *P. gerardiana*, isoenzyme, protocols have been standardized.



Isozyme Variation Studies and Plus Tree of *Pinus gerardiana*



Regeneration Status in *Pinus gerardiana*

Identification of Distinct Traits for DUS for Conifers

Five populations of *Pinus roxburghii* viz. Chabbal forest, Banethi, Nurpur forest, Nerva, Dibkan and four populations of *Cedrus deodara* viz. Chopal, Cheog, Chail and Kinnaur were surveyed for distinct traits. The observations with regard to needle length and colour were found to vary considerably. The distinctness in traits for cone size and crown shape in both the species are also being looked into to identify distinct genotypes. The genotype of deodar in Chopat Forest division has been identified with distinct drooping branches. More populations of both the species are being surveyed for identification of individuals with distinct traits

Moringa oleifera

Information on natural populations/growing areas/ plantations of *Moringa* in Jharkhand, West Bengal, Bihar and Odisha collected. Superior seed sources have



Bark Pattern of *Pinus roxburghii* and *Cedrus deodara*

been identified at different locations and 25 potential areas (8 in West Bengal, 6 in Orissa, 7 in Jharkhand and 4 in Bihar) have been demarcated. Cuttings collected from identified sources and clonally multiplied and maintained in Lagutwa germplasm garden. The rooting season has more pronounced effect than growth regulators with planting of big size woody cuttings (30-50 cms) in open prior to monsoon and gives >90% success.

Kusum (*S. oleosa*) for Lac Cultivation

Studies were undertaken on pollarding and propagation in Kusum (*S. oleosa*) for lac cultivation. Stem cuttings and scion of plus trees of Kusum were collected from Basia, Simdega, Bano etc. and air layering on superior trees made. Ten years old Kusum trees were pollarded at height of 1m & 1.5m and observations on number of shoots / branches emerged are being recorded.

Natural Dye Yielding Plants

Study was undertaken on selection and improvement of natural dye yielding plants. Accordingly, 17 superior dye yielding trees of *Mallotus philippensis* and 6 of *Wrightia tinctoria* were selected. Laboratory protocols are being developed for extraction of dyes from *Mallotus philippensis* and *Wrightia tinctoria*.

Vegetative Propagation

- Studies are underway on development of micro propagation protocol of *Rhododendron arboretum*. Both micro and macro methods of propagation is being applied. FRI wire technique applied on 15 *Rhododendron* trees near Surkanda. Experiment is till going on.
- Vegetative propagation of *Dalbergia sissoo* and Eucalyptus clones carried out. In *D. sissoo* 75 clones were multiplied and about 10000 plantlets were produced. The propagated plants were established in clonal trials at different locations of Haryana, Punjab, U.P and Uttarakhand. Similarly, in Eucalyptus about 500 plantlets were produced for experimental purpose.
- Developed new technique on rooting of 3 node thin branch cuttings (less than pencil thickness) of *B. bambos* and achieved 46% of rooting with the treatment of IBA and Boric acid.
- The farmers were trained on clonal propagation of farm forestry species like *Eucalyptus*, *Casuarina equisetifolia* and *Bamboos* to make them self sufficient to satisfy their own requirements of superior planting stock.
- In *Calophyllum inophyllum*, standardized vegetative multiplication, using different concentrations of IBA on stem cuttings.
- In *Sapindus emarginatus*, various concentrations of IBA tried for root induction. Apical shoot cuttings using IAA and IBA combination gave rooting success of 25%.
- Seventy four superior *Pongamia* trees are being multiplied through branch cuttings and are being maintained for establishing clonal trial and clone bank.
- Experiments on *in vitro* rhizogenesis in five clones (GBW 4, JB 1, FZB 1, FZK 1, RSK 1) of *Dalbergia sissoo* were conducted. One field trial has been established with tissue culture raised plants of the 5 clones. A good growth of plants with 81% survival has been recorded depicting a maximum height of 79.57 cm in FZB 1 clone.



Developing the Process of Hardening is under Progress



Establishment of Field Trial of Five Clones of *D.sissoo*

- Studied endogenous auxin levels and its relationship with adventitious rooting potential in

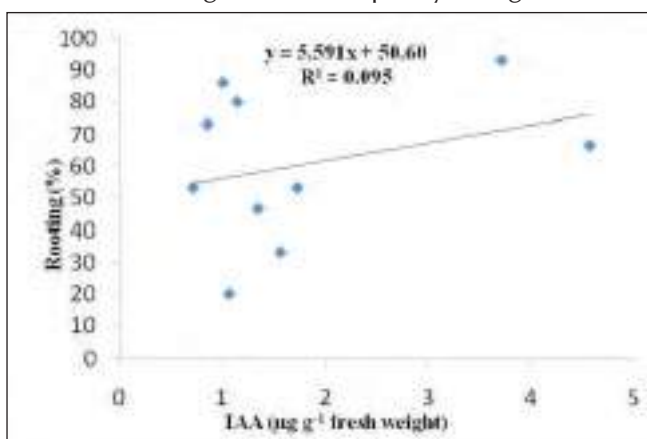
Dalbergia latifolia. Significant seasonal/genotypic variation was recorded in endogenous auxin (IAA) and in rooting potential of selected trees. Selected trees exhibited maximum rooting potential just after rainy season. Rooting potential of selected



Adventitious Rooting in *Dalbergia sissoo*



trees do not correspond with their endogenous IAA level. Exogenous IAA treatment helped in expression of the inherent rooting potential by way of local redistribution and lateral supply of endogenous IAA to the target cells in the pericycle region.



Relationship Between Endogenous IAA and Adventitious Rooting

- Studies were undertaken on development of vegetative propagation protocol of selected bamboo species viz., *Bambusa polymorpha*, *B. bambos*, *Teinostachyum dullooa* and *Melocanna baccifera* using different growth hormones. It was observed that 200 ppm IBA for *Melocanna baccifera*; 300 ppm IBA for *Bambusa bambos*; 100 ppm IBA + 50 ppm NAA for *B. polymorpha* and 50 ppm IBA + 100 ppm NAA for *Teinostachyum dullooa* gave best results for maximum shoot production. Observations also revealed that the standard basal media was Soil: Sand: FYM (1:1:1) in case of *Bambusa bambos* and *B. polymorpha*.
- Grafting technique for mature trees of *Ailanthus excelsa* developed (grafting success \approx 50%), which is presently more efficient over any other clonal technique. Wedge grafting gave better success than patch grafting. This technique can be handled easily by farmers and field staff of SFDs.
- Variability in rooting proficiency in selected genotypes of *Pongamia pinnata* was investigated. Scions were collected from 23 trees. Up to 30% success in rooting of mature stem cuttings was observed. Whereas, >70% rooting was observed

in cuttings taken from seedling. Variability in grafting success among PTs was also observed.

- For clonal propagation of *Salvadora persica* from Rohat, Sanderav, and Balotra, different concentrations of auxins (500-4000 ppm) were tested. IBA 2000 ppm was found to be the best for rooting from stem cuttings. Rooted cuttings were transferred to polybags consisted of mixture of FYM: Sand: Soil in the ratio 1:1:1 (V/V), and kept in agroshade net for one month. Among the rooting media studied (viz; Sand, Soil, Vermiculite) sand proved the best rooting medium.
- For development of technique for multiplication of economically important desert plant *Capparis deciduas*, three types of cutting of *Capparis deciduas* were used for rooting viz, softwood, semi hard wood and hard wood. Semi hard wood cutting gave better response. 1000 ppm IBA was found to be the best for rooting from stem cuttings. Experiments for rooting of stem cutting were conducted in April to March. Cutting harvested during the month of March-April and August-September-October were found to be best for rooting. Sand:Soil:FYM (2:1:1) was found to be the best for rooting of stem cutting.

2.3.3 Biotechnology

Use of Molecular Markers in Breeding Programmes

- *Eucalyptus camaldulensis* and *E. tereticornis* are the most commonly cultivated for industrial plantations in India. Both the species are closely related and hybridized naturally hence discrimination of these species based on morphological features is challenging. Authentication of species identity is highly essential in genetic improvement program, particularly during the establishment of seed orchards and progeny trials. Efforts were made to use microsatellite markers and discriminate the species and their putative hybrids. Fifty five microsatellite loci belonging to 11 linkage groups



and 7 unmapped loci were amplified in 93 individuals, belonging to two species and landraces. Fifty nine microsatellite markers (95%) were polymorphic and 3 loci were monomorphic, across all the three groups. Analysis of 38 microsatellite loci (61%) for the presence of most common alleles with GDA software showed that 36, 27 and 39 SSR alleles were specific for *E. tereticornis*, *E. camaldulensis* and landrace respectively.

- In an attempt to estimate the outcrossing rate in *Acacia* seed orchards, fifty three families of *Acacia auriculiformis* in the orchard (Panampalli) were studied for the diversity analysis using ten ISSR primers.

Quantitative Trait Loci (QTL) Mapping in *Eucalypts*

Efforts are being made to develop linkage and QTL maps in *eucalypts*, wherein SSR genotyping of parents such as *E. camaldulensis*, *E. tereticornis* and *E. grandis* was carried out to select polymorphic loci. In the present study, a cost effective M13- tailed three primer strategy was optimized for SSR polymorphism studies in *Eucalyptus* species. In this approach, PCR amplification was carried out using locus-specific forward primer with M13 tail (TGTA AACGA CGGCCAGT) at its 5'end, a locus-specific reverse primer, and the fluorescent-labeled M13 primer, the same sequence added in the locus-specific forward primer. The M13 primer can be labeled with various fluorescent dyes such as FAM (blue), VIC (green), NED (yellow) and PET (red) and this enables multiloading, which further reduces the cost per sample. The three primer M13 strategy is presently used for characterizing the mapping populations, *E.camaldulensis* × *E. tereticornis* and *E.tereticornis* × *E. grandis*. Concurrently, identification of DNA markers using association mapping strategy was also initiated in *E. tereticornis*. In this study, three developing xylem specific cellulose synthase (*CesA*) genes were isolated and characterized. Alternately, another gene HD-Zip class II transcription factor responsible for fiber related traits was also isolated partially. These genes can be used as one of the candidate gene for identifying the marker for pulping traits. This study will play an essential role in isolating the differentially expressed

genes involved in xylogenesis from commercially important species of *Eucalyptus*.

Gene Isolation and Functional Analysis

- In *Casuarina equisetifolia*, a truncated gene sequence of Cinnamyl Co A reductase (CCR) was characterized and the 850 bp sequence was deposited in NCBI. This would provide a lead to identify alleles targeting lignin deposition in wood.
- Further, studies are in progress to identify genes conferring biotic and abiotic tolerance in various forest tree species and medicinal plants. In this effort, a total of fifteen new gene sequences pertaining to sodium transport (HKT1, NHX1), housekeeping genes (Actin) from *Eucalyptus tereticornis*/ *Eucalyptus camaldulensis*/ *Casuarina equisetifolia*/ *Prosopis juliflora*/ *Millettia pinnata*, and insect growth and development (chitin synthase), xenobiotic responsive gene (SXR-like protein), housekeeping gene (Actin, elongation factor 1-alpha mRNA), from *Leptocybe invasa*/ *Hyblea purea* were identified and published in NCBI. The database (*In silico* Gene Bank for Adaptation to Abiotic Stresses) was hosted in the web (www.igpaas.co.cc) and is, now, in the test phase. In *C. equisetifolia*, salt tolerance was found to be associated with higher proline levels in the salt tolerant clone TNIPT4, when compared to the susceptible clone, PYN.
- Full length lectin gene with approximate size of 894bp was cloned and sequenced from salicylic acid treated leaves of *Withania somnifera*. The gene designated as *WsMBP1* showed significant similarity to *CaMBL1*, a mannose binding lectin from *Capsicum annum* ($e=0.0$, maximum identity = 88%). Presently, study is in progress to characterize the recombinant lectin for its antifungal and antipest properties.

Salinity Tolerance in *Casuarina equisetifolia*

Efforts are on to identify suitable biochemical markers to enable screening of clones of *C. equisetifolia* developed and maintained by IFGTB. Plant samples were tested for morphological, physiological and



biochemical responses. A demonstration trial to test the clonal performance on saline soil was established. Identified biochemical markers and grouped the clones based on saline tolerance

Pretreatment of Bamboo chips

On the basis of chemical analysis and SEM, pretreatment of Bamboo chips and mechanically processed fibers with best identified fungus *Trametes versicolor* initiated for conducting pulping experiments in bulk. Kraft pulping of treated and untreated was carried out. Black liquor generated was analyzed for various parameters with respect to chemical recovery. Pulp yield and kappa number of unbleached pulp in both the cases were determined. Bleaching by conventional CEHH sequence was carried out on the basis individual kappa number of control and treated chips's pulp. Chlorine was applied on the basis of kappa number. Physical strength properties and optical properties were determined. It was observed that there was 8-10 points gain in brightness over the control untreated chip's pulp, however, the pulp, yield was slightly lower than the unbleached pulp. The physical strength properties were adequate in both the pulps.

Development of Micro propagation Technique

- Studies were taken to scale up the protocols for *in vitro* propagation, hardening, production of cloned plants and establishment of field trials of Sandalwood (*Santalum album* L). For micro propagation through axillary shoots proliferation, the best medium for *in vitro* rooting was standardized as MS basal medium consisting of Glucose 3% and Agar 0.58% when shoots were inoculated after pulse treated with IAA 2500ppm + IBA 2500ppm (pH-7.0) for 30 min. For hardening, it was found that primary hardening in sand followed by secondary hardening in potting medium consisting of sand : compost: soil (35:50:15) is ideal for hardening of *in-vitro* raised plants of sandal. Field trial of *in-vitro* raised plants of sandal was carried out. 73.68 % survival was recorded after five months.

- Development of micropropagation protocols for production of superior germplasm of *Dalbergia latifolia* Roxb. and *Pterocarpus santalinus* was done. Two different explant types were compared for multiple shoot induction. Nodal segment performed better in MS medium supplemented with 1.0 mg/l BAP. Among the several media combinations tested, MS medium supplemented with NAA (0.1mg/l) and BAP (1.0-2.5 mg/l) proved best for multiple shoot induction. 80% success in shoot initiation with 4.20 shoots per explant and maximum shoot length (1.50 cm) was obtained on MS medium supplemented with NAA (0.1 mg/l) + BAP (1.0 mg/l) within 4 weeks period.
- Studies were conducted to develop an efficient micropropagation protocol for clonal multiplication of *Dendrocalamus hamiltonii*. Methodologies have been developed for shoot multiplication and root induction.
- Effects of different types of medium; MS, WPM, and B₅ were studied for *in vitro* shoot multiplication in *Salvadora persica*. Amongst the media, MS medium was found to be the best for shoot multiplication. Among the different cytokinins (BAP, Kn, TDZ and Zeatin), used for *in vitro* shoot multiplication, MS medium with BAP was found to be the best. *In vitro* shoot multiplication cultures were maintained on MS medium supplemented with 0.5 mg/l BAP + 0.1 mg/l IAA + additives (ascorbic acid, citric acid, L- arginine, L- asparagine, adenine sulphate).
- For micropropagation of *Capparis decidua*, two types of basal media viz, MS and WPM were tried to optimize multiplication rate of *in vitro* raised shoots. Maximum shoot multiplication rate and 3-4



Macropropagated Plant of *Salvadora persica*



In-Vitro Shoot Multiplication of *Salvadora persica*



folds were obtained on MS medium supplemented with 2mg/l BAP + 0.5 mg/l IAA + additives.

- Studies have been undertaken on development of micropropagation protocol for mature superior recombinants emanating from F2 generations of *Eucalyptus* hybrid *E. citriodora* x *E. torelliana*. Experiments on multiplication resulted best in MS supplemented with 2 BAP + 1 NAA, Sterilents used: Sodium hypochlorite. Standardization of rooting is still going on.
- A network research project on guggal *Commiphora wightii* was executed. More than four years old embryogenic callus cultures were maintained

continuously on modified MS medium supplemented with hormones and without hormone free medium with alternate sub-culturing. Secondary and tertiary somatic embryos (SEs) were also obtained. Cyclic embryogenesis was established and stabilized. White long matured SEs were harvested for the germination on hormone-free MS medium. Germinated SEs were used for *in vitro* hardening. 40 plants in *in vitro* hardening stage and 70 plants in poly-bags, which are ready for out planting. Growth data (height, collar diameter, primary and secondary branches and number of leaves) were collected at regular intervals. Plants are growing well in the field condition for the last one year with 100% survival. The plants exhibited normal growth and no morphological abnormality noticed. Isabgol, sago powder and guar gum were used along with agar as a control for alternative low cost gelling agent experiments. DNA isolation and purification from fresh leaves of tissue culture raised *C. wightii* plants growing in field were carried out by using the protocol given by Sanghamitra *et al*, (2009). Six RAPD primers were tested to check the genetic fidelity of *C. wightii* tissue culture plants at preliminary level. It was observed that all bends were found monomorphic, as such, no variation was observed.



In vitro Multiplication of *Capparis decidua*



Bud Break in Nodal Explants of *Eucalyptus* hybrid



Multiplication (one to many) of *Eucalyptus* hybrid



Rooted Plantlets of *Eucalyptus* hybrid



DNA Fingerprint Generated Using two RAPD Primers (OPA 20 and OPN 6) of Tissue Cultured Plants of *Commiphora wightii* Growing under Field Condition

2.4 Forest Management

2.4.1 Overview

One of the most important forest policy goals is to improve forest management on sustained basis. For sustainable use of forest resources, the strategy is to harness the potential productivity of forests, simultaneously maximizing net yield from afforested lands. For conceptualizing a production function, forest management essentially needs accurate predictions of output of socio-economic benefits in terms of yields for all relevant combinations of measurable forest characteristics viz., age, site, density and growth. These estimates are crucial for intelligent management decisions on optimum rotation, planting density, thinning schedule, and treatment regime. Too much removal from forests may lead to liquidation of growing stock and too little would be inefficient use of resource because available growth potential is not fully harnessed and society is deprived of immediate benefits. Such information is also required for silvicultural and environmental management and is, therefore, generated by ICFRE since long. This work is being extended to cover more species and areas of the country. Forest management plan of forest fringe areas is being developed with the aim to provide better tools for managing these areas in harmony with local socio-economic and ecological requirements. National Working Plan Code is being revisited and modified to give specific guidelines for microplanning of JFM and wildlife areas. A draft report for revised National Working Plan Code has been submitted to MoEF, Govt. of India.

Wood carving industry has great potential for export. Hurdles in the way of this industry are being examined with the goal of overcoming them. Need for demand, supply and market intelligence information system of forest produce has been

realised and effective steps have been taken at ICFRE to bring it to the doors of buyers, sellers and consumers. Successful marketing models of agriculture and forestry sectors are being analysed for their wider application in forestry. Rapid steps have been taken to apply information technology for providing internet-based information on various plant, insect and diseases.

Project under the Theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	03	10	04
Externally Aided	00	07	01
Total	03	17	05

2.4.2 Sustainable Forest Management

Soil and vegetation survey has been carried out towards the goal of preparing management plan for Asola Bhatti Wildlife Sanctuary, New Delhi.

Mathematical models have been developed to understand infestation pattern of herbivorous insect pests. Models suggest a distinct possibility of factors like protandry in regulating discrete generation cycles.

The process of identification of forest fringe villages and their socio-economic and ecological survey has been initiated which upon completion will cover 275 rainfed districts of India. Socio-economic survey of 67 villages and ecological survey of 7 villages have been completed in Jorhat, Sonitpur and Darang district of Assam. The GPS data were recorded for the villages surveyed.



2.4.3 Forest Economics

Data on demand, supply and market intelligence of bamboo resources has been collected and analysed in four states/ union territories of north India.

Data on non-timber forest products of chir pine has been collected from government bodies and forest dwellers. Studies are being conducted on successful marketing strategies in agriculture and forestry sectors and distribution channel of state forest departments, NGOs, farmers' cooperative initiatives, etc.

Ten wood carving centres have been selected in north India to generate information on constraints in export of carved wood products and impact on livelihood and ecology. Socio-economic, technical and technological data are also being collected.

Development and testing of questionnaire is being done to understand the marketing mechanism of *Ailanthus excelsa* and *Melia* spp. in Haryana, Punjab and western Uttar Pradesh.

Information on price of selected commercial timber species and bamboo has been collected from selected markets and forest department/ corporations on country basis. The collected information is published in the form of Timber and Bamboo Trade Bulletin.

2.4.4 Forest Biometrics

Fourteen sample plots have been set up for *Prosopis cineraria* and *Ailanthus excelsa* in IGNP region of Rajasthan. Measurements of trees have been taken for productivity and biometrics studies.

Sixteen permanent sample plots of teak have been laid out in Gujarat state and permission has been sought from the concerned state forest department for felling.

Twenty-seven sample plots have been laid out in teak plantations of Karnataka.

2.4.5 Policy and Legal Issues

A draft report for revised National Working Plan Code has been submitted to MoEF, Govt. of India along

with the annexure on "Micro Plan Process for JFM Areas" and "Micro Plan of Eco-development for Wildlife Areas". Workshop-cum-meeting was conducted and suggestions from participants were incorporated in the draft Working Plan Code.

2.4.6 Information and Communication Technology

Deodar (*Cedrus deodara*) and Kail (*Pinus wallichiana*) Information System is in advanced stage of development using remote sensing & GIS techniques. Text has been compiled and edited. Scanning and editing of all the diagrams, figures and photographs are complete. Deodar and kail maps of Uttarakhand state have been prepared and verified by ground truthing. The maps of Himachal Pradesh and J&K are being developed.

Survey has been completed and ground truthing is being carried out for development of GIS/RS based system for identification and monitoring of lac host belts in Chotanagpur region.

An information system has been developed for forest tree species associated insects and their management. Data have been collected for the insect pests and diseases associated with *Shorea robusta*, *Dalbergia sissoo*, *Dalbergia latifolia*, *Acacia catechu*, *Acacia nilotica*, *Albizia lebbek*, *Ailanthus excelsa*, *Bamboo*, *Tectona grandis*, *Butea monosperma*. For insect pests, information has been provided on taxonomical details, distinguishing characters, nature of damage, host range, natural enemy and control measures. For diseases, data have been uploaded for seed, nursery, plantation/natural forest and wood diseases, type of pathogen and remedial measures.

A web portal is being created for forestry research extension to provide comprehensive information on tree and shrub species of arid and semi-arid areas. Relevant data and photographs have been collected.

Data collection is in progress for development of sandalwood information system. Necessary equipment



has been procured and fields of database have been finalised.

Web database has been designed for more than 100 commercial timbers species of south India. Information about market price and supply route has also been included in the database.

Format has been finalised for the collection of information on fast growing tree species in Tamil Nadu and Kerala for development of database.

Studies are being carried out on successful information technology enabled (web 2.0) marketing strategies e.g. blogs, wikis, social networking hubs (e.g., facebook, MySpace), web-based communication modes (e.g., chatting, chat groups), special interest groups, photo-sharing, video casting and sharing, audio sharing, mashups, widgets, virtual worlds, micro blogs (e.g. twitter) etc. in several organizations viz. CIFOR, ICRAF, ICRISAT, Cisco, etc.



Flowering in *Albizia lebbbeck* (Siras)



Tecomella undulata under Flowering (Rohida)



Flowers of *Butea monosperma* (Palash)



A Flowering Tree of *Butea monosperma* (Palash)



Flowering in *Azadirachta indica* (Neem)



Flowers of *Kigelia pinnata* (Balam Khira)

Few representative tree species used for web portal

2.5 Wood Products

2.5.1 Overview

Wood and wood products are selected mainly on the basis of physical and mechanical properties for various end uses besides other properties. Non-destructive testing like ultrasonic and FTNIR spectroscopy techniques that are undertaken may be a potential tool for estimating quality of timber in short duration in comparison to the traditional test procedures and ultrasonic technique may also be useful for the detection of defects in log/ trees. Current research is focused towards using plantation timber; use of FT-NIR and ultrasonics for wood quality assessment; modification of wood surfaces for enhancing its stability, durability and surface qualities; development of new methods of timber drying; testing of exotics and imported species for their durability and treatability; developing surface coating systems, use of plant extract as preservative and lignin in various by products.

Finger jointing as a tool for utilizing economically mill waste has caught the imagination of solid wood industries worldwide. However, this technique is yet to pierce the Indian market. The present utilization is mainly on non-load bearing members like table tops, frames of flush doors etc. FRI has initiated research into utilizing finger joints for structural and semi-structural uses. In this direction a project on laminated short beams of different species was concluded. Results are indicative of finger jointing being effective in *Ailanthus excelsa*, *Populus deltoides* and *Mangifera indica* wherein more or equal bending strength and elasticities were observed as compared to those in laminated beams of solid sections without finger joints.

Drying behaviour of timber of Chir pine and Shisham wood was studied in a self designed convection-heating type vacuum kiln. Treatment

methodology for Douglas fir with ZiBOC developed. Complete protection of Meranti (Red, Yellow and White) and Douglas fir is yard test could be achieved after treatment with ZiBOC, CCA and CCB after 20 months of installation. Two species of timber (*Acacia auriculiformis* and *Hevea brasiliensis*) were thermally treated at different temperatures under different environments (vacuum and nitrogen atmosphere). Certain physical and mechanical properties were determined and compared with untreated samples. Dimensional stability and colour of the wood samples were improved due to thermal modification which makes the material more suitable for flooring applications. Thermal treatments are found to be effective against termites in soft wood but not in hard wood. Twenty two imported species of different country of origin were evaluated for natural durability in Dehradun test yard. After 36 months, samples of all species were badly decayed except teak of Myanmar, Ghana and Tanzania. Performance of *Pinus roxb.*, *Pinus radiata*, *Pseudotsuga menziesii* in prototype cooling tower with CCA, CCB and ZiBOC preservative revealed that *Pinus radiata* performed badly as compared to other species.

Physical and mechanical properties of *Bambusa bambos* (L.) and *Dendrocalamus strictus* (Roxb.) have been carried out to find their suitability as an alternative of wooden dunnage pallets. Wood quality of clones of *Eucalyptus tereticornis*, *Eucalyptus eurograndis* and *Acacia* hybrid have been carried out for finding the suitability of clonal material for handicraft sector.

A solvent free process has been developed concerning the chemical modification of wood by acetic anhydride and butyric anhydride with iodine as catalyst. The presence of small amount of iodine elevated the conversion rate of modification significantly. This finding has commercial implications



as reduction in treatment time will bring down the cost of modified wood.

Properties of thermally modified rubberwood and silver oak were evaluated. Heat treatment resulted in colour darkening and improved dimensional stability although a significant loss in static mechanical properties was observed.

Project under the Theme			
Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	04	12	06
Externally Aided	02	01	00
Total	06	13	06

2.5.2 Wood and other Lignocellulosic Composites

Plantation grown wood like poplar and eucalyptus are mostly being used extensively in plywood industries. Therefore, plywood industries in the country have been looking for alternative species. As it is difficult to get single species for making plywood, and non-availability of data, the combination plywood may be the solution for this problem. In this direction paper mulberry and in combination with poplar is being tried for plywood. Plywood and other composite wood items are susceptible to fire and degradation. However, on treatment with fire retardant chemicals, glue shear strength of plywood decreases. Therefore, to overcome this weakness, different fire retardant and preservative compositions were being tested on plywood to evaluate their effect on glue shear strength.

Jute and wheat husk were explored as a reinforcing materials for bio-fiber filled polypropylene composites. Composites with varying proportion of jute and wheat husk (10% to 50%) were prepared with and without compatibilizer. Jute filled composites exhibited

superior mechanical properties than wheat husk filled composites. At 50% jute content, tensile strength, flexural strength and tensile modulus exhibited 87%, 95% and 300% increase, respectively over virgin polypropylene. Whereas, for wheat husk, these properties exhibited a marginal improvement. M-TMI-g-PP was proved to be a better coupling agent than MAPP.

Cellulose HDPE and HDPE co PP composites were prepared using Cellulose supported catalyst system. For one step synthesis of cellulose filled composites a high pressure gas-liquid slurry reactor system with metered feeding of gaseous monomer and a catalyst feeding system was used. Experiments were conducted to study the effect of monomer to comonomer concentration and catalyst to cocatalyst ratios on polymerization yield. Molecular weight was determined by gel permeation chromatography. A kinetic model for ethylene homopolymerization was developed to predict instantaneous reaction rates. The kinetic rate constants for initiation, propagation, chain transfer and deactivation were estimated using a systematic optimization strategy. It was found that the reaction rates increases with temperature and monomer and catalyst concentration (pressure). Temperature exhibited strong negative influence on molecular weight. Pressure has little effect on Mn but high pressure produce polymer with higher polydispersity (PDI). Higher catalyst content will produce low molecular weight polymer.

All the experiments planned to study the effect of concentration of nanoclay, use of additives, method of incertation of nanoclay, and wood content on properties of composites are completed. All the formulations were moulded into test specimens and evaluated for mechanical performance as per ASTM standards (Impact strength both notched and un-notched, Flexural strength, Tensile strength and MoE). Microstructure-based FEA models in 2D were developed to study the mechanical behavior of montmorillonite-filled polypropylene



nanocomposites. Monte Carlo simulation gave the range of modulus values. Mean values of the modulus obtained by Monte Carlo simulation is in agreement with the experimental results.

Experiments on Extraction of cellulose nowhiskers by acid hydrolysis, tempo oxidation method and enzyme hydrolysis method completed. Effect of temperature and sonication time on yield studied. Nanocellulose was prepared using a combination of mechanical (ultrasonication and high pressure homogenization), Chemical (acid hydrolysis and enzyme hydrolysis, and tempo oxidation) and using a combination of mechanical and chemical methods. Achieving nano cellulose with pure mechanical methods was very difficult. High shear forces were thermally degrading the cellulose extensively and high pressure homogenization was getting clogged very frequently. Only chemical methods were able to reduce the size upto 200-300nm. For further reduction mechanical treatment was necessary. Acid hydrolysis and tempo assisted oxidation produced best results with fiber diameter in the range of 40 to 130 nm and lengths of several hundred nano meters. Enzyme hydrolysis did reduce the size but it was too large for processing in homogenizer. The homogenizer was getting clogged very frequently and due to large size shear induced thermal degradation was also taking place. Grafting of MMA for preparation of nanocomposites completed. Cellulose nanowhiskers were grafted with polylactic acid and compounded with neat polylactic acid. Specimens preparation as per ASTM standards evaluation of mechanical properties is under progress.

For development of Natural Fiber-PVC composites for light structural applications, a high speed mixture and specific screw elements were procured. A new screw has been designed and fabricated for blending of PVC with lignocellulosic fibers. Rheological behaviour of PVC blended with different fibers (Wheat husk and coir) having different levels of loading ranging from 10% to 50% and with two

coupling agents (in house developed m-TMI-g-PP and commercial grade MAPP) were carried out to study shear effect and torque with time. PVC-coir composites were characterized by FTIR.

2.5.3 Wood Processing

An indigenously designed convection heating type vacuum kiln has been installed in 2010-11 in the Wood Seasoning Discipline, FRI Dehradun. Drying behaviour of timber of Deodar, Toon, Chir pine and Shisham wood was studied in this kiln. The drying time of these timbers reduced remarkably in the vacuum kiln as compared to the conventional steam-heated kiln. The vacuum kiln is clean energy based emission free timber drying technology.



Vacuum Kiln for Timber Drying Developed by FRI, Dehradun

2.5.4 Value Addition and Utilization

Due to environmental concerns regarding the use of certain classes of preservatives, there has recently been a renewed interest in alternative methods for wood preservation. Different heat treatment techniques are tried to improve durability of wood. Modification of wood is also tried to improve durability. There is scarcity of suitable wood for cooling tower industry; therefore the study to find out alternate species and preservatives which can give substantial life to cooling tower is being tried. Imported species are also being studied for their performance in three agro climatic



condition for their natural durability and durability after treatment.

Under the study on constraints in the export of carved out wood products and its economical and social impact on the livelihood of dependent people in north India, literature regarding distribution of Wood Carving Industry, its economic contribution and identification of problems with focus on raw material procurement, manufacture of carved out wood products and their marketing has been studied. Ten wood carving centres have been selected throughout North India viz. Srinagar, Rajouri, Chamba, Kullu, Hoshiarpur, Amritsar, Saharanpur, Nagina, Udaipur and Jodhpur. Reconnaissance survey has been undertaken. Questionnaires have been developed in such a way so as to assess the economic condition, literacy level, specialization, working tools or machines (technology) used, number of working months, alternate source of income, type of working, constraints in the development of skill and economic upliftment.

Chemically modified (benzoylated and acetylated) wood specimens of Rubber wood (*Hevea brasiliensis*) and Radiata pine were coated with a transparent and opaque polyurethane exterior paint. The coated panels were exposed to outdoor weathering and samples were periodically examined for weathering deteriorations. Results indicate that performance of coating on modified wood was remarkably improved as compared to unmodified specimens. Chemically modified wood, improved coatings adhesion and enhanced performance of paints significantly.

Analysis on the quantum and types of woods imported in India revealed, teak as the most preferred species of import. Based on the cumulative natural resistance in the graveyard conditions, major imported timbers were classified. Accordingly the highly resistant woods were *Dryobalanops aromatica*, *Tectona grandis* (from five countries), *Shorea laevis*, *S. marcoptera*, *S. robusta*, *Pterocarpus soyauxii* (from two countries) and *Xylia dolabriformis*. *Quercus robur* was moderately

resistant to termite attack. *Fagus sylvatica* (from two countries), *Fagus grandifolia*, *Fraxinus angustifolia*, *F. excelsior*, *Acer pseudoplatanus* were susceptible to termite attack. All the tested imported species performed more or less in the same way as in marine condition. In general, woods from temperate regions were found more susceptible to termites than that of tropical regions. The study on the seasonal wood degradation activity of four species of *Odontotermes* viz., *O. horni*, *O. feae*, *O. obesus* and *O. wallonensis* revealed that all the four species were active throughout the year. Peak abundance of *O. obesus* was in the month of May, whereas for *O. wallonensis* it was from April to May. *O. feae* was active throughout the year and *O. horni* was highly active during June and August. The strength properties of resistant woods remain more or less the same and comparable before and after exposure for a period of one and three years.

Ten, 15 & 20 yrs old timber of *Acacia auriculiformis* and *A. mangium* showed good resistance against both decay fungi and termites and they may be classified under Class I; whereas, 5 yr timber comes under Class II. *E. tereticornis* are highly resistant (Class I), *G. robusta* belongs to class III and *M. dubia* falls under non-resistance class (IV). *Ailanthus* species exposed to termites and fungus showed that they belong to the durability class III with service life less than 60 months but resistance of *A. malabarica* is more than *A. excelsa*. All the age group timbers of *Grevillea robusta*, from both the wet and dry regions fell within the resistant to moderately resistant class when tested against decay fungi under laboratory conditions. Timber from 5 year old trees was destroyed completely by termites within 4 years of exposure in test yard. While 10 year samples showed retention between 35 and 50 %, 15 and 20 year timber samples showed good resistance (80–100 %) up to 3 years of exposure. The susceptibility to termite attack reduced as the age of the tree increased. Any age group of *Maesopsis eminii* is not naturally resistant. Studies revealed that durability is affected by the tree age and the source of the timber.



Chemical modification of wood (Rubberwood and Silver oak) has been carried out using octanoyl and lauryl chloride. Reaction parameters were optimized. Chemical modification of wood using alkylene epoxides viz., propylene oxide and butylene oxide carried out. Esterified / etherified wood was characterized using FTIR and NMR spectroscopy. TGA analysis of Esterified wood was carried out. Properties of wood modified with acid chloride (dimensional stability, UV resistance and fungal resistance) completed. Modified wood flour was pressed in a hot press at 150 °C. Modified wood particles became softer and show thermoplasticity and self bonding effect.

The work carried out for developing technologies for protection of wood for exterior applications, particularly through chemical modification and thermal treatments. A solvent free process has been developed concerning the chemical modification of wood by acetic anhydride and butyric anhydride with iodine as catalyst. The presence of small amounts of iodine elevated the conversion rate of modification significantly. Rubber wood was esterified with phenylisothiocyanate, and dimensional stability, decay resistance, and photo stability of the modified wood assessed. Unmodified and modified samples were exposed to a brown rot (*Polyporus meliae*) and a white rot (*Coriolus versicolor*) fungus for 12 weeks. Modified wood samples exhibited good dimensional stability and were very resistant to decay. However, phenylisothiocyanate modification of wood was not effective in decreasing photo-yellowing. Rubber wood esterified with fatty acid chlorides exhibited good dimensional stability, degree of dimensional stability increased with increasing carbon chain length. Treated wood was partially effective in inducing stability against UV light irradiation. Modified wood samples exhibited very good resistance to brown rot and white rot fungi. Dispersion of ZnO nanoparticles in maleic anhydride modified polypropylene (MAPP) enhanced UV resistance of wood polymers, indicating potential of nano-particle based wood coatings in future for providing protection from harmful UV radiation in

outdoor environment. Properties of thermally modified rubberwood and silver oak were evaluated. Heat treatment resulted in colour darkening and improved dimensional stability although a significant loss in static mechanical properties was observed.

Under the study to find the suitability of bamboo for dunnage pallets, Determination of physical properties has been completed. Studies on mechanical properties under green condition are in progress. Consulted the officials of Central Warehousing Corporation for designing of pallets.

Under the comparative study of clones of Eucaly and Acacia hybrid for handicraft sector physical properties (specific gravity, moisture content and shrinkage) were studied. Studies on mechanical properties under green conditions completed and that for air-dry samples is under progress. Observed air seasoning behaviour on small planks for all the clones. Gross anatomy of *Eucalyptus* clones completed and that for *Acacia* hybrid is under progress. Studies on wood working qualities are under progress. The properties are being evaluated to assess the wood quality of clonal material for handicraft sector.

Thermal processing of different wood species namely *Acacia auriculiformis* and Rubber wood were carried out at different temperatures in the range of 150 to 240 °C under different environment such as vacuum, air and nitrogen. Physical and mechanical properties of small clear specimens are being carried out as per BIS standard. Colour and surface roughness test were also carried out on heat treated and control specimen. Samples of treated and un-treated wood were installed in grave-yard and observations are being made to access the extent of decay.

Preservative treatment of rubber wood and *Melia dubia* wood were carried out using micronised copper under vacuum and pressure cycle for two pressure duration of 1 and 2 hours. Specific gravity and shrinkage studies were completed. Mechanical properties are being evaluated. Data on leaching are being collected.



Specimens for durability tests were prepared and observations are being made against wood decay and durability in the grave-yard test.

Under the study on screening of oil of *Pongamia pinnata* Linn., *Jatropha curcus* Linn. and *Simarouba glauca* D.C. for developing eco-friendly wood preservatives oils of *Pongamia pinnata*, *Jatropha curcus* and *Simarouba glauca* were incorporated with copper metal by refluxing with Cupric oxide. Treated rubber wood specimens with metal ions incorporated oils of *Pongamia pinnata*, *Jatropha curcus* and pure oil of *Simarouba glauca* by different methods. Laboratory tests of treated and control specimens against wood decay fungi is in progress. Borer test in the laboratory with powder post beetle larvae is in progress. Installed 135 specimens of treated and control samples in the test yard for field exposure, following randomized block design.

Preservative based on extractives of *Acacia auriculiformis*, *Acacia nilotica*, and *Gliricidia sepium* were prepared. Specimens were treated by pressure method by "Full cell" process following 15'/50/60'/5', initial vacuum for 15 minutes, pressure of 50 psi for 60 minutes followed by a final vacuum for 5 minutes. Absorption of each of the specimen was calculated by weight gain method before and treatment. Treated specimens were installed in the Test-yard at Nallal along with untreated controls for field exposure, by half buried in the ground, Grave-yard test, 145 Nos were installed. A field chart about the position of each specimen was prepared. Laboratory tests of treated and control specimens against wood decay fungi is in progress. Borer test, exposing the specimens to borer is in progress.

Under the study on Nanoparticles based wood coatings for outdoor applications, the equipments (Reflectance Accessory for UV spectrometer and Homogenizer) were procured. The experiments on dispersion of nanoparticles in polyurethane coating carried out. UV resistance of rubberwood coated with zinc oxide (ZnO) nanoparticles dispersed polyurethane exterior clear coating was evaluated.

Under the study on wood quality, variability in sawn timber from three plantation grown species, a warp measuring table has been commissioned. The table can measure extent of bowing, cupping and twisting in boards. The measuring procedure has been standardized with the six feet long boards. Methods for measuring resonance frequency and acoustic velocity in boards have been established. Silver oak planks (50 cft) have been procured and acoustic velocity in these boards in initial condition has been measured. An initial investigation on the effect of moisture content variation with acoustic velocity in silver oak wood samples has been carried out with small samples. Measurement of other wood quality traits is under progress. Samples for density measurement, shrinkage measurement and quality gradient are prepared and initial measurements are completed. Acoustic velocity in green board varied from 2.20 km/s to 3.89 km/s suggesting stiffness variation from 5.0 GPA to 15 GP-a. Similarly pilodyn penetration also varied from 28 mm to 37 mm in the boards.

Study was done to develop Near infrared spectroscopy (NIR) based high throughput application methods for evaluating physical, chemical and mechanical properties. NIR methods have been developed for specific gravity, bending properties (MOE- modulus of elasticity, MOR- modulus of rupture and FS at LP – Fiber stress at limit of proportionality), lignin and holo-cellulose estimation. The methods are now ready for use in place of conventional one. Upgradation of NIR methods is a continuous process and will be done on regular basis by enlarging NIR library.

Wide variations in properties of 47 phenotypes of *E. tereticornis* have been observed. Specific gravity has varied from 0.494 to 0.767 and similarly other strength properties, making a good case for further selection of material with desired traits. Lignin content varied from 26 to 32% and holocellulose content from 65-72%. Combination of different traits can be used for developing the material for further propagation.



Development of NIR methods will help in reducing cost, time and efforts in assessing wood quality of eucalyptus in future programmes. NIR is of great relevance for quick assessment of the properties. The advantage is that all the properties can be evaluated simultaneously on the same samples with no extra time and cost. This was not possible till now with conventional methods.

Two wood species viz. *Eucalyptus* sp. and *Pinus roxburghii* were studied for quality assessment through ultrasonic technique and conventional test procedures. The relationship of ultrasonic velocity measured by direct pulse transmission method has been established with strength properties determined under static bending and compression tests. On the basis of developed regression models of ultrasonic velocity with strength properties, timber material can be sorted out/graded in to the different grades (strength-wise). Ultrasonic velocity decreases with increasing moisture content in timber up to the fibre saturation point (F.S.P.) and also above the F.S.P. Ultrasonic velocity was found to be higher along the longitudinal direction than transverse ones (radial/tangential) of timber. Generated data on defect indicate that speed of ultrasound decrease significantly in the presence of structural irregularities (centre hollowness, cracks etc.) in timber. Centre hollowness/ cracks and its size detected successfully by ultrasonic technique. But hollowness and multiple cracks in timber disc may not be distinguished by ultrasonic defect detection technique. Testing of log can be performed for defect detection (hollowness/multiple cracks) in the field. Ultrasonic testing technique developed for defect detection in log was also applied in the tree trunk of different tree species viz. *Mangifera indica*, *Dalbergia sissoo*, *Delonix regia* and *Eucalyptus* spp. Current status of these trees was identified. The new study to enhance the strength of finger joints through manipulating the L/P ratio of the profiled fingers initiated in the last year was continued. Preliminary results are expected in the coming year.

2.5.5 Pulp and paper

In the study on Evaluation of Alternative Raw Materials for Pulp and Paper making, anatomical analysis in terms of fiber length, outer diameter, lumen diameter, wall thickness, vessel length, vessel diameter, runkel ratio and fiber shape factor was carried out for *Melia composita*, *Prosopis juliflora* and *Gmelina arborea* by Schultz method. In case of *Melia composita* the average fiber length was 870.3 μm , outer diameter 15.67 μm , lumen diameter 7.0 μm , wall thickness 4.33 μm , vessel length 217.13 μm , vessel diameter 140.63 μm , runkel ratio 1.23 and fiber shape factor was 0.66. In *Prosopis juliflora* the average fiber length was 1215.6 μm , outer diameter 33.5 μm , lumen diameter 23.0 μm , wall thickness 5.25 μm , vessel length 387.60 μm , vessel diameter 246.8 μm , runkel ratio 0.45 and fiber shape factor was 0.35, however, in case of *Gmelina arborea* the average fiber length was 899.6 μm , outer diameter 24.9 μm , lumen diameter 15.1 μm , wall thickness 4.9 μm , vessel length 316.0 μm , vessel diameter 156.4 μm , runkel ratio 0.64 and fiber shape factor was 0.46. Pulping of the proposed raw materials i.e. *Melia composita*, *Prosopis juliflora* and *Gmelina arborea* was done by Mechanical and Chemical methods.

Mechanical pulping of *Melia composita*, *Prosopis juliflora* and *Gmelina arborea* was carried out with 8%, 10%, 12%, 14% and 16% NaOH (cold soda process), however, chemical kraft pulping was carried out at different cooking time periods i.e. 30, 60, 90 minutes at 170°C, with sulfidity 15, 20, 25% having chemical charge 14, 16, 18%. Analysis of unbleached pulps was done for yield, Kappa number and CSF. The lowest Kappa number was 31.49 with the yield of 45.75% in case of *Melia composita* during kraft pulping while it was 16.61 with yield of 49.12% in case of *Prosopis juliflora*. In *Gmelina arborea* the yield and lowest Kappa no. of unbleached pulp was 51.44% and 16.32 respectively. For evaluation of unbleached pulp, the pulp was subjected to beating and the beaten pulp was evaluated for strength properties (Tear Index, Tensile

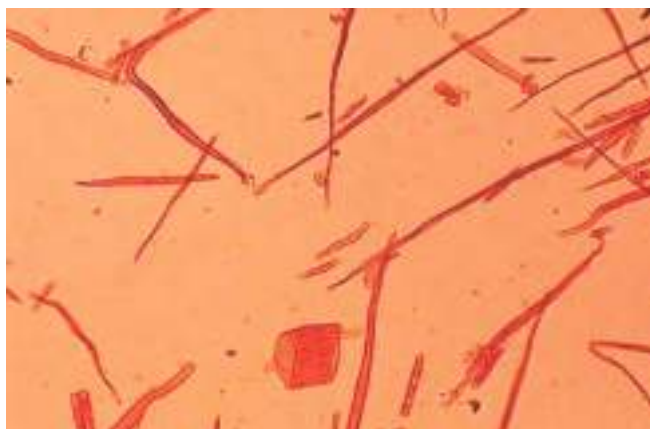


Index and Burst Index). For evaluation of strength properties, hand sheets of 60 gsm were prepared by laboratory sheet making machine.

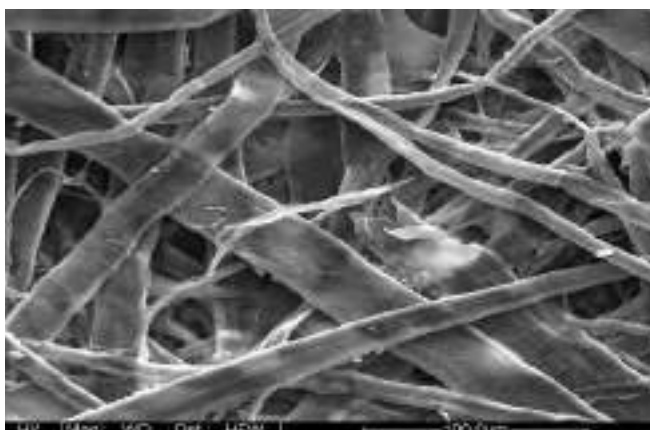
In another study on Evaluation of *Sesbania grandiflora* and *Lannea coromandelica* for papermaking, proximate chemical analysis of *Sesbania grandiflora* received from ITC, Bhadrachalam was carried out for ash content, solubilities (cold, hot water, alcohol-benzene, 1% NaOH), holocellulose, Alpha (α)-Cellulose and klason lignin. The ash content was 2.5%, solubilities ranges from 2.5 to 13.25%, holocellulose content was 68% with 41.65% Alpha (α)-Cellulose and klason lignin was 26.0%. Fibre length, lumen diameter, wall thickness, vessel length, vessel diameter Runkel ratio & fibre-shape factor were 1135, 19.9, 5.26, 358.08 and 161.42 μ m, 0.51 and 0.38 respectively for *Sesbania grandiflora*. The values of fibre length, lumen diameter, wall thickness, vessel

length, vessel diameter, runkel ratio and fibre- shape factor for *Lannea coromandelica* were 1025.86, 29.47, 19.61, 4.92, 178.08 μ m 0.59 and 0.38 respectively. Pulping of *Sesbania grandiflora* under varying kraft cooking conditions (14-18% as Active alkali, 740-1200 H factor) was completed. The total yield varies from 40-44% with kappa numbers 31-40. The physical strength properties with respect to tensile burst and tear indices were 90, 7.9 and 6.63 respectively which indicate that good quality of strong kraft paper can be prepared from *Sesbania grandiflora*. Black liquor collected under varying kraft cooks were analyzed for pH, total solids and Residual active alkali. The results obtained so far indicate the pH (9.2-11.1), total solids (12.2-20.5) and RAA (1.86-8.68).

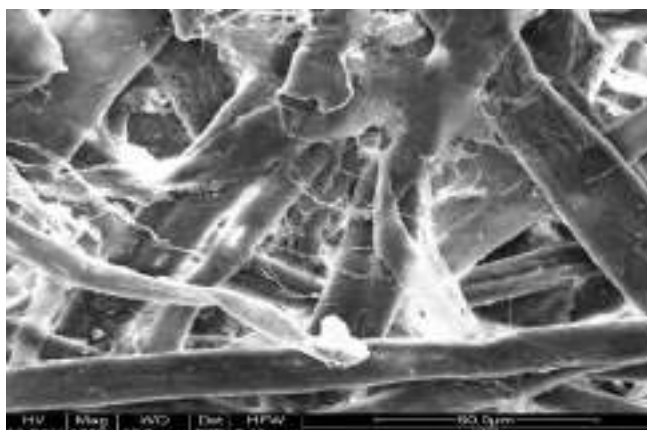
For the Biodeinking of waste paper, the cultivation conditions (incubation period, pH and temperature) were optimized for *Trichoderma viridi* and *Coprinus disseminatus* for enzyme production. Best incubation period of eight days was observed for *Trichoderma viridi* and fourteen days for *Coprinus disseminatus*. Moisture level was optimized at various ratios of 1:1, 1:2, 1:3, 1:4 and 1:5 and the maximum cellulase activity at 1:3 carbon source was observed for *Trichoderma viridi*, however, it was 1:2 in case of *Coprinus disseminatus*. To obtain optimal pH, *Trichoderma viridi* and *Coprinus disseminatus* were cultivated with different pH ranges from 3.0, 4.0, 5.0, 6.0, 7.0, 8.0 and 9.0 pH with Substrate: Wheat Bran at optimum condition and the maximum enzyme activity at pH 4.0 was observed for *Trichoderma viridi*, however, it was pH 5.0 in case of *Coprinus disseminatus*. Temperature was optimized by incubating the flasks at a range of 20 $^{\circ}$ C to 40 $^{\circ}$ C. The results showed that the maximum cellulase activity was at 30 $^{\circ}$ C for *Trichoderma viridi*, however, it was 35 $^{\circ}$ C for *Coprinus disseminatus*. The optimal activity of produced enzyme by *Trichoderma viridi* and *Coprinus disseminatus* was tested in the range of 3 – 9 pH, and pH 5 was found optimal for *Trichoderma viridi* and pH



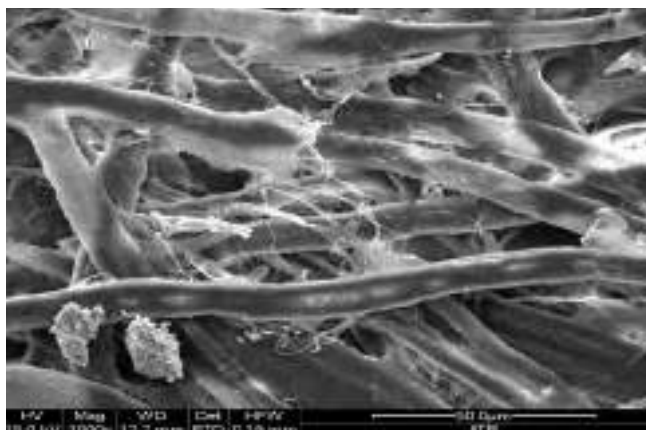
Microscopic Features of Fibers



Untreated Deinked Pulp



Chemically Deinked Pulp



Enzymatic Deinked Pulp

6.5 for *Coprinus disseminatus* for maximum enzyme activity. To obtain optimum temperature, the optimal activity of produced enzyme by *Trichoderma viridi* and *Coprinus disseminatus* was checked in the range of 30°C – 80°C, and the optimum maximal enzyme activity was found 45°C and 50°C for *Trichoderma viridi* and *Coprinus disseminatus* respectively. Chemically

and enzymatic deinked pulp was analyzed under Scanning Electron Microscopy (SEM).

Enzymatic deinking parameters i.e. enzyme dose, pulping time and consistency, optical properties (ERIC value, Brightness, Opacity) and other physical properties of paper sheet (tear index, tensile, burst and double fold) were evaluated.

2.6 Non-Wood Forest Products

2.6.1 Overview

Role of Non-Wood Forests Products (NWFPs) as a source of income and livelihood for the large population of our country, depending on forests resources is indispensable. People in rural areas get self employment through the collection of NWFPs. More than half of the employment generated in the forestry sector till date in our country, is through NWFPs.

Although NWFPs are a renewable resource, their continuous harvest may deplete these natural resources thereby affecting biodiversity as well as threatening the livelihood of forests depended communities. Sustainable forest management practices only can ensure effective conservation of NWFP resources and address the need of forest dependent communities vis-a-vis augmenting their livelihood. Accordingly, ICFRE institutes have undertaken extensive researches on various aspects that include resource development of medicinal plants and NWFPs, conservation technologies, sustainable harvesting regimes, value addition, natural gums, bio-prospecting, cultivation technologies, plantation techniques, and documenting the traditional knowledge of indigenous people besides exploring the bamboo, bio-fuel and bio-energy prospects of Indian forests.

Project under the Theme			
Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	13	24	16
Externally Aided	07	12	03
Total	20	36	19

2.6.2. Resource Development of NWFPs

Development of Nursery Technique of Fibre Yielding Himalayan Nettle

The nursery technique of fibre yielding Himalayan Nettle (*Gerardina heterophylla*) was developed by conducting different trials of seed germination and vegetative propagation in natural habitat area Chakrata (6000ft above m.s.l.) and at FRI, Dehradun. The extension activities on nursery and cultivation of nettle was also carried out with Uttarakhand State Forest department.



Nettle Seedlings in Chakrata NWFP Nursery



Nettle Seedlings in FRI- NWFP Nursery



Standardization of Drying and Storage Protocol and Quality Assessment of Selected Commercially Cultivated Medicinal Plants of Uttarakhand

Farmers are cultivating a number of medicinal plant species without much concern for the quality of planting material, leading to perhaps an inferior produce that makes them vulnerable to market forces. Besides, this approach also significantly affects the quality and therapeutic efficacy of the resultant products. In view of the emergence of global marketing system, it is of utmost importance that the raw material produced under cultivation systems must adhere to global standards. Most of the cultivation packages available to the farmers, however, lack post-harvesting processing like optimal drying and storage conditions. Further, there is need to assess the shelf life of the raw material, in order to achieve the quality standards desirable by the herbal industry and exporters. There are very limited studies that have been undertaken in fragmented form that deals with the determination of quality of raw material. In order to achieve the objectives of GMP, it is therefore, necessary to investigate and develop protocols for optimum drying and storage conditions of medicinal plants and assessing the effect of these processes on the quality of the produce.

Keeping in view the above slated reasons, the present project proposed envisaged to undertake detailed scientific investigations on the effect of different drying and storage conditions for some selected medicinal plants, being cultivated in Uttarakhand with the major aim of developing package of drying and storage regimes/protocols.

Development of standard optimum drying and storage conditions have been achieved for five commercially cultivated medicinal plants namely *Asparagus racemosus*, *Withania somnifera*, *Rauvolfia serpentina*, *Aconitum heterophyllum* and *Picrorrhiza kurroa*.

Data Compilation of R & D in Medicinal and Aromatic Plants by ICFRE Institute and Other Institutional Projects funded by ICFRE

Project completion reports (164 nos.) from FRI, Dehradun, HFRI Shimla, TFRI, Jabalpur, AFRI, Jodhpur,

IFGTB Coimbatore and IWSB Bangalore, IFP Ranchi were analyzed and compiled. Research papers (303 nos.) from Indian Forester and individual scientists were collected. Compilation and updating of R&D information on 57 medicinal plants is in progress.

Field Trials for Increasing NWFP Productivity Using *Piper pedicellatum*

Piper pedicellatum plant grows in moist subtropical and sub-tropical forest areas. The germ plasm was collected and Nursery technique developed in FRI, nurseries. Site development carried out in FRI central nursery under *Prunus cerasoides* and Lachhiwala RF under *Dalbergia sissoo* plantation. The seedlings were planted in both developed sites. The initial result indicated from the collected data, that Lachhiwala RF



Piper Fruits



Field Trial of *Piper pedicellatum* FRI Central Nursery

was not suitable for *Piper pedicellatum* growth hence high mortality rate was found, whereas, in FRI central nursery area, it showed success of plantation with 92% (approx) survival rate. Field trials were maintained.



National Study on Commercial Production of Non Timber Forest Products for Ensuring Fair Economic Returns to Primary Collectors

In order to estimate the production of Non Nationalized Commercial NTFPs, a national level study has been sanctioned by the MoEF. Under this programme, Data Collection Manuals and Formats have been developed for field data collection. Extensive household based surveys have been undertaken in Six (PESA) states and field data collection on production of various NTFPs has been undertaken.

Development of Sustainable Model for Enrichment of Selected Medicinal Plant Conservation Areas (MPCAs) of Uttarakhand Himalayas

Survey for identification of habitats of target species at Khuliya and Kandara MPCA were undertaken. Collection of seeds of Atish and Kutki 50 gm each done and Atish (400 nos.) and Kutki (200 nos.) plants procured. Seed sowing of Atish and Kutki done in identified sites at



Habitat of (a) *Nardostachys jatamansi*, and (b) *Picrohiza kurroa* at Khuliya and (c) *Aconitum heterophyllum* at Kandara MPCA

Kandara and Khuliya MPCAs. Maintenance of nursery/ planting stock also done. Data recorded on habitat types, their geo coordinates and frequency and density of target species collected from Kandara MPCA area.

Diversification of Hill Agriculture through Integration of Medicinal/Aromatic Plants for Livelihood

Willing farmers (02) identified at Gawar village Khirsu for undertaking on-farm trials. *Thymus serpyllum*



Field Planting of *Thymus serpyllum*



Growth in Stone Walls in Farmer's Field



nursery (6000 no.) raised. On farm trial on stone walls of terraced agriculture fields (approx. 0.05 ha) area were established at the identified farmers fields in northern, western, eastern and southern aspects.

Effect of Fertilizer Application on Growth and Yield of 10 years old *Salvadora persica* and *Acacia ampliceps* plantations under Silvipastoral System on Arid Salt Affected Soil

Salvadora persica Trials

In the above average monsoon (562 mm) year, the fruit yield ranges from 1.24 kg (T12- FYM + K₂SO₄ + SSP) to nil in control treatment in *Salvadora persica* in 2010. Treatments significantly influenced the fruit yield as there was no fruit setting in control. T12 was the best treatment recording maximum overall fruit yield of 1.25 kg (207 g/tree), closely followed by T13- 1.20 kg (240 g/tree) and T8-1.10 kg (353g/tree), respectively

indicating the positive influence of Potassium on fruit yield in a salty soil. Fruit yield in other treatments ranged from 64 g to 1.04 kg. During 2009 with deficient monsoon (212 mm) use of ZnSO₄ promoted fruit yield.

The flowering was initiated in the month of Nov., 2011 and small seedless fruits were formed in 100% trees. However, they were aborted. Second fresh flowering was initiated in January, 2012. A total of 85.5% tree flowered and fruit setting took place in March, 2012 which was late as compared to that in 2011. While, multicolored fruits were observed in most of the plants, only white fruits were observed in six plants. Annual growth data for the year 2011 showed that the incremental growth of height and crown ranged from 5.2 to 13.2 cm and 6.4 to 13.0 cm, respectively in different treatments.



Seedless Fruits of *S. persica*



Fruits of Different Colour of *S. persica*



Normal Fruits of *S. persica*



Fruits in Different colour of *S. persica*



Acacia ampliceps Trials

In the year 2010, very good monsoon facilitated a high pod yield, 1.32 Kg (control) to 14.66 Kg (FYM + Urea) treatment in *A. ampliceps* trial, while there was no pod setting in the year 2009 due to failed monsoon. In this trial, maximum seed yield recorded was 2.13 kg in T4 (SSP) treatment and minimum 0.05kg in control. Treatments influenced pod/seed yield. Maximum 14.2kg pod yield was recorded in T₇ treatment where pod setting was observed in 90% trees, followed by T4 treatment (9.36kg pod yield in 88% trees) and T5 (6.0 kg pod yield in 50% trees). Zn influenced seed size and no of seed/g were 45 in T5 treatment as compared to 54 & 56 in T7 and T4 treatment, respectively while overall seed yield per tree was same 31-32 in all the three treatments.

Grass trials

Field trial was laid with two grass species *Cenchrus ciliaris* and *Sporobolus diander* on three soil structures, i) raised platform, ii) raised bund and iii) control in 2009. In the year 2011, soil structures influenced the dry grass yield; it was 313.1 and 285.9 g/m² for the platform and slope soil structures, respectively as compared to control 234g/m² for *S. diander*. Grass height ranged from 85- 107cm, no of clumps/m² were 17-30, mean no of tillers /clumps were 48.5 – 71 in different treatments. In case of *C. ciliaris*, slope was the best structure which favoured 130.3 g/m² yield, followed by plat-form



Cenchrus ciliaris on Raised Slope



Cenchrus ciliaris- Control

130.3 g/m² and minimum in control 61.7 g/m². Grass height ranged from 36- 110 cm, no of 5.7-13 clump/m², mean no of tillers /clumps 15.5 – 21 in different treatments. Thus, it is concluded that soil structures showed positive effect on leaching and helped in establishment of non salt tolerant grass on saline soil.



Cenchrus ciliaris on Raised Platform

Identification of Superior Chemotypes and Ex-situ Conservation of *Podophyllum hexandrum* Royle from Himachal Pradesh and Jammu & Kashmir (Ladakh Valley)

Identified the superior genetic stock of *Podophyllum hexandrum* Royle after carrying out extensive survey in 28 sites in different geographical locations of HP and J&K. (Ladakh Valley). Each site was geo- referenced along with characterization of micro habitat. By using the germplasm collected from 34 sites, FGB (Field Gene Bank) has been established at Field Research Station,



Podophyllum hexandrum with Fruiting at Leh (J&K)

Brundhar, Jagatsukh (H.P.). Seed and vegetative propagation trials have been established to develop user friendly propagation trials of *P. hexandrum*

Population Assessment and Identification of Superior Genetic Stock of *Picrorhiza kurroa* Royle ex Benth and *Valeriana jatamansi* Jones by Screening Different Populations from North Western Himalayas (Himachal Pradesh and Uttarakhand)

Identified Superior Genetic Stock of *P. kurroa* and *V. jatamansi* from different geographical locations of Himachal Pradesh and Uttarakhand. In case of *P. kurroa*, out of total 34 sources studied throughout Himachal Pradesh and Uttarakhand, about 10 sources have been found to contain more than 10% total Picroside (P1 & PII). Highest total picroside content (14.70%) has been observed with HFRI/PK/04/KD while the minimum (4.30%) with P



Field Gene Bank of *P. kurroa* at FRS, Brundhar, Kullu H.P.

(2). As far as *V. jatamansi* is concerned out of 39 sources studied throughout from Himachal Pradesh and Uttarakhand, 10 sources have been found to possess Valepotriate content 3.5% and above. Highest valepotriates content (4.50%) has been observed with HFRI/VJ/03/NCH, while minimum (1.37%) with V-6. DNA fingerprint profiling of superior genetic stock of *P. kurroa* has been carried out.

Conservation of Medicinal Plants through Commercial Cultivation and Value Addition by Joint Forest Management Committees / Panchayats and Farmers in Eastern Himalaya and its Socio-economic Impact

Total 320483nos of QPM has been created. 77200 nos. of QPM was distributed for cultivation to the JFMC members through State Forest Department and to the farmers for commercial cultivation on free of cost for motivation. 43800 nos. of QPM were supplied to the farmers for commercial cultivation at minimum rate of Rs. 1/- and utilizes 30950 nos. of QPM for seed garden at USJ Research Plot and IFP, Ranchi and trail plot during the year 2009-2010. Study and survey was done in Bijanbari, Distt. Darjeeling, Lingsey Village, Kalimpong, Distt. Darjeeling, Mangrakata Village, Distt. Jalpaiguri to evaluate socio-economic impact of commercial cultivation of medicinal plants on the cultivator. Preparation & maintenance of trail plantation of different medicinal plant viz. *Rauwolfia serpentina*, *Withania somnifera*, *Stevia rebaudiana*, *Asparagus racemosus*, *Gymnema sylvestre*, *Abelmoschus moschatus* for providing practical knowledge on cultivation technique of medicinal plant and study of yield for assessment of income on cultivation of medicinal plant.

Standardization and Dissemination of Complete Package of Cultivation and marketing in Relation to Principal Active Ingredient of ten Selected Medicinal Plants of Jharkhand, Bihar, West Bengal and Odisha

Six medicinal plants have been cultivated using RBD design in Jharkhand and West Bengal. 30 companies have been selected and appropriate data collected from them, growth data have been collected & complete



package will be standardized after harvesting of plants. Demonstration plots in farmer's field have been established. One awareness training on selected medicinal plants was organized in ERS, Sukna & also practical demonstration of cultivation of selected medicinal plants was given to the farmers, NGOs etc.

Standardization of Nursery Techniques for Cultivation of *Celastrus paniculatus* and *Vitex peduncularis* – Medicinal Plants Highly Exploited in Jharkhand

Seven sites of the natural occurrence of *V. peduncularis* in Gumla, Simdega, Ramgarh and Lohardaga have been identified. Five sites of the natural occurrence of *C. paniculatus* have been identified in Ramgarh and Lohardaga. Propagation from root suckers and shoot cuttings have been very successful in *V. peduncularis*. A nursery has been raised out of the shoot cuttings of *C. paniculatus*.

Multilocational Trial of *Jatropha curcas* in Different Agro-climatic Zones and Study of Agronomic Practices

Four replications of agronomy trial have been established. Each replication has 10 treatment blocks including control. In each treatment block, 20 accessions of *Jatropha* have been planted at a rate of 9 plants per accessions. Irrigation and fertilizer treatment was given as per the recommended experimental treatment plan. Data including plant height, collar diameter, no. of branches per plant, no. of inflorescence per plant, no. of fruit bunches per plant and other remarkable feature like disease susceptibility etc. were recorded. Four replications of Silviculture trial has been established. Each replication has 10 treatment blocks of 2 accessions planted randomly. Each block of either accession has 9 plants. Irrigation, fertilizer and pruning treatment were given as per the recommended treatment plan. Data including plant height, collar diameter, no. of branches no. of inflorescence per plant, no. of fruit bunches per plant and other remarkable feature including disease susceptibility etc were recorded. Four replications of multilocation trial, each having 100 accessions of *Jatropha* have been planted with 9 plants in each replication. Data for plants height, collar diameter, no. of branches, no. of inflorescence

per plant, no. of fruit bunches per plant and other remarkable feature including disease susceptibility etc were recorded.

2.6.3. Sustainable Harvesting and Management

Creation of Seed Production Areas and Commercial Cultivation Trials of *Uraria picta*

Collected germplasm from Uttarakhand and planted in seed bank at FRI campus. Seed Bank area has been developed and is being maintained. Seed Bank has been established with 1000 mother plants in NWFP nursery at FRI campus and is being maintained. The seed production of 5.6 kg has been achieved and seeds produced in the seed bank have been sown in the mother beds for commercial cultivation trials. Field plantation in 2 bighas of land around Dehradun has been undertaken for commercial cultivation trials. The field plantation was maintained using irrigation as per requirement and manuring was undertaken. The crop has been maintained by undertaking weeding and requisite soil working. Observations on plant growth have been recorded on periodic intervals.

Field Trial of Borehole Method of Resin Tapping for *Chir pine* of Uttarakhand for Better Oleoresin Yield

Pinus roxburghii trees were selected for developing effective and non-harmful resin tapping technique in Mussoorie Forest Division (Magra Compartment) .The site was divided in three portions on the basis of altitude in the selected compartment. One site selected at FRI in Champion and Seth Block for demonstration purpose. Total 195 trees were marked for resin tapping work using Borehole method and the yield compared with rill method. Field trial sets were maintained in Magra Mussoorie and FRI Champion Block. Determination of tree age was done by using increment borer. Closing of bore holes and removal of resin pots was done. Oleoresin data from both sites were collected and analyzed. Recorded variation in the yield of resin in different sites using the two methods. Oleoresin sample was kept for analysis.



Collection by Bore Hole Method



Collection by Rill Method



Propagation of *Microstylis wallichii* in the Experimental Site Field

Testing of Vegetative Multiplication Technique of *Microstylis wallichii* in its Natural Habitat

Vegetative propagation techniques of *Microstylis wallichii* were carried out in its natural habitat at Chakrata, Mussoorie and Dhanolti. The survival and growth data were recorded under different trials at selected sites. Germplasm collected from Pauri, Mussoorie and Chakrata Dehradun. Surveys conducted for occurrence of species in Badrinath and Uttarkashi Forest Division. Growth data recorded and trial plots were maintained at three sites.

Population Dynamics of Selected Threatened Medicinal Plant Species and Conservation Management through Community Participation In Buffer And Transition Zone of Achanakmar-Amarkantak Biosphere Reserve, Madhya Pradesh

The project activity includes mapping the

populations of threatened selected medicinal species, namely *Celastrus paniculata* (Malkangani), *Embelia tsjeriam-cottam* (Baibidang), *Rubia cordifolia* (Pilia), *Thalictrum foliolosum* (Mamira) and *Peucedanum nagpurens* (Tejraj) in Amarkantak Range, Anuppur Forest Division, Anuppur (M.P.) and Karanjia Range, Dindori Forest Division, Dindori (M.P.) of Achanakmar-Amarkantak Biosphere Reserve. Marking of plots with tagged plants has been done for recording of demographic observations in the next season. The awareness generation amongst forest villagers for sustainable harvesting of medicinal plants targeted under the project has been initiated. The physico-chemical properties of soil from population sites were analysed for comparison among varied habitat.

Studies on Developing Alternative Methods of Sustainable Harvesting of Medicinal Plants

Sustainable harvesting practices of *Bauhinia*



veriegata (Kachnar), *Holarrhena antidysenterica* (Kutaj), *Oroxylum indicum* (Sheonak), *Saraca asoka* (Ashoka) and *Terminalia arjuna* (Arjuna) have been standardized. The experiments were laid out in the forest areas of Jabalpur, Balaghat, Rewa, (M.P.); Chandrapur, Tadgaon, Allapally, Tadoba, Nasik (Maharashtra); Keonchi, Marvahi, Bilaspur, Kavardha, Raigarh, Gariyaband (Chhattisgarh); Harishankar, Champagarh, Khurd (Odisha). Various harvesting methods such as $\frac{1}{3}$, $\frac{1}{4}$ blaze size and longitudinal strip (alternate and opposite strips) harvesting were experimented. Different plant parts i.e. trunk bark, branch bark, twig bark, root bark, leaves, flowers etc. were collected and analyzed for their phytochemical constituents (tannins, total alkaloids, flavonoids, total phenols, phenolic acids, arjunic acid, baicalein). Regenerated bark was also collected and evaluated for major active ingredients. Regular observations were recorded on bark regeneration. Results revealed that longitudinal strip harvesting method is superior to other harvesting methods in all designated species. In Kutaj and Sheonak bark recovery was faster in trees having GBH < 40cm and completely recovered in 12 months; Arjuna bark recovery was faster in trees having GBH < 90cm and completely recovered in 18 months, Kachnar and Ashoka bark recovery was faster in trees having GBH < 35cm and completely recovered in 24 months. Minimum harvestable girth varies from species to species. There was significant variation in bark recovery among different girth classes of targeted species. Among all selected species Kutaj and Sheonak have faster; Arjuna has medium; Kachnar and Ashok have slower bark recovery. Bark can be harvested from the previously harvested trees after two years from opposite side of previously harvested part. Phytochemical analysis of various plant parts revealed that the trunk bark contained maximum amount of active ingredients but branch bark and leaves can also be used in place of trunk bark. Original bark contains higher amount of phytochemical constituents than regenerated bark. In case of Sheonak, maximum amount ($327.8 \pm 1.26\%$) of baicalein was observed in



Terminalia arjuna Tree Showing a Blaze on the Trunk



Terminalia arjuna Tree Showing Regeneration of Bark

root bark which is at par with stem bark (307.29 ± 1.67). In Arjuna, arjunic acid content was varied from 10.120 to 49.087 mg/100g and also increased with increase in GBH. Arjunic acid varied significantly in original and regenerated bark. *T. arjuna* was found to possess maximum antioxidant activity among all the studied species. The adoption of above harvesting practices will be helpful in sustainable management of above studied species and also provide quality raw material to pharmaceutical industries on sustainable basis.

Standardization of sustainable harvesting practices of Arjuna (*Terminalia arjuna*) bark

Sustainable harvesting practices of *Terminalia arjuna* (Arjuna) bark have been standardized. The study was carried out in the forest areas of Keonchi, Pendra, Bhairasang, Khodri, Marvahi, Gariyaband and Raigarh in Chhattisgarh. Three harvesting methods such as $\frac{1}{3}$, $\frac{1}{4}$



blaze size and longitudinal strip harvesting were experimented. Different growth regulators and plant extracts e.g., IAA, IBA, bordeaux mixture, leaf extracts of Neem, Aak, Karanja etc. were applied on harvested surface of tree trunk in order to study their influence on bark regeneration. Different plant parts i.e. trunk bark, branch bark, twig bark, leaves etc. were collected and analyzed for their phytochemical constituents (tannins, flavonoids, phenols, phenolic acids and arjunic acid). Plant samples were also evaluated for their antioxidant activity. Regenerated bark was also collected and evaluated for their major active ingredients- arjunic acid. Bark re-growth results revealed that longitudinal strip harvesting method is superior to other harvesting methods. The bark re-growth was faster in younger trees having GBH < 90 cm and bark recovered completely in 18 months. Minimum harvestable girth should be > 60 cm. The trees having GBH more than 120 cm, the bark may be harvested from ¼ of tree girth by removing outer and middle bark (longitudinal blaze) leaving inner bark for regeneration. Bark can be harvested from the previously harvested trees after two years from opposite side of the previously harvested part. Results on different growth regulator treatment did not show any significant variation in bark recovery. Phytochemical analysis of original and regenerated bark revealed that original bark contains higher amount of active ingredients than regenerated bark. Stem bark possess maximum amount of active ingredients than other plant parts. Trunk bark exhibited maximum antioxidant activity. Arjunic acid content varied from 10.120 to 49.087 mg/100g and also increased with increase in GBH. Arjunic acid content showed significant variation in original and regenerated barks. There were no adverse effects on the overall growth of the tree. The adoption of above harvesting practices will be helpful in sustainable management of *T. arjuna* and also provide quality raw material to pharmaceutical industries on sustainable basis.

Standardization of Sustainable Harvesting Practices of Bhumi-aonla (*Phyllanthus amarus*), Sal-parni (*Desmodium gangeticum*) and Baichandi (*Dioscorea hispida*)

Sustainable harvesting practices for Bhumi aonla (*Phyllanthus amarus*), Sal Parni (*Desmodium gangeticum*) and Baichandi (*Dioscorea hispida*) have been standardized for tropical climate of Chhattisgarh. Experiments were laid out in six different sites of three forest divisions of Chhattisgarh viz. Marwahi, Gariyaband and Dhamtari. Periodical regeneration surveys were conducted to evaluate the regeneration status in the experimental areas. Regeneration index of the studied species was determined. Plant samples were collected at different maturity stages for assessment of quality of produce. *P. amarus* should be harvested in the month of October at the time of initiation of fruiting. 80% plants can be harvested to maintain sustainability. Maximum phyllanthin content (0.384%) was found at fruiting stage (October) on dry weight basis. For sustainable harvest plants should be cut from the collar part and not uprooted. In *Desmodium gangeticum* only 40% plants should be harvested (uprooted) in the month of December. Maximum (0.113%) total alkaloids content was found in the roots harvested in the month of December. In *Dioscorea hispida* 10% tuber should be left for regeneration while harvesting. If more bulbs are present one bulb should be left for maintaining sustainability. Maximum diosgenin (0.7748 %) and starch (17.56%) content were found in the tubers harvested in the month of January

Standardization of Sustainable Harvesting Practices of Mahul Patta (*Bauhinia vahlii*)

A study has been initiated to standardize sustainable harvesting practices of Mahul leaves (*Bauhinia vahlii*). Experiments pertaining to harvesting intensities and time were also laid out in the forest areas of Keochi, Pendra Road (Marvahi);



Saplawa Pahadi, Pali (Katghora) and Futka Pahad, Balco (Korba) in Chhattisgarh. In each study site 10x10m quadrates (0.1h) were laid out in randomized design with five replications. Each quadrate was sampled initially for Mahul populations before harvesting. To standardize sustainable harvesting limits, leaves were harvested as per different treatments [T₀ (No harvest/control), T₁ (50% harvest), T₂ (60% harvest), T₃ (70% harvest) and T₄ (80% harvest)] in each site. Mahul leaves were also harvested in different months of the year to evaluate effect of harvesting time on quality of leaves. Quarterly observations were recorded. Maximum plant population was found in Futka Pahad, Korba followed by Keochi, Pendra. It was observed that the time of harvesting affects the quality of leaves. Data revealed that best quality Mahul leaves with respect to leaf length, width and area, were found in Korba. Moisture content was found higher (68%) in the small sized leaves harvested from Korba. Further quality analysis on leaf strength is under progress.

Quality Standardization of Some Important Medicinal Plants of Madhya Pradesh

The project started in January 2012. Surveys are being conducted in different agroclimatic zones of Madhya Pradesh for collection of plant samples. Giloe and Gudmar samples were collected from Rewa and Chhindwara districts. The samples were dried and processed for further analysis. Phytochemical screening of the plant samples of Giloe showed the presence of different constituents viz. carbohydrate, proteins, phenols, flavonoids, terpenoids, saponins, cardiac glycoside and steroids. Qualitative analysis for various constituents is under progress. Giloe satva (starch) has also been extracted from the samples.

Harvesting Time of Some Selected Medicinal Plants for their Natural Antioxidants Constituents

Survey was conducted in Tamia and Delakhari natural forest and Medicinal Plants Conservation Area, Delakhari for the availability of the selected species

under study. *Gymnema sylvestre* species was available in Rainikheda beat, compartment no. P-36, Jhirpa range. *W. somnifera* and *Stevia rebaudiana* experimental beds were established in CFRHRD nursery and are being maintained. *M. oleifera*, *G. sylvestre*, *W. somnifera* and *S. rebaudiana* leaves samples were collected from existing plantations of the centre and natural forest at monthly time intervals. Method was standardized and estimated antioxidant constituents viz. ascorbic acid, total phenols, phenolic acids, elements and flavonoids. Phenol content was highest in *S. rebaudiana* and *M. oleifera* leaves which can serve as a potential source of nutraceuticals. Vanillic acid and caffeic acid were the two dominant phenolic acids found in *G. sylvestre* leaves. Results were disseminated through various training programmes of the centre.

Standardization of Inoculation Technique for Agarwood formation in *Aquilaria malaccensis* L

Artificial inoculations of fungi were carried out at Tezpur for inducement of agarwood in agar trees. Fifteen trees were inoculated as per the technical programme. Inoculated trees were observed after 3 months for external symptoms of agar wood formation if any. Spread of formation of agarwood at the point of inoculation was measured. Samples were collected from the inoculated site and brought to the laboratory for laboratory studies. Isolation from the infected samples revealed the presence of the inoculated fungi. Technology is standardized and multilocational trial is being carried out at Rauta (Udalguri District). Edaphic and climatic factors in relation to the agar wood formation are also being studied

Assessment of Optimum Harvest Limits of *Picrorhiza kurroa* and *Valeriana jatamansi* in Himachal Pradesh

Population data of medicinal plants were collected following quadrat study in all the selected experimental sites. Experimental harvesting trials (control 25, 50, 75 and 100 per cent harvest of selected medicinal plants) were established in all the five selected sites to determine



optimum harvest limits of selected plants. Training was organised on identification, conservation and sustainable utilization of medicinal plants of Himachal Pradesh on 25 February 2011 at Forest Training Institute, Chail for field staff of State Forest Department.

Population status, growth, regeneration and the ability of the population to withstand the extraction is being monitored for *Picrorhiza kurrooa* and *Valeriana jatamansi* in all the five experimental sites. The above data have been collected both from the field and nursery trials established already. The preliminary results revealed that both the species have the ability to regenerate after experimental harvest. To create awareness on medicinal plants among the field staff of state forest department, training was imparted on "Sustainable utilization, conservation and cultivation of important medicinal plants" on 27 July 2011 at the DFO office, Keylong, Lahaul Forest Division for about 50 field staff of State Forest Department, Himachal Pradesh and farmers.



Participants of the Workshop

Identification of Extent of Forest lands in Forest Fringe Villages

Study has been initiated for identification of extent of forest lands in forest fringe villages of Madhya Pradesh. Socioeconomic survey in 34 forest fringe villages of Jabalpur district has been completed. Ecological survey has also been initiated.

2.6.4. Chemistry of NWFPs, Value Addition and Utilization

Phytochemical Examination of *Acacia albida*

Five pure compounds were isolated from the *Acacia albida* leaves. Crude extracts of leaves and bark (Petroleum ether, Chloroform, Methanol, and ethyl acetate and butanol fractionated part of methanol extract of leaves and methanol extract of Bark) were tested on *Cylendrocladium quinquesseptatum*, *Aspergillus niger* and *Rhizoctonia solanii*. Extracts were found active at 0.5 % concentration.

To Study the Marketing Mechanism of Commercially Important Medicinal Plants in Selected Districts of Eastern Uttar Pradesh

Based on discussion with relevant resource persons, selected two districts of Gangetic plains i.e. Allahabad, Varanasi and two districts of Vindhyan Plateau i.e. Mirzapur, Renukoot and two districts of Tarai region of Eastern Uttar Pradesh i.e. Baharaich and Basti. Questionnaire on market survey has been tested for Farmers, Market and Industry and modified accordingly as per statistician. Survey of Allahabad district has been completed and the Varanasi district is under progress. Data collected from Allahabad district were compiled.

Non-edible Oils Derived from Tree Borne Oil Seeds as Potential Pesticides

TBO seeds were processed and extracted the oil fractions for bioassays and chemical analysis. Nucleus culture of defoliator and fungal cultures were maintained under laboratory condition till the bioassay study was completed. Oils fractions were tested against *Atteva fabricella* and *Eligma narcissus* larvae in *Ailanthus excelsa* field plantation at Kurumbapatti, Salem and restrained the larval activity. The bioactivity of the extracts and fractions of the oils were further confirmed through bioassay methods. Extracts were sprayed against some of the microbials infected seedlings viz. *Tectona grandis*, *Swietenia mahogani*, *Terminalia bellirica*, *Syzygium cumini*, *Pterocarpus*



marsupium and *Gmelina arborea* raised by Tamil Nadu Forest Department at Thirumurthi Hills Udumalpet. Tree borne seed oils were analysed and identified the major bioactive compounds like fatty acid methyl esters (FAME). Bioefficacy of the identified individual compounds against pests and diseases is in progress.

Essential oil of *Lantana camara* a Noxious Alien Weed as Biopesticide

Essential oil was steam distilled from the leaves of *Lantana camara* differing in flower colour collected from different agro climatic zones. The bioefficacy of the extracts tested against the teak defoliator *Hyblaea puera* showed 60% larval mortality at higher concentration, and antagonistic activity against five fungal pathogens. The bioactive compounds of the essential oil and fractions have been analysed through different chromatographic techniques. Experiments on antifeedant/insecticidal/antifungal properties of the individual compounds (β -Caryophyllene and Aromadendrene II oxide) against pests and diseases are in progress.

Biotransformation of Secondary Metabolites of *Frankia* Strains for Nodulation Enhancement in *Casuarina*

Lyophilized *Frankia* culture of 15, 25 and 30th day were sequentially extracted with ethyl acetate and methanol/chloroform for lipid extraction. The extracts of the lyophilized cultures were resolved in TLC using different solvents. The eluates were further fractionated in HPLC for mass spectral characterization in GC. The GC-MS-MS analysis and the spectral comparison revealed a total of 13, 23 and 14 components in 15, 25 & 30th day cultures respectively. Presence of some of the hopanoids and fatty acid derivatives and their variations were estimated in different day *Frankia* cultures. It was observed that some of them are very specific to nodulation/nitrogen fixation and to different day cultures. Better growth performance was observed at the mixtures of *Frankia* in combination with bioactive compounds inoculated to casuarina seedlings under nursery condition. Experiments are to be repeated for further confirmation.



Screening of Plant products (TBO's, Lantana, Ethnobotanicals) for their Bioefficacy in Lab, Nursery and Field Conditions



Fatty Oil Composition and Utilization of Lesser Known Tree Borne Oilseeds- *Givotia rottleriformis* Griff., *Madhuca insignis* (Radlk.) H.J.Lam, *Shorea tumbergaia* Roxb, *Poeciloneuron indicum* Bedd, *Hopea parviflora* Bedd, *Mesua ferrea* L and *Balanites roxburghii* Planch

Survey was conducted to various parts of Karnataka and Andhra Pradesh, identified and collected seeds of seven tree species namely *Givotia rottleriformis* Griff., *Madhuca insignis* (Radlk.) H.J.Lam, *Shorea tumbergaia* Roxb, *Poeciloneuron indicum* Bedd, *Hopea parviflora* Bedd, *Mesua ferrea* L and *Balanites roxburghii* Planch. The seeds were

processed and the fatty oil extracted. The physico chemical properties of the oils like Acid value, Saponification value, Iodine value, Unsaponifiable matter and Refractive index were determined. Estimated Fatty acid constituents of *Madhuca insignis*, *Mesua ferrea*, *Givotia rottleriformis* and *Balanites roxburghii* seed oils by converting into their corresponding methyl esters. Evaluated the anti-fungal activity of two oils namely *Givotia rottleriformis*, *Balanites roxburghii*. Fatty oils of *Madhuca insignis*, *Mesua ferrea* and *Givotia rottleriformis* were converted into biodiesel by transesterification.



Madhuca insignis (Radlk.) H.J.Lam (Sapotaceae) -Edible Oil Yielding Tree Borne Oilseeds



Lesser known TBOs- *Poeciloneuron indicum* Bedd



Tree Borne Oilseed-*Mesua ferrea* L





Unexploited High Oil Yielding tree of tropical forests- *Givotia rottleriformis* Griff



Balanites roxburghii Planch –High Oil Yielding Used for Biodiesel

***Garcinia indica* Choicy: Pharmacological Evaluation of the Extract/ Active Principle for Anti Diabetic Property**

Garcinia indica fruits were collected from two places in Karnataka viz. Subramanya and Puttur. The fruits were processed and rind was dried in shade. The rind was, then, loaded in a soxhlet and extracted sequentially for active ingredients with solvents of varied polarities. The methanol extract yielded about 40% wt/wt of the rind loaded and on phytochemical investigation gave positive results for coumarins.

The methanol extract was, then, further separated with benzene-alcohol combinations and two distinct fractions were separated. These extracts (methanol and benzene alcohol extract) were tested in mice model using streptozotocin-nicotinamide to induce diabetes and Glibenclamide as the standard drug. The dosages of 200 mg and 400 mg/kg body wt of mice were administered. The methanol extract and benzene alcohol extract have shown comparable anti-diabetic activity with the standard drug.



Garcinia indica Tree and Fruits



Testing of extracts for acute and Chronic effects of Garcinia fruit rind extracts (methanol and benzene-alcohol extracts) completed. The results indicate reduction of 60 % blood sugar after sub- acute observation (14 days blood sample analysis). In chronic studies, the blood sugar level was reduced to about 49% (i.e. after 21 days blood analysis after administration of extracts). Results will be analyzed, compiled and reported. Project is completed.

Evaluation of the Performance of Steam Volatile Creosote (SVC) as a Wood Preservative

Procured creosote and Steam Volatile Creosote was obtained by steam distillation. Applied SVC to wood surface of eight selected tree species and kept for standardization to know its effectiveness. Applied SVC with natural dye (*Dalbergia latifolia*) and synthetic dye in various concentrations and combinations as wood coating. Worked out the coating schedule for the treated four tree species. Worked out the coating schedule for the treated tree species. SVC treated wood were put for effectiveness as wood preservative under terrestrial conditions (Grave yard test). SVC treated wood were also put for effectiveness under marine conditions at Vizhakatnam.

Screening and Evaluation of Selected Members for Rutaceae from Southern India for Anti-malarial Activity

Plant materials of *Toddalia asiatica* and *Ruta graveolens* were collected from Devarayanadurga and Savanadurga areas of Karnataka. The plant parts were washed, processed and shade dried. Then, pulverized and stored for extraction of phytochemicals. The powdered plant material were loaded in soxhlet and extracted sequentially with solvents of varied polarities. Extractives were quantified and phytochemical analysis was carried out. Then the extractives were tested from larvicidal activity of mosquito (WHO guidelines). Preliminary tests for larvicidal effect with extract of *Toddalia asiatica* root (Chloroform extract) have given good results (LC50 value at 155ppm). Experiments on ovi-position deterrent activity is in progress.

The extracts of root, stem and leaves (*Toddalia asiatica* and *Ruta graveolens*) are used to evaluate larvicidal effect and ovi-position activity and experiments completed. Mosquito Repellent property by hand exposure method completed at NIMR. Ovi-position activity and larvicidal activity for extracts of *Ruta graveolens* is in progress and standardization of cell lines (RBC and liver cells) primary screening completed and testing of extracts on these cell lines is in progress.



Toddalia asiatica and *Ruta graveolens*

Quantitative Estimation of Sandal Oil from Different Locations by Colour Reaction

A survey has been carried out in sandal bearing areas of Karnataka, Tamil Nadu and Kerala states, identified sandal trees of above 40 cm girth to validate the colour reaction based on enzyme activity in living bark tissue, of the 12 substrates identified for colour



reaction, only 2 substrates – Benzidine and Guaiacol were found to be effective for distinguishing sandal plants in too low and high oil yielders. Of these two reagents, Guaiacol is found to be cost effective, environment and user friendly and sharp colour to distinguish and high and low yielders of oil in the standing tree. Core samples were taken using increment borer from the experimental plants and oil content in each plant was estimated using UV- spectroscopic method. These results are then compared with developed colour reaction in each plant for verification. Further refinement has been made to estimate oil content in standing tree by measuring colour intensity using portable colorimeter. Recorded growth and climatic factors of the location to correlate with quality and yield of heartwood and oil content. Results of the colour reaction in the selected plants were reviewed periodically to check the results and same results as earlier have been obtained.



Santalum album, L. Collection of Core Samples



Colour Reaction Low and High Yielder of Sandal

Determination of Polysaccharides for the Development of Bioproducts:

Polysaccharides from different species viz., *Curcuma angustifolia*, *C. pseudomantana*, *Dioscorea bulbifera*, *D. hispida* and *Hyptis suaveolens* were isolated and modified by acetylation, hydroxyl-propylation and carboxy methylation. Physical and chemical properties of polysaccharides—starch and mucilage i.e. morphology, size, solubility, viscosity, extraction temperature, amylose, cellulose, oil per cent were determined. Degree of substitution of modified starches were found to be varying from 0.040 to 1.30. The introduction of different chemical groups and their characterization were performed by FTIR spectra.

Compatibility of starches with mucilage, polyvinyl alcohol, chitosan and bentonite and their effect on properties of polyfilms were evaluated. The value of tensile strength of unmodified polyfilms was found to be 9.1 MPa, while significant variation i.e. 12.5 to 45 MPa were observed in modified polyfilm with different additives.

Bio-chemicals like alkaloids, triterpenes, phenols, tannins, flavanoids, and saponins were detected and quantified in mucilage.

Starch-based bioadhesive has been prepared through chemical modification. The changes in physical and chemical properties of adhesives were assessed. Binding ability of adhesives with different substrate were evaluated. Properties of adhesives i.e. setting time, water resistivity, solubility in water and organic solvents were assessed. Comparative efficiency of bio adhesives and synthetic adhesives were also screened.

Processing Techniques of *Aegle marmelos* (Bel) Fruits

Experiments were laid out for standardization of processing techniques (extraction of pulp and drying) *Aegle marmelos* (bel). Traditional as well as indirect heating methods were applied for pulp extraction. It was observed that traditional methods of pulp extraction were found to be severely affecting quantity as well as quality of pulp.



The different drying modes were applied for drying of pulp. The effect of drying on physico-chemical properties of bael pulp samples i.e. colour, moisture, carbohydrate, protein, minerals, fat, fiber, carotenoids, phenolic acids and riboflavin were assessed.

Mini portable solar drier for direct and indirect drying were designed for efficient drying of pulp samples utilizing solar energy which was found to be less time consuming in comparison to traditional methods of drying and retain quality of the pulp.

Drying method had significant effect on carbohydrates percentage with different drying methods, quantity ranged 15.7 -26.7%. Riboflavin concentration i.e. 20.04 $\mu\text{g/g}$ was recorded in sun-dried samples. Solar drying in solar cooker, direct and indirect solar drier resulted in 0.01 $\mu\text{g/g}$, 22.03 $\mu\text{g/g}$ and 92.02 $\mu\text{g/g}$, respectively. The samples dried in shade gave 21.03 $\mu\text{g/g}$ riboflavin value. Tannin concentration varied from 0.05-1.40%. Lower tannin percentage was recorded in sun drying and direct solar drying samples. The HPLC analysis of phenolics isolated from pulp samples, processed by different methods, revealed the presence of phenolic acids i.e. chlorogenic acid, vanillic acid, caeffic acid, elagic acid and gallic acid. Chlorogenic acid was identified as major component varied 0.001- 0.006%. Maximum percentage was detected in shade dried Bael pulp samples. Gallic acid was ranged from 0.002-0.004%.

Bel samples were also collected from Kawardha and Pendra of Chhattisgarh, processed by the villagers and quality of pulp samples were evaluated. Samples were found to be damaged by fungal attack due to destructive processing practices.

Evaluation of Non-edible Oil Seeds for Development of Surfactants and their Utilization in Pest Management

Seeds of *Jatropha curcas*, *Sapindus mukrossi* and *Pongamia pinnata* were collected, processed and seed chemicals were extracted. Physico-chemical properties of oil i.e. specific gravity, saponification value and free

fatty acids were evaluated. Seed oil and protein concentrates of *Jatropha curcas*, *Sapindus mukrossi* were modified by sulphation, saponification and dietanolamine reactions. The properties of developed products viz., solubility, surface tension, viscosity, wetting time and foaming power were assessed. The viscosity, wetting time and foaming power of different dilutions varied from 0.58-1.60mPa.s, 9-60sec and 2.9-7cm, respectively. Pesticidal activities were assessed against forest pest i.e. insects (*Triboleum castaneum*), fungi (*Fusarium oxysporum*, *Penicillium crysogenum*, *Alternaria alternate*, *Flavodon flavus*, *Ganoderma lucidum*, *Tramatis cingulata*, *Stachyldia* spp.) and weed (*Echinocloa colanum*) at different dilutions (0.5-15%) under laboratory conditions.

Chemo-profiling of Some Dashmoola Species (*Solanum indicum*, *Solanum xanthocarpum* and *Uria picta*) in Madhya Pradesh

A study has been initiated to quantify the active ingredients of three Dashmoola species (*Solanum indicum*, *Solanum xanthocarpum* and *Uria picta*) collected from different agroclimatic regions of Madhya Pradesh to locate the best areas/populations for getting the quality raw material. Under the above said study, forest area was surveyed and the different plant parts of *Solanum xanthocarpum* were collected from four agroclimatic regions i.e. Kymore Plateau and Satpura Hills, Satpura Plateau, Chhattisgarh plains and Central Narmada Valley. The plant material of *Solanum indicum* were collected from two agroclimatic regions i.e. Kymore Plateau and Satpura Hills and Chhattisgarh plains. The plant material of *Uria picta* was collected from Satpura Plateau agroclimatic region. The collected plant materials were shade dried and processed. The preliminary phytochemical screening (alkaloids, terpenoids, flavonoids, carbohydrates, phenols, saponins, cardiac glycosides, steroids & tannins) of different plant parts of *Solanum indicum*, *Solanum xanthocarpum* and *Uria picta* were carried out.



Standardization of HPLC method for quantification of active ingredients (Alpha – Solanine in case of *Solanum indicum* and *Solanum xanthocarpum* and Rhoifoilin in case of *Uraria picta*) is under progress.

Development of Food Products from *Madhuca indica* Flowers for the Upliftment of the Tribal/Rural Communities of Central India

Collection of *Madhuca indica* flowers from available source was done. Method standardization for extraction and quantitative estimation of *M. indica* flowers for their nutritional constituents was done. Quantitative estimation of mahua flowers for their nutritional constituents was done. Three value added food products viz. mahua jam, squash and chutneys were developed using dried mahua flowers in collaboration with Department of Food Technology, Rashtra Sant Tukdoji Maharaj Nagpur University, Nagpur. Consumer acceptability tests were conducted. All the three products were accepted by the consumers and were consistent with the Food Products Order (FPO) specifications. Results were disseminated by conducting two training –cum-workshops of two days duration. Target groups were Women Van Samiti members of various forest ranges of Chhindwara District. Practical demonstrations were given for preparation of three value added food products and feedbacks were obtained. Raw material could be effectively utilized for development of cottage scale mahua based food products industry in tribal/rural areas.



Products of Mahua

Comparative Studies on Optimum Treatment Time and Durability Test of Commercially Important Bamboo Species of North Eastern Region

Bambusa pallida and *Dendrocalamus hamiltonii* treated with 8%, 10% and 12% CCB under 1 and 1.5 kg pressure using Boucherie Apparatus (Jagriti) revealed the result that optimum treatment time of bamboo *Bambusa pallida* needed lesser time for chemical preservative treatment in comparison to *D. hamiltonii*. Age of bamboo and its moisture content was found to play an important role in predicting the optimum



Some Boidegrading Agents of Bamboo



Damage to Bamboo due to Undetermined Termite



treatment time required. The average preservative treatment time required was from 25 to 90 minutes. These bamboo samples were established in test yards at Jorhat, Assam and Aizawl, Mizoram for biodegrading agents to act upon them. The test yards were observed every six month for any development of biodegradation.

Studies on Phyto-proteins from Selected Plants of Northeast Region for the Production of Protein Concentrates with Greater Food Value

Increasing prices for animal feed has compelled researchers for research on unconventional feed with special emphasis on protein substitutes. Use of leaves and other parts of plants as possible source of protein can be a viable option in meeting the nutrient need and maintaining the productivity of ruminant and non-ruminant population. However, there is paucity of information on the potential of plant species, as nutritious feed source for animals and adequate research is still needed in the field. Therefore, with an aim to develop new Leaf Protein Concentrates three leaves (*Diplazium esculantum*, *Alocasia macrorhiza* and *Samanea saman*) have been explored. Leaf Protein Concentrates from these three species have been prepared in our lab. Best physical and chemical conditions were optimized for yield enhancement of leaf protein concentrate from these species. Functional properties of leaf protein concentrates were also examined to judge the potential of these leaf proteins concentrates for industrial applications. This is the first study on the leaf protein concentrate from these species. Three samples of Leaf Protein Concentrate, prepared from *Diplazium esculantum*, *Alocasia macrorhiza* and *Samanea saman*, examined for Antioxidant activity for its best end use. The antioxidant activities of these three LPCs were encouraging in comparison to commonly used antioxidants. This property of prepared LPCs may lead to their use in the development of new nutraceutical products with high protein contents and food value.

Molecular Characterization of *Mimosa diplotricha* Seed Polysaccharide

Mimosa diplotricha, a noxious weed is a serious threat to the ecosystems and demands concerted efforts for its management. Though a number of approaches have been adopted for effective management of *Mimosa diplotricha*, however, each approach has inbuilt limitation and satisfactory approach is yet to be seen. Chemical and medicinal screening of *Mimosa diplotricha* plant, which is not undertaken so far, would be open the door for the utilization of this plant. Utilization of abundantly available biomass derived from *Mimosa* could be a practical proposition for the management of the weed to prepare value added derivatives for applications in Herbal Medicare, Cosmetics and other industries. Recent studies based on traditional knowledge have also led to novel and, hitherto, unexplored chemotherapeutic plant polysaccharides to cure various dreaded diseases viz. typhoid, leishmaniasis, meningitis, cholera, cancer, hepatitis, etc. Therefore, the structure determination of polysaccharides is always a matter of interest. In our laboratory, the work of thorough and complete structure elucidation of *Mimosa diplotricha* seed polysaccharide is in progress. Fresh seeds of *Mimosa diplotricha* were collected from RFRI campus in the month of November-December, 2011. Proximate analysis of seed samples was performed in triplicate. Shade dried seeds, in semi-powdered form, have been used for polysaccharide isolation. Polysaccharide from seeds has been isolated by alcoholic precipitation method. The precipitated polysaccharide samples were purified by dialysis and re-precipitation methods. Homogeneity of pure polysaccharide was also determined. The polysaccharide of *Mimosa* seed was hydrolyzed completely by using strong acidic conditions for 18-20 hrs. duration. The hydrolyzed mass was concentrated after neutralization on vacuum rotary evaporator. Qualitative estimation of monosaccharides present in hydrolyzed mass has been



done by Thin Layer Chromatographic technique by using different solvent systems and monosaccharide standards.

Tapping the Potential of Some Selected Indigenous Lesser Known Wild Edible Plants for Food and Nutrition in Arid and Semi Arid Regions

To determine the nutritional content of some selected important wild food plants and to explore the possibility of developing value added products from lesser known species, field survey was carried out for availability of various samples in Jodhpur, Pali, Udaipur, Phalodi, Dungarpur, Barmer and Bikaner districts. BSI, JNV University, local people and forest officials were also contacted. *Cordia gharaf* fruits were collected from Jodhpur area and fruit pulp and seeds were separated. Moisture content, seed dimensions (seed index = 26.45) and seed: pulp ratios (1:4) were determined. Samples of *Cassia tora* were collected from Pali from three areas; Phalna, Bali and Kheda. Samples were shade dried and physical parameters of leaf and pods viz; length x width (4.08 x 2.28cm – leaves and 19.54 x 2.76 cm-pods, Pali), weight, moisture content were recorded. Bhopalgarh area of Jodhpur was surveyed for *Ceropegia bulbosa*. Few samples of *C. bulbosa* were obtained from Kheda (Pali). The weight, length x width (2.82 x 2.32 cm -small; 4.6 x 1.4 long) of leaves and tubers (2.8 x 1.6 cm of Udaipur region) were recorded. Few tubers were sown in polybags for germination. *Haloxylon salicornicum* seeds were collected from Phalodi area. Samples were dried in shade and moisture content was determined. *Grewia tenax* fruits were collected from Kailana, Jodhpur. Nutrient analysis work has been initiated.

Assessment of Nutritional Status of Most Preferred Wild Edible Plants of Kinnaur District, Himachal Pradesh

A total 110 wild edible plant species were documented from different areas of Kinnaur district.

Among the edible plants, fruits (33%) and leaves (27%) are the most widely used plant parts while herbs (58%) and shrubs (22%) are the most widely used growth forms. Total pH, Ascorbic acid, mineral nutrients, carbohydrate, total sugar and antioxidant activity of *Elaegnus umbellata*, *Malus baccata*, *Rosa webbiana*, *Hippophae salicifolia* and *Berberis aristata* were estimated. To disseminate the research findings to stakeholders, two interactive workshops on wild edible plants were organised and a pamphlet on wild edible plants prepared.

Information on wild edible plants was documented by interviewing 16 people from Dunii, Thapa and Kamru villages and alpine areas near Pangi. Samples of wild edible species such as *Berberis aristata*, *Elaegnus umbellata*, *Malus baccata*, *Pyrus persica*, *Prunus cornuta*, *Pyrus pashia*, *Ramaria sp* and *Viburnum cotonifolium* were collected for nutritional analysis. Moisture content, pH, Total soluble solids, Ascorbic acid, crude fiber, reducing sugar, non-reducing sugar of the collected samples were estimated at the institute. The samples are also analyzed at the Institute of Himalayan Bioresource & Technology, Palampur for protein, reducing sugar, phenolics, sugars and antioxidant activity to cross-check the results while the mineral composition of the wild edible plant samples were analyzed at CSK Agricultural University, Palampur.



Wild Edible Plant Samples for Analysis



Helvella sp- A wild Edible Fungi

Study of Various Factors Effecting the Quantity of Active Principles in Some Commercially Important Medicinal Plants Under Cultivation

Two sites have been identified for collection of propagules of *G. sylvestre* from natural sources at NBPGR, Palandu. The dried leaves of *G. sylvestre* have been defatted with petroleum ether; Benzene and chloroform extracts have been prepared from the leaves of three year old plants. *G. sylvestre* plants have been raised under the shade of Teak, Sal and Sissoo.

2.6.5. Biofuels and Bioenergy

Effect of Improved Operational Parameters on Hydrolysis of Lignocellulosic Biomass to Enhance Total Reducing Sugar Yield for Bioethanol Production

Conditions for the pretreatment of *Lantana camara* and *Pine needle* was optimized by varying alkali and acid charge (1%, 2%, 4% and 6%) in bath ratio (solid: liquid) 1:6, 1:10 and 1:20 at 120°C temperature for 90 minute reaction time. The alkali treatment (6% NaOH) of lignocellulosic biomass (*Lantana camara* and *Pine needle*) in bath ratio 1:20 (solid: liquid) extracted maximum 12.92 g/l (25.84 %) total reducing sugars and 10.69 g/l (21.38 %) xylose in case of *Lantana camara* while in case of *Pine needle*, total reducing sugars extracted was 10.83 g/l (21.66 %) and xylose 8.54 g/l (17.08 %). The acid treatment (4% H₂SO₄) of lignocellulosic biomass (*Lantana camara* and *Pine*



Installation of Chemical Reactor



Residual Lignin



Hydrolysate

needle) in bath ratio 1:20 (solid: liquid) extracted maximum 21.36 g/l (42.72 %) total reducing sugars and 16.30 g/l (32.60 %) xylose in case of *Lantana camara* while in case of *Pine needle*, total reducing sugars extracted was 19.72g/l (39.44 %) and xylose 14.33 g/l (28.66 %). Installed a new Chemical reactor and the working efficiency of reactor has been checked out by several trials with water and sulphuric acid at elevated temperature (Maximum 250°C). A more amorphous residual lignin after treatment with sulphuric acid was extracted.

Hydrolysis of lignocellulosic biomass (*Lantana camara* and *Pine needle*) was carried out by varying the acid concentration (0.1 – 0.5 N H₂SO₄) and different ageing period (0-5 days) at elevated temperature (180°C) in bath ratio (solid: liquid) 1:15 for 90 minute reaction time with mechanical agitation in a chemical reactor to extract total reducing sugars. A study to improve the fermentation efficiency was undertaken with combination of yeasts i.e. *Saccharomyces cerevisiae*



and *Pichia stiptis*. Fermentation of glucose sample with co-culture of micro-organism i.e. *Saccharomyces cerevisiae* and *Pichia stiptis* was carried out in different inocula size. It was observed that the co-culture of micro-organism enhanced the fermentation efficiency up to 89.97 % against the previous studies i.e. 82.79% fermentation efficiency.

Chemoenzymatic Saccharification of Cellulosic Biomass

Cellulosic biomass was hydrolysed using Chemoenzymatic route. Different chemical pre-treatment studies were carried out in isolation and in combination of - periodate urea and sodium hydroxide. Variables of pre-treatment reaction studied were viz., reaction time, temperature, solid liquid ratio. The enzymatic treatment was optimized for time, pH, temperature and concentration of the cellulose enzyme. Cellulosic biomass was subjected to treatment with variable solid liquid bath ratio from 1:20 to 1:60 (w:v) of the buffer with cellulase enzyme varying from 1-5% for variable time period from minimum 3 hrs to 120 hrs . The temperature of the reaction was varied from 20 to 70°C and the conditions were optimized for maximum TRS. The chemically treated biomass with urea was also depolymerised using the optimized parameter.

National Network Programme on Integrated Development of *Jatropha curcas* (Externally funded)

Networking trial I: In field trials, genotypes Akola (PKVJ-MKU-1) and PJ Sel-2 performed well for seed yield attribute over others in multi-locational trial with oil content of 33.56 % and 30.66 % on degraded silica mining site of Allahabad in Vindhya region. It was found that in zonal trial, CSFER-1 showed best performance followed by Jhansi (NRCJ-42).

Networking trial II: CPTs CALD-13 and CALD-14 from Allahabad has performed well for growth as well as seed yield. In seed yield, two CPTs of Allahabad, one CPT of Deoria and three CPTs of Gorakhpur performed well with an average seed yield in the range of 323 – 385 kg /ha with good oil content. The canopy dia and

collar dia was highest in the CPTs of Allahabad over other progenies with a value of 211.13 and 45.46 cm.

Networking trial III: Promising genotypes having more than 33% oil content were contributed by the participating institutes and centers. CSFER, Allahabad has received a total of 16 provenances from different Institutes/centers. CSFER, Allahabad also contributed samples of CALD- 14 to member institutes. Seedlings were raised and field trial was carried out at Padilla. Weeding hoeing and maintenance of networking trials are in progress. Pruning was carried out at the height of one feet. Growth ,branching and fruiting data were recorded.

Maintenance and Management of Field Trials are being done as per the requirement. Recording of growth data and fruit yield going on and rate of decomposition and carbon sequestration are being studied.

Study on Microwave Assisted Extraction and Transesterification of *Pongamia pinnata* (L.) seed oil

The effect of microwave irradiation on oil extraction from *Pongamia pinnata* seed was studied. It was observed that microwave irradiation reduces the time of oil extraction from the seeds significantly. The effect of microwave irradiation on the transesterification was also investigated and compared with conventional heating. The result of the study suggested that 0.5% sodium hydroxide and 1.0% potassium hydroxide catalyst concentration were optimum for biodiesel production from *P. pinnata* oil under microwave irradiated conditions. The result also shows a reduction in reaction time for microwave induced transesterification as compared to conventional heating. The fuel properties of biodiesel (viscosity, flash point, cloud point, neutralization value, sulphur content, water content etc.) were determined as per biodiesel ASTM standards. The quality of biodiesel was found suitable as per biodiesel standard.

Production Synthetic Biodiesel from Wood Wastes

Visited the Coal to Liquid Lab of CFRI, Dhanbad and IICT Hyderabad to get input and advice from



them for the work. Necessary chemicals and glassware were procured. The Instruments like FT Reactor, GC accessories, Biomass pellet press and air compressor were procured. Biomass wastes were collected from the AWTC workshop and its Physical properties were measured. The calorific value and proximate analysis of collected biomass were also determined. TGA analysis was done for Bamboo and wood wastes.

Study the Effect of Microwave Assisted Heating and Seed Storage Conditions on Quality of *Pongamia pinnata* (L.) Seed Oil for Cost Effective Production of Biodiesel

The fresh seeds of *P. pinnata* were procured and damaged and infected seeds were shorted out. After initial cleaning, the seeds were irradiated to microwave for different time (1.0, 1.30 and 2.0 min) and then, stored at different storage temperatures (5, 25 and 35 °C). The oil from the seed (treated and untreated) was extracted using hexane. The initial physical and chemical properties of the treated and control oil samples were recorded.

National Network on Integrated Development of *Jatropha* and Karanj

Jatropha: 175 CPTs of *Jatropha* were selected from Jabalpur, Chhindwara, Seoni, Balaghat, Dindori, Mandla, Betul, Katni, Shahdol, Satna, Rewa, Panna, Gwalior, Shivpuri, Sagar, Damoh and Sheopur-Kala district of Madhya Pradesh. The selected CPTs were used for establishment of progeny trials at Chhindwara and Baraha comprising of 20 progenies each. Kherwani; Chhindwara, Timarikala; Chhindwara, Rakala; Panna, Chapara; Seoni, Bizoli Janarpura; Gwalior-4, Gesani Shivpuri-2, Gesani Shivpuri-3, Bilara Pahori Road Shivpuri-2 and Bizoli Janarpura Gwalior -3 was found performing better than other progenies. Multilocational trials in the form of national and zonal trials comprising of 36 accessions in national trials and of 14 accessions in zonal trial of *Jatropha* were established at the Institute's campus, Jabalpur. Data on

growth performance, fruit yield and seed characters were recorded at regular intervals and oil yield estimation of fruits was done. TNMC-22, TFRI-1, TFRI-2, IGAU-2, PDKV-1, PDKV-2, TNMC-7 Palmpur-I, Palmpur-II, CSFER, RJ-92, TR-4, JCP-2, NRCJ-17 and TNJC-19 accessions performed better than the other on the basis of growth, seed yield and oil content. Seed yield was observed maximum in IGAU-1 (157.06 kg/ha) followed by TFRI-2 (155.22kg/ha). The oil content ranged from 32.17 to 39.43%. In zonal trial TFRI-1, TFRI-2, PDKV-1 and PDKV-2 performed better among all accessions. Seed yield was observed maximum in TFRI-1 (101.25 kg/ha) followed by RRL-1 (85.52kg/ha) accessions. Oil percentage varied from 31.80 to 39.50%.

Karanj: 81 CPTs of Karanj were selected from Jabalpur, Satna, Panna, Katni, Seoni, Chhindwara, Balaghat, Mandla, Dindori, Shivpuri, Gwalior, Muraina and Damoh districts of Madhya Pradesh. The selected CPTs were used for establishment of Progeny trial. 20 progenies were used for establishing the progeny trial at Balaghat in 2005. Kasmeli; Chhindwara, Sikharpur; Chhindwara and Lalpur; Satna were found most promising progenies among all other progenies. National trial of Karanj comprising of 5 accessions, zonal trial comprising of 17 accessions were established at the Institute's campus. In national trial TNMP-14 and RAK-5 accessions performed better, in zonal trial IGAU-1, CCSHAU-1, IGAU-5, NRCAF-2, JNKVV-29 and JNKVV-15 performed better. Fruit bearing progenies are Kasmeli; Chhindwara (90 fruits), Sikharpur; Chhindwara (80 fruits), Lalpur; Satna (63 fruits) and Chandangoan; Chhindwara (55 fruits). In zonal trial accessions CCSHAU, Bawal-1 (82 fruits); NRCAF-2, Jhans (81 fruits); IGAU-1, Raipur (55 fruits); TFRI-2, Jabalpur (52 fruits) and TFRI-3, Jabalpur (51 fruits) showed fruiting. However, the amount of fruits were less. The trials are maintained with regular weeding and hoeing practices and irrigation as and when required.



Establishment of Multilocational Trials of Superior Accessions of *Jatropha curcas* under the network Program of DBT

Multilocational trial comprising of nine superior accessions of *Jatropha curcas* and half sib progeny trial comprising of nineteen accessions were established in October 2008 and July 2009 respectively at Institute's campus. The trials are performing well and survival is more than 82%. Regular observations on growth attributes like height, collar diameter, number of branches, flowering, incidence of pests and diseases are being recorded on quarterly basis and data sent to Biotech Park, Lucknow for compilation. Minimal irrigation and maintenance were provided to the trials as and when required. In multilocational trial, two accessions HAP 41 and HAP 44 (HNB, Garhwal) have produced higher number of branches. Fruiting was observed in all accessions: JA-9, NBRI, Lucknow, JA-126, NBRI, Lucknow, JA-139, NBRI, Lucknow, BTP-U, BTP, Lucknow, HAP 41, HNB, Garhwal, HAP 42, HNB Garhwal and HAP 44, HNB Garhwal (74 fruits). Oil percentage in different accessions varied from 25% to 38%. In half-sib progeny trial, flowering has been observed in September-October 2011 in following accessions: JA-9, JA-18 (NBRI, Lucknow), MSSRF-10, MSSRF-16, MSSRF-51 (MSSRF, Chennai), HAP-41 and HAP-44 (HNB, Garhwal). However, less fruiting was observed. The experimental trials are being maintained.

Establishment of Multilocational Trials of 100 Superior Accessions of *Jatropha curcas* under the Network Programme of DBT

Multilocational trial comprising of 100 superior accessions of *Jatropha curcas* received from network partners was established in July-August 2010 at GRC farm house, Sita Pahad, Jabalpur. The experiment was established following Randomized Block design (RBD) with four replications. The experimental field was divided in 400 equal sized plots and 9 plants were



NBDA Type Brick Kiln



Half Burnt Bamboo Charcoal



On Opening the Brick Kiln



Calorific Value Estimation Using Bomb Calorimeter



Traditional Type Pit Kiln



Charcoal Trade in Manipur

planted per plot at a spacing of 3m x 3m. The trial is performing well and the survival is more than 78%. Regular observations on growth attributes like height, collar diameter, number of branches, flowering, incidence of pests and diseases has been recorded on quarterly basis and data sent to Biotech Park, Lucknow for compilation. Best performing accession are JA-128 (IC- 471346), HP-16 (IC -569356), TJS-18 (IC-561291), TJS-07 (IC-569342), TJS-07 (IC-566612), RU-1 (IC-566601), RU-101 (IC-565667), RU-18 (IC-564020), RU-5 (IC-564013) and DBT-20 (569131) on the basis of statistical analysis. The trial is being maintained properly.

Development of Viable Technique for Efficient Charcoal Production from Different Bamboo Species of North Eastern India

Surveys were carried out in charcoal production areas of North East India and bamboo samples were collected. Fabrication of drum kiln and brick kiln (NMBA type) and carbonization of bamboo samples were carried out. Studies on average calorific value of different charcoals (*B. balcooa* 3623 Kcal/kg, *B. bambos* 4636 Kcal/kg and *B. tulda* 2810 K cal/kg) were found out by using Bomb Calorimeter.

Establishment of Multilocational Clonal Trial and Seedling Seed Orchard of *Jatropha curcas*

Two multilocational clonal field trials have been established at Haldighati, Udaipur. The first trial was established in the month of November, 2007 with 12 accessions and the second clonal trial was established with 8 accessions in the month of September, 2008 in RBD with four replications. Seedling seed orchards in Randomized Block Design (RBD) with 5 replications were established at Arid Forest Research Institute, Jodhpur and 15 replications at Haldighati, Udaipur. Percent survival in trial 1 varied from 08 to 42 percent. Highest value of mean plant height, number of branches and collar diameter was observed 124.24 cm in TERI/DBT/Jat/04-05, 4.33 and 5.30 cm in SDHQ4N4.



While, lowest value of mean plant height, number of branches and collar diameter was observed in accession BTP-K (96.92 cm), 1.50 and 2.67 cm in TERI/DBT-Jat/06/16, respectively after 52 months of growth period. Data were non-significant for plant number of branches height and collar diameter.

In clonal trial 2, percent age survival varied from 0 to 13.89. Maximum value of mean plant height and collar diameter was 103.75cm and 4.32cm in NBRI-JA-9, whereas, maximum numbers of branches were 4.50 in J-2. However, minimum value of plant height was 41.67cm in HS-44, number of branches were 2.00 in both accessions i.e. HS-44 and NBRI-JA-139 and collar diameter 2.14cm in HS-44. Data were non-significant for all the three parameters.

At AFRI, Jodhpur site, percent survival varied from 0 to 100 percent in SSO. The accession TERI/DBT-JATROPHA/07/05-06/14 showed maximum plant height 340.00cm and collar diameter 11.39cm, whereas number of branches was 7.50 in accession J-110. Minimum plant height 142.50cm and collar diameter 3.45cm was observed in accession TERI/DBT-JATROPHA/05/85 whereas, minimum number of branches was 4.00 in five accessions (TERI/DBT-JATROPHA/04/03, TERI/DBT-JATROPHA/04/05-06/04, TERI/DBT-JATROPHA/04/19, TERI /DBT/ JATROPHA/01/05-06/02, and TERI/DBT-JATROPHA/05/26).

At Haldighati, Udaipur site, percent survival varied from 13 to 73 percent. Maximum plant height, number of branches and collar diameter were observed as 211.67cm, 5.20 and 6.61 cm in accession TERI/DBT-JATROPHA/04/16, TERI/DBT/ JATROPHA/ 01/05-06/24, and TERI/ DBT-JATROPHA/ 07/05-06/38, respectively. Minimum plant height was shown by accession TERI/DBT-JATROPHA/05/26 (81.25cm). While, minimum number of branches were 1.50 in accession TERI/DBT-JATROPHA/07/05-06/30 and collar diameter 2.78cm in accession TERI/DBT-JATROPHA/04/31. Plantation at AFRI, Jodhpur site performed better than at Haldighati, Udaipur in term of growth parameter, however,

accessions planted at Udaipur site showed better survival than at Jodhpur site. Data were non-significant. In half-sib trial, survival after 33 months of plantation varied from 0 to 46.67 percent. Maximum average plant height, number of branches and collar diameter observed were 226.25cm, 7.75 and 4.55cm in accession MSSRF-62, respectively. Accession HAB-GARHWAL showed lowest value of plant height (99.44cm), number of branches and collar diameter (1.94cm). The data were non-significant for all parameters.

Genetic improvement of *Jatropha curcas* for Adaptability and Oil Yield

Performance of 18 selected elite accessions under arid conditions after 72 months of growth period indicated that survival varied from 6.25 to 75.00 percent. Overall, mean plant height, number of branches and collar diameter varied from 165.00 to 250.00cm, 3.00 to 5.50 and 4.68 to 9.48 cm, respectively. Seed yield ranged from no seed to 660.00g per plant. Percent survival in accessions of CRIDA varied from 31.25-75.00 percent. In accessions of CRIDA mean plant height, number of branches and collar diameter varied from 182.69-218.33cm, 4.00-4.75 and 6.38-7.30cm, respectively. Maximum plant height and collar diameter was observed in CRIDA-MP-Jhabua-02-03-JJ-06, while number of branches in CRIDA-AP-Adila-0904-JL-06. In CRIDA sources, only one accession CRIDA-MP-Jhabua-02-03-JJ-06 produced fruits and seed was 740.0g per plant. Performance of 63 native accessions after 65 months of growth period under arid conditions ranged from 33.33 to 100 percent, whereas, average plant height, number of branches and collar diameter from 165.0 to 305.00 cm, 2.00 to 5.00 and 3.77 to 12.68cm, respectively. Seed production varied from nil to 340.00 g per plant.

On the basis of across site performance, 14 accessions have been selected. The percent survival varied from 12.50 to 50.00 percent in elite accessions and 33 to 66 percent in native accessions. Mean plant height, number of branches and collar diameter



ranged from 150.00 cm to 230.00 cm, 32.0 to 86.00 and 5.25 cm to 7.60 cm, respectively in elite accessions. In native accessions, mean plant height, number of branches and collar diameter ranged from 177.50cm to 290.0cm, 37.50 to 165.00 and 6.96 cm to 10.63cm, respectively. No fruiting was observed in elite and native accessions.

In spacing trial, after 56-months of planting, percent survival varied from 13.75percent in (2x2) to 38.75 percent in (3x3). Maximum mean plant height was observed 218.79cm in 2.5x2.5 spacing treatment, while number of branches and collar diameter was maximum 51.58 in 2.5x2.5 and 6.99cm in 3x3 spacing. Minimum plant height, number of branches and collar diameter was observed 192.00cm, 27.60 in 2x2 and 6.75cm in 2.5x2.5 spacing. Only one treatment seeded this year 86.4g per plant in 3x3 spacing.

From the result of main plot analysis (irrigation effect), average plant height was 230.00cm in treatment I_0 and varied up to 245.52cm in I_1 . Maximum number of branches and collar diameter was observed 85.02 and 10.19cm in I_3 , respectively, while these were noticed minimum 50.54 and 8.09cm in control. Three irrigation treatments were seeded this year except control and I_1 , which was ranged from 40.10g per plant in I_2 to 74.2g per plant in I_3 treatment. Plant growth performance was not significantly affected by irrigation.

From sub-plot analysis (effect of fertilizer) result revealed that mean plant height ranged from 227.01cm in F_1 to 246.56cm in F_2 . The mean number of branches and collar diameter was observed maximum 80.83 & 10.12cm in F_2 and minimum 57.47 & 8.25cm in F_1 and control, respectively. Three fertilizer treatments were seeded this year except control, which ranged from 3.2g in F_1 to 32.10g in F_2 treatment. Plant growth performance was not significantly affected by fertilizer. Interaction of irrigation and fertilizer does not show any significant effect on growth performance of *Jatropha* after 61-months of planting.

In pollarding trial, performance of all the treatments was recorded after 49 months of imposing treatment. Percent survival varied from 24 percent (except control) to 32 percent in (T_0). The mean plant height and collar diameter ranged 171.75cm (T_2) to 216.13cm (T_3) and 6.71cm (T_0) to 7.97cm (T_2), respectively whereas, the mean number of branches ranged from 16.34 in control (T_3) to 30.70 in (T_0). In pollarding trial, fruiting was observed in control and T_2 treatments during 2011-12. Analysis of variance suggested that effect of pruning is non-significant on all parameters of plant growth after 56 months months of planting.

Network Research Project on Guggal *Commiphora wightii* Arn. Bhandari

The clonal performance trial was established in RBD design with 4 replications with each replication has 8 plants per accession in September, 2007. The trial is 53-months old and survival varied from 44% of Jalore to 100% of Jaipur, followed by 94% of Barmer, Bikaner and Dausa. Mean Plant height varied from 120.14cm of Bharatpur to 205.22cm of Tonk, mean crown diameter varied from 114.64cm in Jalore to 203.9cm in Sikar source, nearly followed by 193.5cm of Tonk source and mean number of branches ranged from 4.1 in Bhratpur to 7.6 in Jhunjhunu source. The data were significant for all the growth parameters at <0.01 probability level.

The main effects of various irrigation ($I_1, I_2, I_3, 30, 45, 60$ days) and fertilizer treatments ($F_0 =$ No organic manure (FYM), $F_1 = 2$ kg/pit, $F_2 = 5$ kg/pit, $F_3 =$ Urea 50g pit (46% Nitrogen), $F_4 =$ SSP 50 g pit (20% Phosphorus), $F_5 = 5$ kg FYM+ Urea 50g/plant, $F_6 = 5$ kgFYM+ SSP 50g/plant, and $F_7 =$ Urea + SSP (50g each) applied. In agri-trial of *Commiphora*, after 52 months of planting in the field on mean plant height (cm), number of branches and crown diameter (cm) ranged from 192.69cm in I_3 to 208.69cm in I_1 , 4.46 in I_1 to 5.05 in I_3 and 168.96cm in I_1 to 174.08cm in I_3 , respectively. The analysis of variance showed that irrigation intervals had high significant effect on



mean plant height and number of branches, whereas, crown diameter was not affected by irrigation.

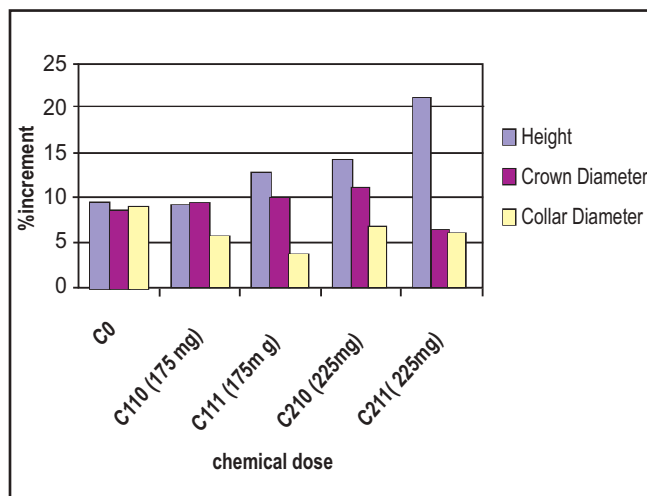
Fertilizer showed significant effect on *Commiphora wightii* plants. The mean height, number of branches and crown diameter varied from 192.2cm in F_7 to 215.8cm in F_2 , 4.2 cm in F_1 to 6.6 cm in F_7 and 169.9 cm in F_5 , nearly followed by F_1 (167.6cm) to 188.2cm in F_2 , respectively. Analysis of variance revealed that effect of fertilizer on plant growth with respect to number of branches was highly-significant, whereas, plant height and crown diameter were significantly affected by fertilizer response.

To Develop Methodology for Enhanced/Non-destructive Gum Production

Tapping experiments were initiated in last week of March, 2011 in all the plants including those which were tapped twice earlier (in the year 2008 and 2009) with varying ethephon doses (C_0 , C_1 -175 and C_2 -225 mg) and irrigation I (I_0 no irrigation, I_1 -60 lit./plant; two days before tapping in both the ethephone doses). The first collection of gum was done after 7-15 days. Subsequent gum was collected after ten days to thirty days till May, 2011. Irrigation adversely influenced the gum yield in both the ethephone doses. Control recorded the least (25.13g) and C_2I_0 treatment yielded the highest (153.82 g) gum.

The total gum yield in different treatments was as C_0 - 25.13 g (range 4.62-12.59g), C_1I_0 (175mg) - 59.54g (range 11.36-27.98g), C_1I_1 (175 mg)- 36.53g (range 5.96-16.35 g), C_2I_0 (225mg)- 153.82g (33.63-65.19g) and C_2I_1 (225 mg)- 50.73g (12.77-22.65g). Though the trees were tapped third time so far (12 months after third tapping) there was no casualty in any treatment.

All the three experimental trials were maintained in Kumatia enclosure, Kailana Forest Area, Jodhpur. Protection measures (application of termiticide and fungicide) were applied in August, September and December, 2011. Growth data (Height, crown and collar diameter) were recorded in Oct- Nov, 2011.



Per cent Increment of Growth Parameters (year 2011)

While the control plants have minimum mean height 215.0 cm, crown diameter, 265.0 cm and collar diameter 13.5 cm C_2I_0 (225mg ethephon) treatment recorded maximum height 323.3 crown diameter 356.66 cm and collar diameter 18.06 cm, having 3-10 number of branches/plant. The incremental height, crown and collar diameter range from 8.91 to 21.11%, 6.31 to 11.17% and 3.72 to 8.96%, respectively, in different treatments.

Data showed that on the same dose of ethephon, irrigated plants have higher height increment as compared to un-irrigated plants. In case of collar diameter, the trend is reverse in which un-irrigated plants showed higher increment on the same dose. In crown increment, the effect of irrigation is not visible.

Soil analysis of plant pit samples collected in summer 2011 after cessation of gum exudation has been carried out. The ranges of per cent moisture were (0.25 to 1.22%), pH (7.31 to 8.32), EC (0.254 to 0.722 dSm^{-1}), % SOC (0.119 to 0.973 %) and phosphorus (0.22 to 2.26 ppm).

Thin branches were collected to analyze secondary metabolites in the month of November, 2011. Percent moisture in thinner branches (post ethephon treated plants) was ranging from 62.55 in treated plants to 68.66 % in control. In experiment-2, Pre-ethephon



solvent extractions with petroleum ether, ethyl acetate and acetone extracts were 1.52 to 1.86%, 1.02 to 1.38% and 0.71 to 0.94%, respectively. The thinner branches (post ethephon -2010) were collected after second consecutive gum extraction and pulverized. The powdered material was extracted with petroleum ether (60-80°), ethyl acetate and acetone, successively. The mean values showed that maximum per cent extractives were obtained with petroleum ether. It was maximum in control (2.89 %), followed by 2.36 to 2.76 % for different doses of ethephon. In case of ethyl acetate, the pattern was reverse, minimum per cent extractives obtained in control (1.56%) while, maximum 1.62 to 2.12% in different doses of ethephon. Similarly, in acetone, 1.35 per cent in control, followed by 1.38 to 1.51% in different doses of ethephon. Indicating that extractives yield is increasing in treated plants as compared to control. It is also reported that Guggulsterone comes in ethyl acetate fraction.

Phenological observations were recorded on monthly basis for all the plants in experiment viz; 1, 2 and 3. Plants were lush green after rains in monsoon with occasional fruiting. Leaves started yellowing in early October and all the plants were completely leafless in late October, 2011 with flowering and sporadic fruiting. Fruits were collected in Dec, 2011 and it was found that untreated plants recorded 130 fruits/20 g as compared to 144 fruits/20 g in treated plants.

Development of a Database on Tree Borne Oilseeds (TBO) in India

In order to estimate the statewide acreage of cultivation of seven Tree Borne oilseed species from Gujarat and Rajasthan, government Institutions viz; State Forest Department, Horticulture, Agriculture Departments, NGO etc. were contacted and data collected. Under this study, information regarding seven mandatory Tree Borne Oilseed Species viz; *Jatropha* (*Jatropha curcas*), *Karanja* (*Pongamia pinnata*), *Neem* (*Azadirachta indica*), *Mahua* (*Madhuca indica*),

Mango kernel as feed, *Jajoba* (*Simmondsia chinensis*), *Piloo* (*Salvadora spp.*) falling in the jurisdiction of AFRI viz. Gujarat and Rajasthan were collected and summerized. Bio-fuel authority of Rajasthan plantation data; targets and achievement for *Jatropha curcas* raising, seedling raising and district-wise progress of nursery raising from 2006-07 to 2010-11 were collected.

Survey, Selection Performance Trial and Estimation of Yield Potential of *Jatropha curcas* in Rajasthan and Gujarat

Two progeny trials one with 5 replications at AFRI, Jodhpur and another with 15 replications at Haldighati, Udaipur having single plant per replicate in RBD with 30 CPTs were established in July, 2008. At AFRI, Jodhpur site, the survival varied from 40 to 100 percent. Maximum mean height, number of branches and collar diameter were observed as 268.33cm (in BK-499), 6.80 (in 86 AFRI-3) and 10.95cm (in CSMCRI-1), while, these were minimum 126.00cm, 3.60 and 4.66cm, respectively in EL-19 AFRI-17. At Haldighati, Udaipur site, percent survival varied from 20 to 67 percent. Plant height, number of branches and collar diameter were maximum 151.67cm, 5.33 and 6.36cm, respectively in 76 AFRI-2. Minimum plant height and collar diameter were 46.67cm and 1.83cm in (86 AFRI-3), respectively and number of branches was 1.75 in CSMCRI-3. The CPTs at AFRI, Jodhpur site only yielded fruit and seeds, whereas, at Haldighati, Udaipur no flowering/fruiting was observed. Analysis of variance showed that the number of branches was significant at 0.01 probability level in AFRI, Jodhpur trial, whereas remaining growth parameter were non-significant at both the sites.

Development of seed yield equations

Carried out measurement in the two sample plots of *J. curcas* laid out at Motiya Research Farm, Rajpipla (Gujarat) during 2011-12. Total mean height, mean collar diameter and mean crown width varied from 2.65m to 3.06m, 14.61-15.78cm and 2.23 to 2.33m, respectively. Observation on the seed yield was also



taken, which varied from 300.0g to 360.95g/plant. Regression could produce relationship between seed yield and height, and SY vs. CD. Two different relationships: one LN (SY) vs. 1/HT or 1/CD, other SY vs. HT or CD. Calculated estimated seed yield based on these equations. The equation which gives more close value to observed data was considered. It was clear that CSMCRI clones were better as compared to SRT and BCR. They are having more height and seed yield as compared to SRT and BCR, though their age as only 5 years, while ART and BCR are of 7 years of age. Based on data recorded from two plots (5-7 years) at Motiya research farm during 2011-12, the yield equation developed is as follows:

$$\begin{aligned} \text{LN}(\text{SY}(1)) &= 6.614686 - 2.24806 * 1/\text{HT} \\ \text{LNSY}(2) &= 4.33385 + 22.36682 * 1/\text{CD} \\ \text{SY}(1) &= 94.50689 + 69.33952 * \text{HT} \\ \text{SY}(2) &= 821.4786 - 32.1123 * \text{CD} \end{aligned}$$

Suitability of *Jatropha curcas* L. Seed Sources in Lower and Mid Himalayan Regions of Himachal Pradesh (Externally Aided Project)

Under this project, seeds were collected from 29 seed sources and 19 individual trees in Himachal Pradesh and sent to The Energy Research Institute, (TERI), New Delhi for estimation of oil per cent. Passport data of all the collections recorded as per standard format provided by National Bureau of Plant Genetic Resource (NBPGR), New Delhi. After the result of oil contents, the plants were raised from the seeds of superior accessions i.e. >30% oil contents. Identified 21 nos. seed sources having seed oil contents >30% from various parts of Himachal Pradesh out of which 9 nos. seed sources have oil content >35%. Established demonstration plantations with approximately 57,000 plants planted at various places of Himachal Pradesh on 23 ha. area namely Thakurdwara (Nagarh), Joharji (Solan), Majhouli (Solan), Brahmpukher (Bilaspur), Bhojnagar (Solan), Samloe (Sunni), Devidhar (Sunni), Dharja (Solan), Samati (Solan), Narag (Sirmour), Sarahan (Sirmour), Nagarh (Solan). At the end of the

project, demonstration plantations on 16 ha. were surviving. The various growth parameters were recorded regularly in those demonstration-cum-experimental plantations. Subsequently seeds were also collected from the various demonstration plantations and seed yield recorded. The seeds from some progenies were also sent to TERI, New Delhi for oil estimation. Nursery studies, for raising *Jatropha curcas* in lower and mid-Himalayan regions of Himachal Pradesh was conducted. Seeds from various seed sources were also submitted to NBPGR, New Delhi for getting IC#No of the seed sources. Cuttings of different accessions were provided to network partners at different stages of the project. Frost seems to be an important factor in fruit setting in *Jatropha curcas* as frost prone areas produced very less seed per plant. Seed maturity was also reported as a serious problem owing to early winters in some areas of Himachal Pradesh. Altitude and aspect found to considerably affect growth and survival in *Jatropha curcas* plantations in lower and mid Himalayan regions. Establishment of *Jatropha* in Lantana infested areas was proved to be a very difficult task. However, the project has been completed successfully during March 2011 and, now, the demonstration plantations will serve as source of experimental material for future research activities as well as for training purposes.

Field Evaluation of Superior Accessions of *Jatropha curcas* Under Micro-mission Programme in Himachal Pradesh (Externally Aided Project)

Multilocational experimental trial of rooted cuttings of 10 superior accessions of *Jatropha curcas* repeated at Jawalaji area of Kangra district of Himachal Pradesh during September 2010 was maintained. The trial also covered 0.5ha area and recorded very good initial survival. The growth and survival data are being recorded regularly. Similarly, half-sib trial of *Jatropha curcas*, representing 20 superior accessions obtained from NBPGR, New Delhi as per the instructions of the funding agency was also carried out at Jawalaji of Kangra district of Himachal Pradesh in 1ha. area. The



Jatropha plants were growing vigorously in the trial and flowering was recorded in the second year of plantation. Pruning of plants has been done in the month of February 2011 as per the guideline provided by Jatropha National Coordinator of DBT, New Delhi.

Growth and survival data of experimental plantations was recorded regularly. Maintained Jatropha experimental plantations intensively, during

2011 for better growth, survival and branching. In Multi-location experiment, beating up of casualties carried out during 2011 rains. After pruning, vigorous branching has been recorded in the half-sib progeny trial, however, that also resulted into less fruit yield during 2011. Fruits/ seeds collected from different accessions during October- November 2011 from half-sib progeny trial and Various fruit and seed parameters were recorded.



Enhancement of Branching after Pruning in Jatropha plant at Half-sib trial



Half-sib Trial of *Jatropha*

2.7 Forest Protection

2.7.1 Overview

Research on Forest Protection is focused on activities envisaged under different ongoing and completed projects funded by ICFRE and various external funding agencies by ICFRE institutes. The important aspects are identification of insect pests, pathogens, beneficial microbes and protection of forest seeds, seedlings, saplings, trees in plantation, and stored wood by developing Integrated Pest Management strategies for the key pests of important tree species, seed pests of selective indigenous tree species and their management, assessment of disease problems of fast growing tree species, screening of eucalyptus clones for the gall insect, pest-host plant interactions, exploring natural enemies of insect pests, identification and testing of efficacy and effect of ecto- and endo-mycorrhizal fungi and PGPRs on rooting and growth improvement of indigenous trees, identification of salt tolerant AM fungi and PGPRs, studies on association of AM fungi in heavy metal contaminated soil, and field evaluation of superior strains of *Frankia* in casuarinas, exploration of scope of microbes in bioremediation and biofertilization and DNA finger printing of pathogenic and useful fungi. Under changing environmental conditions, the forest health is a matter of serious concerns under changing climatic conditions especially temperature, erratic rainfall, receding glaciers in hills and drought like conditions interfere with the growth and development of tree. They also influence the population dynamics and development of insect and pathogens, which negatively impact the sustainability of ecosystem and its services.

2.7.1.1 Summary of the Achievements under the Theme

Insect/Marine Pests

- Gas chromatography coupled electro-antennogram detector studies on *Leptocybe invasa* and its

parasitoids showed significant variation in acceptance and deterrence to volatiles extracted from resistant and susceptible eucalyptus clones.

- Twelve bacterial isolates, obtained from *Ailanthus* and *Casuarina* insect pests were characterized (morphological and biochemical) and all 12 isolates identified as *Bacillus* spp. Two effective bacterial isolates identified, using nucleotide sequencing, as *Bacillus thuringiensis* and *B. sphaericus*.
- Host specificity studies, using four prioritized insects species i.e., *Anomalococcus indicus*, *Isturgia disputeria*, *Dereodus denticollis*, and *Physita* sp. on 9 species of Australian and Asian acacias were completed.
- Screening of 238 clones of eucalyptus raised in field trials and maintained at VMG at Satyavedu, Panampally and Bharathiar University campus for gall insect attack was continued and the status of the clones for the attack of the pest was categorized into resistant/tolerant, less susceptible, moderately susceptible and highly susceptible.
- Standardized low cost non-chemical and chemical control measures to contain the eucalyptus gall wasp problem in nurseries.
- Effective concentrations of chemicals and botanicals, earlier studied in the lab bioassay studies, were field tested for their effectiveness against the following targeted insect pests: *Eupterote geminata*, *Tingis beesooni*, *Mylocerous discolour*, *M. viridanus*, *Atteva fabriciella* and *Eligma narcissus*.
- Bio-assayed two species of potential entomopathogenic fungi (*Beauveria* sp. and *Metarhizium* sp.) and two Bacteria (*Bacillus* spp.) against the following targeted insect pests: *Atteva fabriciella*, *Eligma narcissus* and *Lymantria ampla*.



- Infestation of *Indarbela quadrinotata*, a pest of *Casuarina equisetifolia*, was the highest in the North Eastern agroclimatic zone of Tamil Nadu. Data on growth parameters of the trees and pest incidence were periodically collected at plantation raised in 2006, at T.S. Pettai. It was found that there was no significant growth reduction due to the pest attack, though the infestation led to mortality of a few trees due to the invasion of wound by pathogens.
- Bioactive compounds responsible for biopesticidal properties have been identified from the ethnobotanical extracts against teak defoliator and *Ailanthus* defoliators through bioassays.
- Mealy bug survey was conducted in various tree plantations, agroforestry plantations and horticulture crops in southern districts of Tamil Nadu. Leaves were sequentially extracted with solvents to screen the bio-efficacy against papaya mealy bug.
- Sandal dominated ecosystems of Karnataka revealed the presence of 25 coccinellid spp. in selected provenances. A new coccid viz *Coccus viridis* was found attacking Sandal and Aonla. *Tectona grandis* was found to be severely attacked by an unidentified coccid.
- Seed insect pests of *Acacia nilotica*, *Ailanthus excelsa*, *Prosopis cineraria*, *Salvadora persica*, *Salvadora oleoides*, *Tectona grandis* and *Azadirachta indica* were studied.
- Rearing of different larval instars of *Acanthophorus serraticornis* on artificial diet/wood was observed.
- A native strain of baculovirus was extracted from infected larvae of *Lymantria obfuscata*,
- Life cycle and biology of predatory social spider *Stegodyphus sarasinorum* was studied in the nursery. The result indicated that each female produced on 1-2 egg-case containing about 100-150 eggs in each. These eggs hatch in 20-25 days and spiderlings emerge out of the egg-case in 30 days. There are 12 instars of the spiderlings to become adult and only at the end of 12th instar, the sex can be determined.
- A new mite species has been found infesting the stored seeds. The data on different treatments applied against various attacks have been taken and analyzed for developing suitable control measures to protect the stored Chilgoza seeds for longer period.
- During the surveys in Jharkhand, *Psylla*, black weevil, leaf miner, green bug, and trunk borer, aphid have been observed from sal, gamhar trees and cow bug and plant hopper from sissoo trees.

Diseases and Useful Microbes

- Screening for resistant clones of *Dalbergia sissoo* against *Fusarium solani* and *Ganoderma lucidum* using direct inoculation technique was done. Clones were also tested in a sick plot with four virulent strains of *Fusarium solani* f. sp. *dalbergiae*.
- Diseased samples were collected from Uttar Pradesh for *Cylindrocladium quinqueseptatum* leaf spots and blight disease and after the DNA finger printing of 26 isolates, by nrDNA amplification, sequencing and BLAST search, Haplotype analysis was conducted and different lineages identified.
- Four primers were designed for Eucalyptus pathogens *Pestalotiopsis* spp. which will be helpful in quickly detecting and identifying the isolates.
- Isolates of *Alternaria alternata* from FRI, Rudrapur and Paniyala have been collected on poplar genotypes. Relative growth study and toxin extraction of the pathogen done.
- A new stem canker disease on *Dalbergia sissoo* caused by *Lasiodiplodia* sp. from Sirsa, Haryana; wilt disease in *Uraria picta* by *Fusarium solani* and leaf spots disease in *Piper longum* by *Botrytis cinerea* from Dehradun were reported.
- Qualitative and quantitative solubilisation efficiency and HCN and siderophore production of isolates of *Pseudomonas fluorescens* collected from FRI (UK), Kalka (Haryana) and Hoshiyarpur (Punjab) have been carried out.
- Seven different fungal pathogens viz., species of *Alternaria*, *Cercospora*, *Coniella*,



Cylindrocladium, *Pestalotiopsis*, *Corticium* and *Lasiodiplodia* were recorded causing leaf and stem diseases. There was a variation in the incidence and distribution of these diseases caused by different pathogens in various locations during two years period of observations.

- Foliar diseases such as leaf spot, leaf blight and powdery mildew on *Ailanthus excelsa*, *Gmelina arborea*, *Melia dubia* and *Pongamia pinnata* caused by *Alternaria alternata*, *Colletotrichum* spp. and *Oidium* sp. were recorded from TCPL nurseries and plantations in Tamil Nadu.
- A field trial with 36 resistant clones of *Casuarina equisetifolia* identified for blister bark disease-through controlled condition studies has been established to test the consistency of resistant nature in the field.
- The distribution, nature and intensity of damage of bamboo blight disease were recorded.
- Surveys were conducted in seven different *Khasi* pine inhabiting areas of Meghalaya to assess the status of pine mortality and maximum of 40% disease incidence recorded in NEHU Campus, Shillong.
- Four isolates of *Ganoderma lucidum* were collected from western Rajasthan for pathogenicity test and effective control measurement.
- A nematode *Bursaphelenchus* sp. was collected and identified from the soil of infested *Prosopis cineraria* trees.
- Through Koch's postulate it was established that *Lasiodiplodia theobromae* and *Acremonium* sp. caused canker in *Tecomella undulata*.
- The total protein content in infected seedlings increased as the days of inoculation of the pathogen (*L. theobromae*) increased, i.e. concentration of protein was more after 90 days of inoculation as compared to after 15 days of infection.
- In composting the major litter decomposing mycoflora reported isolated and identified were *Aspergillus niger*, *A. flavus*, *Trichoderma* sp. and *Fusarium* sp.
- Anaerobic composting in pits by using Farm Yard Manure + Dried leaves + Niprovat (containing *Trichoderma viride*) with mulching has taken 120 days in winter season; it was due to slow microbial activity in low temperature.
- Molecular and RAPD markers analysis done for 3 isolates (Panampally, Tuticorin and Rameswaram) of *Casuarina* blister bark pathogen *Subramanianospora vesiculosa*, showed same genotypic characters.
- Under elevated CO₂ *Frankia* inoculated rooted stem cuttings of *Casuarina* responded significantly and produced root nodules within 25 days.
- A total 94 isolates of PGPRs were isolated from the rhizosphere of 18 different shola tree species in the Nilgiri hills, Tamil Nadu and species level identification was done.
- Efficient PGPR isolates were short listed based on the efficacy of IAA production and phosphate solubilization under *in-vitro* conditions.
- A total 51 isolates of PGPRs were isolated from different salt affected sites in Tamil Nadu and Puducherry.
- Efficacy of PGPRs isolated from different salt affected sites was screened for the production of plant growth hormone (IAA) and Phosphate solubilization under *in-vitro* condition.
- Rhizospheric soil samples were collected from two ranges i.e. Umtasor (five compartments) and Nongpoh (Lc. Colony, Morok, Diphu-Sydang & Tower point) and screened for endomycorrhizal qualitative and quantitative analysis.
- Different strains of species of *Acaulospora*, *Glomus* and *Gigaspora* were isolated and inoculum production and mass multiplication through trap culture and pot/plot culture worked out.
- Diversity of mycorrhizal associations with *Dipterocarpus* and *Shorea* species in Assam was documented.



- In association with *Acacia nilotica* and *Ailanthus excelsa*, important genera of AM fungi viz. *Acaulospora*, *Gigaspora*, *Glomus* and *Sclerocystis* were identified. *Glomus* occurred most frequently.
- The different species of *Glomus* were recorded as *G. aggregatum*, *G. fasciculatum*, *G. mosseae*, *G. macrocarpum*, *G. microcarpum* and *G. constrictum*. *G. fasciculatum* was dominant species in all the sites of nurseries as well as in plantations of *A. nilotica* and *A. excelsa*.
- The spore population varied from site to site and ranged between 163 to 480 propagules per 100 g soil from the rhizosphere of *Acacia nilotica* and 195 to 670 propagules per 100 g from the rhizosphere soil of *Ailanthus excelsa*.
- Antifungal properties of selected plant parts (flower bud of *Datura stramonium*; leaf and root of *Tribulus terrestris*; root, flower and fruit of *Argemone mexicana*) were evaluated against fungal pathogens *Alternaria alternate*, *Fusarium solani*, *F. verticilloides*, *Rhizoctonia solani* and *R. bataticola*.

Dendrocalamus strictus, *Dendrocalamus calostachyus* and *Gigantochloa atroviolacea*. Average attack percentage on these species was recorded from 1.63 to 51.29 % with maximum attack of 51.29 % in *Bambusa wamin*.

Insect Pests of Selected Bamboo Species in Assam and their Management

Surveys were conducted in the SFD, JFM and homestead bamboo plantations and nurseries in the district of Nagaon, Sonitpur, Sivasagar, Kamrup, Golaghat and Jorhat District. Thirty one insect species belonging to various orders were recorded. Based on the incidence and intensity of insect pest attack, the insect *Antonia* sp., *Psara licarsisalis*, *Crocidophora* sp., *Pyrausta coclesalis*, *Oxya nitidula* were categorized as major pests. Two new hosts were recorded as *Discophora sondiaca* and *Nemetis chandica* on *Bambusa pallida*. During survey, the natural enemies of four different predatory spiders *Oxyopes* sp. and *O. refisternum* on the larvae of *Crocidophora* sp. and *Psara licarsisali*, *Argiope catenulate* on *Pyrausta coclesalis* and *Crocidophora* sp. were recorded.

Field Manual of Insect Pests and their Control in Plantations

Literature and field data have been sorted out and finally compiled for preparation of field manuals of *Populus deltoides*, *Dalbergia sissoo* and *Bamboo*. During collection of data, six new insect pests have also been recorded from the field. Regular surveys are being conducted in field for collection of photographs that are not available in the literature.

Thrips of Forests and Medicinal Plants and their Management in Uttarakhand

A new species *Streothrips anshumani* has been described from Dehra Dun, Uttarakhand, India. It was collected from flowers of pear tree, *Pyrus communis*, growing in the FRI, Dehradun. The genus *Streothrips* Bhatti is known to pertain three species, of which two species have been recorded from India and 1 species (*Streothrips alaris* Reyes) reported from Philippines. Both Indian species have been collected from Doon

Project under the Theme			
Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	15	27	17
Externally Aided	05	05	07
Total	20	32	24

2.7.2 Insects Pests, Diseases and Control

Insect Pests

Insect Pest Surveys, Incidence and Biology *Phloeobius crassicollis* – a New Insect Pest

P. crassicollis was reported as new pest on the following ten bamboos species in and around Dehradun: *Bambusa bambos*, *Bambusa nutans*, *Bambusa polymorpha*, *Bambusa tulda*, *Bambusa vulgaris*, *Bambusa wamin*, *Dendrocalamus giganteus*,



valley. Apart from one new species other thrips species, *Lefryothrips lefroyi*, *Scirtothrips dorsalis* Hood, *Thrips flavus* Schrank have also been collected and identified. One more species of genus *Lefryothrips* has been collected, which is yet to be identified up to species level.

Status of Sal Heartwood Borer, *Hoplocerambyx spinicornis* and its Management

Sal forest areas of Madhya Pradesh and Chhattisgarh were surveyed for monitoring of sal borer, collection of information on borer incidence, natural enemies and abiotic and biotic factors. Natural enemies were identified and sample plots were laid out in sal forest areas of Mandla, Dindori and Anuppur Forest Divisions. Sal borer problem was investigated in Chhattisgarh and a training programme on sal borer and its management was conducted.

Seed Insect Pests

The seed samples have been collected from eight selected tree species recommended by Gujarat Forest Department to study the insect pest incidence. The sites selected for the seed collection of respective tree species were - Nadiad Social Forestry Division (*Acacia nilotica*), Mehsana Social Forestry Division (*Ailanthus excelsa*), Palanpur (Banas Kantha division) (*Boswellia serrata*), Bhuj (Kutch), Sorastra, Jamnagar (*Prosopis cineraria*, *Salvadora persica*, *Salvadora oleoides*), Gandhinagar Division (*Azadirachta indica*), Rajpipla, Valsad and Dang (*Tectona grandis*) and Rajkot (grass species). Seeds of *Acacia nilotica*, *Ailanthus excelsa*, *Prosopis cineraria*, *Salvadora persica*, *Salvadora*

oleoides, *Tectona grandis* and *Azadirachta indica* have been collected and kept in laboratory for further studies related to the identification of emerged insect pest and their incidence of attack. The rearing of insects was conducted in laboratory under control conditions.

Insect Pests of *Dysoxylum malabaricum*, *Garcinia gummigatta*, *Myristica malabarica*, *Vateria indica*

Studies on insect pest problems and their management were made for the seedlings of eight forestry species viz., *Dysoxylum malabaricum* Bedd., *Garcinia gummigatta* (L.) Robson, *Myristica malabarica* Lam., *Vateria indica* L. *Azadirachta indica* A. Juss, *Pongamia pinnata* L., *Emblica officinalis* Gaertn. and *Sapindus emarginatus* Valph raised in forest nurseries. Insect population varied with location and season. Hebbal nursery possessed 46%, followed by Sulikere, 32%, and Udane 12%, and Medinadka 9%. Total 12 different species of insects were found associated in different nurseries. Infestation was more severe in plains when as compared to nurseries of Western Ghat area. Control measures were carried out and it was found that Chlorophyriphos was more effective.

Flower and Seed Pests of *Neolamarkia cadamba*, *Ailanthus excelsa*, *Pongamia pinnata*, *Thespesia populnea* and *Melia dubia*

Many Coleopteran and Lepidopteran species of seed pests were collected but no serious pest was recorded during pre harvest and during storage in *N. cadamba*, *A. excelsa*, *P. pinnata*, *T. populnea* and *M. dubia* seeds. Damage assessment in terms of nature and intensity of attack by pests in *P. pinnata* during post harvest storage by an unidentified Lepidopteran species caused loss of 250g/kg of seeds and an unidentified bruchid beetle resulted in damage of 15g/kg of seeds during storage. Monitoring pests during storage using TNAU traps carried showed that significant number of coleopteran species could be trapped in *P. pinnata* seeds during storage. Four species of hymenopterans were collected from *P. pinnata* seeds.



Infested Pods of *Acacia nilotica*



Infested Seed of *Acacia nilotica*



Insect Pests in Selected Silvi-horticultural Models in Karnataka

Model -1: At Bevanahalli, *Tectona grandis* (Teak) and *Grevillea robusta* (Silver oak) with *Mangifera indica* (mango); Sandal and silver oak with Mango, Pomegranate and guava combinations had very high coccid infestations as compared to the other insects present. Bark feeding termites were also high on sandal and silver oak.

Model-2: At Mudenahalli, Sandal with amla and tamarind; *Tectona grandis* with Mango combinations, both Sandal and Amla had dominant infestation by bark eating caterpillar, *Indarbela quadrinotata*. A new coccid viz *Coccus viridis* was found attacking Sandal and Aonla. *Tectona grandis* was found to be severely attacked by an unidentified coccid and Mango was found to be severely attacked by Black Band Rot disease. This disease was affecting flowering and fruiting of Mango.

Model-3: At Kolar, *Tectona grandis*, *Terminalia arjuna*, *Dalbergia latifolia*, *Pterocarpus santalinus*, *Eucalyptus*, *Grevillea robusta* grown along with *Mangifera indica* (Mango), *Achras zapota* (Sapota), *Citrus maxima*, Pomegranate, *Citrus limonia* and guava). *Pterocarpus santalinus* was heavily infested by an unidentified membracid, and unidentified weevils. *Tectona grandis* was infested by the teak defoliator and skeletonizer. *Dalbergia latifolia* was also heavily infested by unidentified weevils. *Grevillea robusta* showed severe termite infestation with gummosis and *Tectona grandis*. *Psidium guajava* (Guava) was severely affected by white flies (*Aleurodicus dispersus*). The leaf gall wasp *Leptocybe invasa* was observed on the *Eucalyptus hybrid* trees.

Model-4: At Devanahalli, in Teak with Mango and sapota combination, termite infestation was severe on the most of the trees of *Tectona grandis*.

Fouling Organism

During studies on macro wood detriogens at Kakinada port and Narsapur Greenfield port, Andhra Pradesh, test ladders of wooden panels exposed at the three test sites, viz, deep water port and fishing harbour

at Kakinada and test site at Narsapur. Monthly observations on fouling and wood boring organisms carried out, test panels retrieved and replaced, water samples analyzed for various parameters. Data on fouling and wood boring forms have been recorded.

Control

Chemical

Eucalyptus Gall Wasp, *Leptocybe invasa*

Soil application of Acetamaprid significantly controlled the gall formation. On the other hand, plant based extracts and foliar applications of various pesticides did not significantly controlled gall formation.

Seed Pests of *Pongamia pinnata*

Seed treatments with 3 pesticides, 2 plant based extracts to study protection of seeds during storage against two sp. of pests in *Pongamia* seeds showed that plant based extracts like Neem powder and neem based extracts and pesticides like Dichlorvos and Monocrotophos protected seeds for a longer period and pest mortality was higher than plant based extract treated seed lots. Persistence of protection in terms of number of days for each treatment was also studied.

Control of *Eupterote geminata*, *Tingis beesooni*, *Myllocerous discolor*, *M. Viridanus*, *Atteva fabriciella* and *Eligma narcissus*

The effective concentrations of 5 chemicals (Quinalphos, Monocrotophos, Chlorpyriphos, Imidacloprid and Dimethoate) and 5 botanicals (Neem oil, Jatropha oil and *Pongamia* oil, *Hydnocarpus* seed oil and Neem azal 1%) determined in the lab bioassay studies were tested for their field efficacy against the targeted pests. The chemical Monocrotophos @ 0.025% was found effective for all the pests, whereas, the efficacy was found to vary between 0.05% to 0.075% with the species with the other chemicals. In the case of botanicals, the product Neem azal 1% at 30 ppm was able to cause mortality (50-60%) in respect of defoliators and good repellency for both the defoliators and sap suckers. Cultural and mechanical control methods were also devised and practiced for the targeted pests.



Management of Khejri Mortality in Rajasthan

Trials were laid out at six sites in five districts: Surani (Balesar Road, Jodhpur), Raghunathpura (Didwana in Nagaur), Jhareli (Jayal in Nagaur), Goshala (Fatehpur in Sikar), Churu (Churu) and Sultana (Jhunjhunu). The treatments T-1 = Bavistin (0.1%) + chlorapyrophos (0.05%) + powermin @2ml/l and applied around two feet of trees trunk root treatment of 20 litre solution, T-2 = 20 g phorate granules at the base of the pit, covered with 8-10 inches layer of soil + 50 g *Trichoderma* in talc mixed with 5 kg FYM, applied above the layer of phorate and another layer of soil over it, T-3 = chlorpyriphos (20 EC) 15 ml + carbandazium (50 WP) 20 g + copper oxychloride (50 WP 40 g / tree. T-4 = as control using soil work and drenching with 20 litres water /tree. First round of treatments were conducted during February-March, 2011 and data pertaining to infestation caused by pests/diseases were collected after six months of treatment to evaluate the effectiveness of different treatments in the various experimental sites. It was observed that the treated trees exhibited a significant effect on recovery ranging from 25 to 35% as compared to the control, wherein percentage of infected trees remained 100%. Observation was also recorded to study the impact of good rainfall during last two years on present scenario of Khejri mortality. A significant increase in foliage production in Khejri tree has been observed after good rains experienced since past two years, but the percentage of infestation caused by the root borer, *Acanthophorus serraticornis* and disease *Ganoderma lucidum*, in Khejri remained unchanged, ranging between 90-100% of trees in the farmer's field. The second treatment was given during December, 2011 – January, 2012. The observations on the effect of second treatment have been recorded in June-July, 2012, six months after the treatment.

Phloeobius crassicollis

Phloeobius crassicollis is a major pest of bamboos. Newly emerged beetle feed on the outer surface of the bamboo culm, preferably at the nodes during May-June and damages the new culm. Chlorpyriphos at 0.04% and 0.05% concentration gave 78.16 and 80.94% control, respectively.

Oak Stem Borer, *Aphrodisium hardwickianum* White (Coleoptera: Cerambycidae)

Monocrotophos (36 EC) and dimethoate (30 EC) at concentrations of 0.4% each and 5-10 ml of of fumigant (saturated solution of para-dichlorobenzene in kerosene oil / emergence hole) were found to be most effective measure. Mechanical control by hammering stone into the exit hole for adult was also effective.

Biocontrol

Eucalyptus gall wasp, *Leptocybe invasa*

Considering the adverse impacts of chemical pesticides, difficulties in application in vast areas of plantations and concealed nature of the pest inside the gall, integrated management measures were attempted in nurseries involving traps, plant based extracts, pesticides, classical biological control and utilization of gall resistant germplasm of eucalypts. Trap methods (Light trap, colour traps, sticky traps) did not reduce the gall wasp population in nursery beds. Significant reduction in gall wasp population was observed when gall tolerant clones were deployed along with release of natural enemies *Quadrastichus mendeli* and *Megastigmus* sp. Results show that deployment of these two methods helped in reducing the high cost of containing the pest in outbreak situations and avoid loss of planting material.

Through a classical biological control programme, natural enemies *Quadrastichus mendeli* and *Megastigmus* sp. were introduced from Israel for the management of gall wasp. Parasitisation efficiency of natural enemies to galls on different species/clones of Eucalypts was studied. Host preference by the natural enemies of *L. invasa* in relation to the variation in gall incidence on different Eucalypts germplasm was also studied. More individuals of parasite and reduced gall induction was observed in susceptible eucalyptus clones in nursery beds. Gall tolerant clones showed less gall induction and less population wasp population. Gas chromatography coupled electro-antennogram detector studies of eucalyptus gall wasp and its parasites response to various eucalyptus germplasm showed significant results. Response of gall wasp to volatile



profiles of resistant clones showed absence of key compounds necessary for eliciting acceptance reaction by gall wasp, whereas those of susceptible clones revealed several compounds which are known as attractants or deterrents. These results will go a long way in tailoring gall tolerant/resistant clones with pest deterrent chemoprofiles.

Acacias

Host specificity studies with four species of prioritized insects (*Anomalococcus indicus*, *Isturgia disputeria*, *Dereodus denticollis*, *physita* sp.) were continued on live hosts of 9 species of Australian and Asian Acacias. The studies revealed that the scale insect, *A. indicus* survived on *Acacia planiferans* and *A. tortilis*. The defoliator *I. disputeria* survived and completed lifecycle on 3 species of Acacias viz., *A. planiferans*, *A. leucophylae* and *A. tortilis*. The weevil *D. denticollis* survived only on *A. nilotica* ssp. *indica* and *A. nilotica* ssp. *tomentosa*. Further studies on this line are in progress.

Insect Pests of *Ailanthus* and *Casuarina*

Pathogenicity studies were carried out with 5 isolates of *Bacillus* and 2 species of entomopathogenic fungi on targeted pests. It was found that 2 isolates of bacteria, *Bacillus thuringiensis* and *B. sphericus* and 2 species of fungi, *Metarhizium anisopliae* and *Beauveria bassiana* were pathogenic. Further laboratory bioassay studies, with these potential bio-agents against the targeted pests, *Atteva fabriciella*, *Eligma narcissus* and *Lymantria ampla*, expressed that the bacteria at the concentration 1×10^8 cells/ml and the fungus *B. bassiana* at the concentration of 2×10^8 spores/ml were effective resulting 100% larval mortality over a period of 72hrs and 5days, respectively.

Coccinellids Based Biocontrol of Sandal Scales and Mealy Bugs

The study aimed to identify more potential coccinellids in sandal dominated ecosystems of Karnataka revealed the presence of 25 coccinellids in selected provenances of sandal in Karnataka. The non outbreak of insect pests on sandal is attributed to the prevalence of these coccinellids in the natural habitats

of sandal. Five species of coccinellids which were active on sandal plantations in areas outside forests were collected in association with scales and mealy bugs infesting sandal.

Field Evaluation of Indigenous Species of *Trichogramma* against Teak Skeletonizer *Eutectona machaeralis*

Population of teak skeletonizer, *Eutectona machaeralis* was observed in experimental areas. *Trichogramma* species was released against teak skeletonizer, *Eutectona machaeralis* in the field condition. Field evaluation have been initiated in three different localities Moiyanal, Udaipur and Tikariya in Mandla Forest Division, Mandla and observations recorded.

Biocontrol Potential of Native Isolates of Entomopathogenic Nematodes for the Management of Insect Pests of Teak

Biocontrol potential of 6 native isolates has been determined against the teak skeletonizer using the laboratory culture of one exotic and six unidentified (native) populations of EPNs native to central India, maintained *in-vivo*, round the year. The improved method for field applications of entomopathogenic nematodes and related parameters affecting field applications were also experimented. The determination of best effective formulation of the selected EPN and its efficacy with regards to the stages and time of application against the target pests was investigated. The work is still in progress.

Biological Control of Teak Leaf Skeletonizer *Eutectona machaeralis*

A total of 2.5 crores of egg parasitoid, *Trichogramma raoi* were released for management of teak defoliator and skeletonizer in selected sites (300 hectares in plantation and 300 hectares in natural forests of teak) at Maharajpur range of Mandla Forest Division, Madhya Pradesh. To assess and demonstrate the biological potential of *T. raoi* in field, observations on damage impact (defoliation intensity) of target insect pests and tree growth in released and non released sites are being recorded.



Biological Control of Insect Pests of Medicinal Plants- *Abelmoschus moschatus*, *Gloriosa superba* and *Withania somnifera*

Target species of medicinal plants were raised in experimental plot in Forest Entomology Division. Multiplication of *Trichogramma* and *Chrysoperla* was done. Seasonal history of key insect pests was worked out. Sampling of natural enemies was done. Different doses of biopesticides were tested in laboratory conditions. The insect pests of target species of medicinal plants were identified in different localities, egg parasitoid, *Trichogramma* and predator, *Chrysoperla* was tested against key insect pests (Defoliator & shoot borer). The work is in progress.

Studies on Larval Parasitoids, *Apanteles* spp. (Hymenoptera: Braconidae) of Major Defoliators of Teak and Sal Forests of Odisha

Surveyed teak and sal forests of five districts of Odisha (Bargarh, Bolangir, Boudh, Sambalpur and Sonepur) for the collection of larvae and pupae of insects defoliating teak and sal forests. Collected 152 samples of larvae and pupae of teak and sal defoliators from field and by laboratory rearing recovered 34 specimens belonging to *Apanteles* spp. Identified 10 species of *Apanteles* (*A. asmeadi*, *A. coleman*, *A. deliodis*, *A. endymion*, *A. erionotae*, *A. hyblaea*, *A. lakhaensis*, *A. philoempus*, *A. prodinae*, *A. rudius*) on defoliators of teak and sal. All these *Apanteles* spp. are indigenous and are being recorded for the first time from Odisha. Worked out natural field parasitisation of these 10 species of *Apanteles*, parasitising the defoliators of teak and sal. Studied biology of *Apanteles machaeralis* on teak skeletonizer.

Efficacy of *Beauveria bassiana* Against Bamboo Pests

Beauveria bassiana was evaluated on bamboo insect pest viz. *Pyrausta coclesalis*, *P. licarsialis* and *Crocidophora* species in lab condition and found effective on these pests.

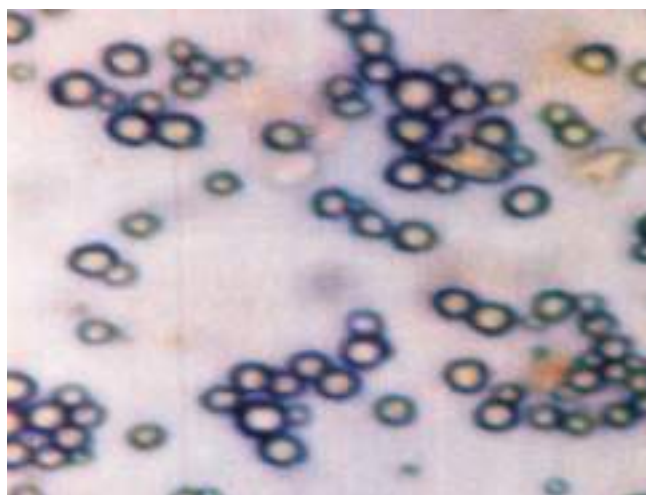
Oak Stem Borer, *Aphrodisium hardwickianum*, White (Coleoptera: Cerambycidae)

Following natural enemies of the borer were recorded (a) Insects: an undetermined Elatrid beetle (b) Birds

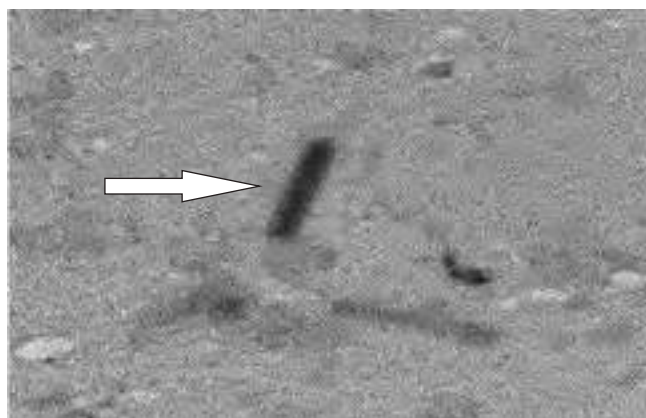
- (i) Himalayan Woodpecker, *Dendrocopos himalayensis*,
- (ii) Brown-fronted Woodpecker, *Dendrocopos auriceps*,
- (iii) Scaly-bellied Woodpecker, *Picus squamatus* and
- (iv) Greater Yellowthroat, *Picus flavinucha*.

Management of Indian Gypsy Moth (*Lymantria obfusca*) in Himachal Pradesh

Laboratory Rearing Technique of Indian Gypsy Moth (IGM) has been standardized. Through continuous rearing of IGM in the laboratory condition for past consecutive 5 years, the methodology of rearing neonate larvae and its subsequent development to adulthood have been finalized. Moreover, as IGM overwinter in egg form, rearing of egg-mass for 7-8 months, in very specific ambient environment without



Baculoviral (LONPV) Occluded Bodies



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Print Mag : 144000X@7. in
14:54 01/12/10
TEM Mode : Imaging

100 nm
HV = 100Kv
Direct Mag : 66000X
AMT Camera System

TEM image of single virion of LONPV



interference of parasitic microhymenopteran parasitoids, in the laboratory was done. One native strain of baculovirus extracted from infected larvae of *Lymantria obfuscata*, was purified.

Management of Insect Pests of seeds of *Pinus gerardiana* in Storage

Chilgoza seeds which are economically important are heavily infested by insect borer. The seed borer identified as *Cateremna tuberculosa* Meyrick (*Plodia interpunctella* Hübner) is reported for the first time infesting the Chilgoza seeds. The seeds were stored in different containers such as Cotton bag and airtight containers for observations

It was observed that the seeds stored in the cotton bags were least effected by insect. Four insecticide/ biopesticides i.e. 1) Praghat (Antifeedant: *Nerium odorum* + *Bombax malabaricum* 1ml/lt.) 2 sprays/4days intervals, 2) Farsa, 10%EC (Alphamethrin (EC)-129, contact & stomach poison), 3) Robust: Chloropyriphos, 205EC, and 4) Neem Manure: product of *Neem (Azadirachta indica)* were applied to protect the seeds from different attacks. New mite species have been found



Mite Infestation on Chilgoza Seeds

infesting the stored seeds. The data on different treatments applied against various attacks have been taken and analyzed for developing suitable control measures to protect the stored Chilgoza seeds for longer period.

Bionomics of *Pityogenes scitus* in Himachal Pradesh

Five forest areas viz. D-91 Bhawan Ki Dhar under Solan Forest Range, D-73 Mashobra under Mashobra

Forest Range, Jamunda Forest Under Kotgarh Forest Range, Jangi Forest Under Akpa Forest Range and Brundhar Forest Under Manali Forest Range were selected for this study and climatological data were collected. The male adults of *P. scitus* bore the first tunnel down to the sapwood and eat out the pairing chambers. The female beetle enters through the same tunnel or eats out the separate tunnel, which meet the lower part of the male tunnel or pairing chamber directly. About five female enter the pairing chamber and pair with a single male. The single female lays 10-15 eggs in each gallery. The larvae on hatching out bore away from the mother galleries curving in irregular manner. The larvae feed chiefly in the bast layer and their



Symptoms of Attack of *P. scitus*



P. scitus Blanford (colepetra: Scolytidae)



Stellate Appearance of Galleries Formation on the Bast Layer – Polygamus Galleries

galleries do not get into the sapwood. Full grown larvae eat out a depression at the end of their galleries in sapwood and pupate. The number of 4-5 adult beetles/20 cm² on infested tree was found.

Botanicals

Flora Evaluation for Pesticidal Properties: Phenol and phenolics extracted from ten plant species have been



screened for allelochemical effects against *Ailanthus* defoliators (*Atteva fabriciella* and *Eligma narcissus* in plantations at Kurumbapatti, Salem) and teak defoliator (Kerala Forest Research Institute, Research station at Nilambur).

Anti-insect Secondary Metabolites from Fungal Endophytes: The endophytic fungi viz., *Colletotrichum*, *Phomopsis*, *Lasiodiplodia*, *Pestalotiopsis*, *Phyllosticta*, and *Fusarium* were recorded from the leaf samples (*Tectona grandis* and *Ailanthus excelsa* leaves were collected for isolation and taxonomic confirmation of

endophytic fungi. Variation in distribution and occurrence of different endophytic fungi was observed in different leaf segments of young and mature leaves). Pure cultures of endophytes such as *Phoma* sp., *Phomopsis* sp., *Colletotrichum gloeosporioides*, *Botryodiplodia theobromae* and *Fusarium* were maintained in the laboratory and mass cultured using Potato Dextrose broth medium. Isolation and characterization of secondary metabolites from *C. gloeosporioides* and their bioefficacy on teak and ailanthus defoliators are in progress.

Biopesticide against Papaya Mealy Bug

Extracts from plant viz., *Adhatoda vasica*, *Melia dubia*, *Vitex negundo*, *Aristolochia bracteata* and *Pongamia pinnata* were processed with organic solvent extraction and stored at 20 °C for their bioassay against exotic papaya mealy bug.

Insecticidal Properties of Extracts from Leaves and Flowers/Seeds of *Lobelia* sp. and Seeds of *A. concinna*

Bioassays were conducted on the 3rd instar larvae of *S. litura*. The formulated products were tested against laboratory hosts and on arboreal termites and pests of Teak, *Mangifera indica*, Neem, *Pongamia pinnata*, *Syzygium cumini* in the field conditions.

Extractives from *Lantana camara*, *Ageratum conyzoides*, *Parthenium hysterophorus* and *Croton bonplandianum* Against Marine Wood Borers

Herbage of 4 plant species were collected and extracted with acetone, ethanol and water. Extractives were complexed with copper and chrome and with these formulations timber panels were treated. These treated panels were exposed in harbour waters and observations on the performance of treated panels taken.

Methanol Extract of *Acorus calamus* Against Bamboo Pests

Extract was evaluated against *Parasa* sp. in lab condition. The higher conc. 3 and 4% caused 64 and 76% of larval mortality respectively after 48 hours. NSKE (Neem Seed Kernel Extract) was evaluated against the I, II, III instars larvae of *Crocidophora* sp. The



Fungal Endophytes Isolated from Teak Leaves



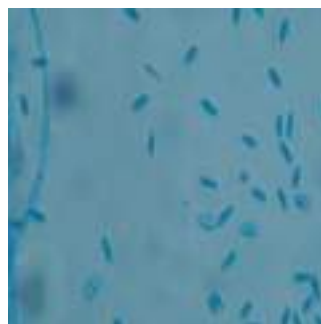
Fusarium sp.



Phomopsis sp.



Colletotrichum gloeosporioides



Spores of *Colletotrichum gloeosporioides*



concentration of 10% caused the highest larval mortality of 76% after 48 hours.

Insect Resistant Germplasms

Screening for Eucalyptus gall resistant clones:

Screening of 238 clones of eucalyptus raised in field trials and maintained at VMG at Satyavedu (AP), Panampally (KL) and Bharathiar University campus (TN) for parameters like -incidence of the pest, oviposition damage, gall formation, intensity of attack, was done. On the basis of data collected quarterly for two years on these parameters, clones were categorized as resistant/tolerant (20 clones), less susceptible (70 clones), moderately susceptible (48 clones) and highly susceptible (100 clones).

Others

Management of Insect Borer Complex in Chir Pine Forests

A) Tree Trap:

To evaluate the effectiveness of **tree trap** for entrapping the beetles of *Polygraphus longifolia* and other, billets of two sizes (80 cm L X 70 cm GBH and 100 cm L X 90 cm GBH) were kept at 5 experimental sites and the data on insect activity and population abundance of *P. longifolia* and *Cryptorhynchus rufescens* and *Sphaenoptera aterrima* were recorded along with moisture content of the logs. Trees falling into the girth range of 90-180cm were found to be highly susceptible to infestation in comparison with young (below 90 cm) and mature (above 180 cm)



Tree Trap to Attract Bark and Wood Borers In Chir-pine Forest

stands. Trap with 95 – 110 cm L X 90 - 100 cm GBH and 25 to 35 % moisture content was found to be effective to attract the beetles.

B) Pheromone:

Pheromone, Ipsdienol (C₁₀H₁₆O) at 1mg, 2mg, 4 mg and 8mg loading/ concentration in four types of pheromones Traps viz. Fero-T™, Del-Ta™, Wot-T™ and Fligh-T™ by following factorial RBD design is being evaluated at Platto Chir-pine forest in Barsar Forest



Some Pheromones Traps in Chir-pine Forests

Range under Hamirpur Forest Division to manage bark and wood borers in chir pine forest especially *Ips longifolia* (Steb.) (Coleopteywra: Scolytidae) under factorial RBD, design, two factors (4 Types of Pheromones traps and 4 loading/ dozes of pheromone) with 3 replications. Combination of higher loadings (4 and 8mg with Fero-T™ trapped significantly higher beetle catches as compared to low loadings with other traps in the experiment during first year of observations.



Diseases And Their Control

Screening for Resistant Clones of *Dalbergia sissoo*

Screening for resistant clones of *Dalbergia sissoo* against *Fusarium solani* and *Ganoderma lucidum* using direct inoculation technique was done. Sick plot has been developed and being monitored for population of *F. solani*. Nine clones have been put to pathogenicity testing in the sick plot and Clone No. 9093 and 375 were found susceptible to wilt disease. Clone No. 2, 6, 10, 11, 16, 23 and 24 were found susceptible to *G. lucidum*.

Natural Decay Resistance of Imported Woods

Twenty one species of imported woods were tested for natural decay resistance using accelerated laboratory tests, using two white rot and two brown rot fungi. Seven woods were found in decay resistant Class-I while seven each in Class-II and III. Most resistant wood sample was of Padauk (*Pterocarpus soyauxii*) from Cameroon followed by teak (*Tectona grandis*) wood sample from Ghana, whereas, least resistant wood was of Beech wood (*Fagus sylvatica*) from Belgium followed by Maple (*Acer pseudoplatanus*) wood sample from France. White rot fungi caused more weight loss than brown rot fungi and *Pycnoporus sanguineus* caused more weight loss in wood blocks than other test fungi.

Screening of Eucalyptus germplasm for Disease Resistance Against *Cylindrocladium* leaf and Seedling Blight

Diseased samples were collected from Uttar Pradesh and after the DNA finger printing 26 isolates by nrDNA amplification, sequencing and BLAST search. Haplotype analysis was conducted and different lineages were identified. All the 26 annotated gene sequences were deposited in NCBI, Genbank, USA and accession number was obtained. Highly virulent isolates of *Cylindrocladium quinqueseptatum* were identified. The disease resistance testing of eucalyptus germplasm for clones from industries and FRI germplasm has been done.

Development of Molecular Diagnostic Kits for Identification and Early Detection of Nursery and Plantation Pathogens of Eucalyptus

ITS region of nrDNA of *Pestalotiopsis* spp. isolates from eucalyptus leaves were amplified, sequenced and BLAST searched to authenticate their taxonomic identity. Four primers were designed for *Eucalyptus* pathogens *Pestalotiopsis theae*, *P. foedans*, *P. oxyanthi* and *P. disseminata* which will be helpful in quickly detecting and identifying the collected isolates.



Treatment of Trees at Ta Prohm Temple, Cambodia



Trainees with the Director General Dr. V. K. Bahuguna at Ta Prohm



Screening of Poplar Genotypes Against *Alternaria alternata* toxin(s)

Isolates of *Alternaria alternata* from FRI, Rudrapur and Paniyala have been collected and maintained. Relative growth study of 20 isolates of *A. alternata* was completed and Toxin extraction of 4 isolates done.

Treatment of Heritage Trees

Thirty trees were treated at Ta Prohm temple, Cambodia with training to Cambodian officials. One Cambodian was given exposure training at FRI. Bodhivriksha at Bodhgaya was examined for its health status and given treatment.

New Disease of *Dalbergia sissoo*

A new disease of *Dalbergia sissoo*, caused by *Lasiodiplodia* sp. and responsible for stem canker disease has been reported from Sirsa, Haryana. The



Canker in *D. sissoo* by *Lasiodiplodia* sp.

disease is causing wet spots on the bark initially which turn into oozing of sap and splitting of bark and exhibits typical canker symptoms. The cankers are seen causing girdling and death of the severely affected trees. About 10 per cent trees were noticed affected by this disease which appears to be progressing in Haryana and Punjab.

Fungal Diseases in Forest Nurseries of Bangalore and Western Ghats

Leaf spot disease was very severe in *Pongamia pinnata* in Bangalore nursery and blight was common in

Western-Ghats nurseries with 100% severity. In Bangalore area, seedlings were free from diseases in March-June. Diseases start manifesting from July onwards and reaches peak in October- November and starts receding from December onwards; whereas, in Western Ghats area, blight was common in all seasons. Causal organisms viz. *Fusarium*, *Pestalotiopsis*, *Colletotricum gloeosporioides* and *Alternaria* species were identified from infected seedlings. Pathogenicity of *Colletotricum gloeosporioides* on *P. pinnata* was confirmed. Botanicals like *Cleistanthus collinus* and *Prosopis juliflora* leaf and bark extract and one standard fungicide Indofil-M45 was used for controlling disease incidence for *P. pinnata*, *Vateria indica* and *Sapindus emarginatus*. It is observed that disease was controlled up to 80%.

Diseases of Important Medicinal Plants and Their Biocontrol

Disease survey on medicinal plants was conducted in Madhya Pradesh and Chhattisgarh forest nurseries, plantations and farmers' fields. The disease incidences in various localities were assessed. The study revealed that *Rauvolfia serpentina* infected from leaf spot, inflorescence top dying and wilt diseases caused by *Alternaria alternata*, *A. tenuis*, *A. tenuissima*, *Cercospora rauvolfiae*, *Cladosporium oxysporum*, *Colletotrichum dematium*, *Corynespora cassicola*, *Fusarium oxysporum* f. sp. *Ruavolfiae*, *Lasiodiplodia theobromae*, *Macrophomina phaseolina*, *Mycosphaerella rauvolfiae*, *Phoma jolyana* and *Phomopsis sethii*. Similarly different pathogens viz. *Cladosporium cladosporioides*, *Fusarium oxysporum*, *Pseudocercospora withaniae*, *Sclerotium rolfsii* and *Meloidogyne incognita*, were recorded from *Withania somnifera*. The leaves of *Chlorophytum borivillianum* were found to be infected with *Colletotrichum capsici*, *C. chlorophytum*, *C. graminicola*, *Macrophomina phaseolina* and root rot disease caused by *Fusarium oxysporum*. The *in-vitro* test showed that the antagonistic activity of *Bacillus amyloliquefaciens* and *Streptomyces* sp. was very effective against the



pathogens. Field experiment for management of *R. serpentina* revealed that Bavistin 0.05% + *Streptomyces* sp. (10^6 spores/ml) was significant treatment among the other treatments, while *Streptomyces* sp. (10^6 spores/ml) was best for the control of leaf spot and root rot disease of *C. borivillianum*. Root knot disease of *W. somnifera* caused by *Meloidogyne incognita* was effectively managed by adding 50% neem cake in the potting mixture.

Integrated Management of Vascular Wilt Disease in Forest Nurseries

Occurrence of wilt disease of Aonla, Neem and Khamer in different forest Research and Extension nurseries of Betul, Chhindwara, Seoni, Balaghat and Pandarkaura have been recorded. Wilt causing pathogens viz. *Fusarium solani*, *F. oxysporum*, *F. concolor*, *Verticillium* sp. and *Rhizoctonia solani* have been isolated and identified. The disease predominated during the month of Jul- Aug. The average incidence of the disease ranged between 3.75 to 26%. Out of ten provenances of neem, provenance from Bargi was found more susceptible as compared to other provenances, while Shahdol and Raigarh provenances showed resistance to disease. The Kanchan variety of aonla was found more susceptible in nurseries at Balaghat and Seoni. The grafted saplings of Kanchan, Chakaiya, Francis and Desi (wild) varieties at Balaghat nursery have shown comparatively more incidence of disease, may be due to shade effect of broad leaved tree cover over the agronet shade of the nursery. Ridomil (carbendazim 4% + mancozeb 64%) was found more effective against *Fusarium solani* in nursery.

Wood Decay and its Control in Stored Tropical Timber

Forest wood depots of Madhya Pradesh (18), Chhattisgarh (13) Maharashtra (12) and Orissa (25) were surveyed for collection of wood decay fungi and 1159 specimens of wood decay fungi were collected on 34 hosts (timber). The wood decay fungi belong to 83 species of 47 genera distributed in 15 families. Four species were reported for the first time from India, namely, *Australohydnum dregeanum*,

Hapalopilus nidulans, *Hjortstamia friesii*, and *Schizopora flavipora*. Three wood species namely bijasal, teak and sal were treated with 2% mix of 4:3:1 combinations of K_2CO_3 , $KHCO_3$ and K_2CrO_7 . After incubation period of 8 to 16 week the decay fungi caused wood decay ranging from 16 -37 per cent in control, whereas, the treatment reduced the rate of decay up to 5 per cent. Experiment was laid out by using two biocontrol agent *Aspergillus niger* and *Trichoderma viride* against ten white rot and one brown rot fungus by dual culture technique. Both *A. niger* and *T. viride* inhibited the growth of all decay fungi tested. Although the percentage inhibition of radial growth values of *T. viride* and *A. niger* are almost the same (ranging from 29.2 to 66.7%) but the average mean value of *T. viride* was 51.7% and for *A. niger* it was 45.5%.

Taxonomy and Documentation of Wood Decay Fungi of Chhattisgarh

Three hundred forty three specimens were collected from Kawardha, Bilashpur, Marwahi, Dhamtari, Ambikapur, Manendragarh and East Raipur of Chhattisgarh region. Out of 343 specimen, 31 genera and 41 species of wood decaying fungi, collected from 35 host tree species were identified. Taxonomy and documentation of 38 wood decaying fungi were done, in which 25 new documents for fungi were prepared and 13 already prepared documents were amended.

Root rot and Stem Decay Diseases in *Acacia catechu* and Their Control

The following fungi were identified from samples of *Acacia catechu* collected from MP and HP: *Auricularia*, *Daedalea*, *Flavodon flavus*, *Ganoderma lucidum*, *Lenzites palisoti*, *Monodictys*, *Phellinus badius*, *P. gilvus*, *P. pachyphloeus*, *Stachylidium*, *Schizophyllum commune*, *Torula herbarum* and *Tremetes cingulata*. Nine fungi namely, *Alternaria alternata*, *Aspergillus flavus*, *A. niger*, *A. fumigatus*, *Cladosporium cladosporioides*, *Curvularia* sp., *Fusarium concolor*, *F. solani* and *F. verticilloides* were isolated from seeds of *A. catechu*. Out of four tested fungicides, Bavistin 0.2% was proved successful to control the growth of *Ganoderma lucidum*.



Potential Pathogens Responsible for the Low seed Production in Teak Seed Orchards

Spermiophyte mycoflora of *Tectona grandis* were recorded from the inflorescence, young fruits and mature fruits collected from Mandla and Jabalpur Forest Divisions. The fungi associated with inflorescence and immature fruits were recorded as *Absidia* sp., *Alternaria raphani*, *Ampulliferina fagi*, *Aspergillus flavus*, *A. niger*, *Cladosporium cladosporioides*, *Curvularia lunata*, *Fusarium oxysporum*, *Helminthosporium* sp., *Humicola grisea*, *Phialophora lagerbergii*, *Rhizoctonia solani*, *R. bataticola*, *Septonema* sp., *Trichoderma harzianum* and *T. pseudokoningii*. The fungal flora associated with weathered seeds was also recorded as *Aspergillus flavus*, *Fusarium oxysporum* and *Rhizopus stolonifer*, while the unweathered seeds have shown the presence of *A. flavus*, *Fusarium equiseti* and *F. solani*. *Bacillus amyloliquefaciens* an antagonistic bacterium isolated from the rhizosphere soil of *Rauvolfia serpentina* from nursery of Institute campus inhibited the mycelial growth of spermiophyte mycoflora of teak. The teak seeds extracted from the hard nuts treated with 11 days old broth culture of *B. amyloliquefaciens* showed inhibition of the seed borne fungal flora.

Incidence and Management of Culm Rot and Bamboo Blight Disease in Assam

Representative sites of six agroclimatic zones of Assam were surveyed to assess the culm rot and bamboo blight disease. The distribution, nature and intensity of damage of bamboo blight disease were recorded and climatic data and diseased samples collected. The pathogenicity tests were conducted on three bamboo species viz., *Bambusa tulda*, *B. balcooa* and *B. nutans* in laboratory as well as in nursery. Field trials were carried out in Marigaon district on *Bambusa tulda*, with 4 fungicides (Trade name Indofil m-45, Bavistin, Stuff, Result) were tested and except result all were found effective.

Incidence and Management of Pine Mortality in Manipur

Surveys were conducted in seven different Khasi pine inhabiting areas of Meghalaya to assess the status of

pine mortality and maximum of 40% disease incidence was recorded in NEHU Campus, Shillong. Diseased samples were collected and brought to the laboratory for further investigation. Analysis of rhizosphere soil samples revealed nine different fungal genera. Soil samples were also analyzed for physico-chemical properties.

Broad Spectrum Antifungal Compound from Selected Tree/Shrubs/Weeds of Indian Arid Region

Antifungal properties of selected plant parts (flower bud of *Datura stramonium*; leaf and root of *Tribulus terrestris*; root, flower and fruit of *Argemone mexicana*) were evaluated against fungal pathogens. Alcoholic extract of *Argemone mexicana* root showed good antifungal activity against *Fusarium solani*. Aqueous and ethanolic extract of *Tribulus terrestris* leaves showed mild antifungal activity against selected fungi. Alcoholic extract of *Datura stramonium* bud showed good antifungal activity against *Alternaria alternata*.



Inhibition Zone by Alcoholic Extract of *Argemone mexicana* Root Against *Fusarium solani*



Inhibition Zone by Alcoholic Extract of *Datura stramonium* Flower bud Against *Rhizoctonia solani*



Alcoholic extract of *Datura stramonium* bud showed good antifungal activity against *Rhizoctonia solani*.

2.7.3 Mycorrhizae, Rhizobia and Other Useful Microbes

Salt tolerance ability of different Arbuscular Mycorrhizal (AM) (*Glomus* spp., *Acaulospora* spp. and *Gigaspora* spp. and ectomycorrhizal (ECM) fungi (*Pisolithus albus* and *Suillus brevipes*) was tested against three different sodium salts, such as, sodium chloride, sodium citrate and sodium sulphate under *in-vitro* condition and selected and short listed the potential salt tolerant AM and ECM fungi for nursery application.

Selected shola tree species were inoculated with different bio-inoculants (AM fungi and PGPRs) and it was observed that the bio-inoculants applied seedlings had better seedling health and growth parameters over uninoculated (control) seedlings. Field trials were established in 2 locations in the Nilgiri Hills, Tamil Nadu and it was recorded that the bio-inoculants applied saplings had significantly better survival and establishment.

Attempts were made to study the population density of AM fungi from heavy metal contaminated sites in Tirupur, Tamil Nadu and it was observed that



Effect of Inoculation of PGPR and AM Fungi on Growth Enhancement of *Gmelina arborea* Seedlings



Azospirillum



Azotobacter

large amount of AM spore population was noticed in Kasipalayam area (132/g soil).

Dynamics of Litter Decomposition in Sal Forest of Central India

Litter decomposition in five different sites of sal forests of Madhya Pradesh Chhattishgarh and Odisha was studied. Overall, 63 different fungal species involved in litter decomposition were recorded. The influence of carbon flux, nitrogen, phosphorous, and potassium at different stages of decomposition were estimated.

Total five potentially beneficial fungi were screened for their ability to enhance the decomposition rate and nutrient release. Nine mycorrhizae forming fungi (*Astraeus hygrometricus*, *Geastrum triplex*, *Boletus* sp., *Boletus fallax*, *Mycena* sp., *Russula* sp., *Scleroderma bovista*, *S. geaster*, *S. verrucosum*) were identified from different sites of sal forest. Two ectomycorrhizal fungi were multiplied for their capability of mycorrhization. Experimentation on sal seed germination have been carried out, which revealed that nursery beds containing solarised soil + FYM + mycorrhizae infested soil shown 47% germination, whereas, in case of unsolarised soil with same treatment germination was 20.50 %. Eleven documents of important litter decomposing as well as mycorrhizae contributing fungi have been prepared. A new species, *Asterostomella shoreae* collected from Achanakmar Biosphere Reserve in Chhattishgarh, on fresh fallen leaves of *Shorea robusta* has been reported. Two new fungal records *Helicosporium phragmitis* and



Boletus fallax have been recorded from India and the latter is a new mycorrhizal record for sal.

Microbial Inoculants for Application in Forest Nurseries and Plantations

For product development of different microbial inoculants, microbes including *Azotobacter*, *Azospirillum*, *Rhizobium*, AM fungi (*Glomus mosseae*, *Acaulospora scrobiculata*, *Gigaspora* sp.) were isolated from Madhya Pradesh (adjoining areas of Chitrakut, Sanawad, Badvaah and Khandwa) and Chhattisgarh (Bilaspur). Microbial samples of bel, tinsa, mahua and beeja-sal are maintained in pot cultures. Pot experiments on bel has been conducted by using combination of AM fungi, *Azotobacter* and *Azospirillum*. After 3 months biomass production was found superior in the treatment of *Azospirillum* + AM fungi.

Utilization of Vesicular Arbuscular Mycorrhizal Diversity for the Quality Stock Production in Meghalaya

Surveys were conducted to visit two ranges i.e. Umtasor (five compartments) and Nongpoh (Lc. Colony, Morok, Diphu-Sydang & Tower point) in Meghalaya and two ranges of Titabor and Borhola, Joypur Reserve Forest, Kaziranga National Park, Amsoi Reserve Forest for the collection of rhizospheric soil samples. The collected rhizospheric soil samples were screened for endomycorrhizal qualitative and quantitative analysis. Two dominant and efficient strains (*Glomus* sp. and *Gigaspora* sp.) which were prevalent in the forest soil were isolated and inoculum production and mass multiplication through trap culture and pot/plot culture completed. The seedlings of two selected plant species (*Mesua ferrea* and *Aquilaria agallocha*) are being raised by inoculation experiment with VAM fungi.

Diversity of Mycorrhizal Associations with *Dipterocarpus* and *Shorea* species in Assam

The seeds of *Dipterocarpus retusus* and *Shorea robusta* were collected from forests and sown in fumigated soil in nursery bags. Mass inoculum of

ectomycorrhizal and endomycorrhizal fungi had been raised *in-vitro* and *in-vivo* respectively and the seedlings of selected tree species were inoculated at the time of sowing. The results revealed a better root and shoot biomass in the inoculated seedlings in comparison to the control. After six months, the inoculated and control seedlings were transplanted to field and it has been observed that the inoculated seedlings in comparison to control performed better for their establishment and on growth characteristics.

Augmentation of Composting and Biofertilizer in Hot Arid Regions

Litter decomposition mycoflora i.e., *Aspergillus niger*, *Aspergillus flavus*, *Trichoderma* sp, and *Fusarium* sp were isolated and identified. Mass multiplication of indigenous consortium inoculum with dominance of *Glomus fasciculatum* of AM fungi of *Prosopis cineraia*



Anaerobic Composting (FYM + Dried Leaves + Niprovat (*T. viride*))



Mulching with PVC Sheet of Anaerobic Composting



VAM Multiplication in Beds



Rhizobium Nodules in Roots of *Acacia nilotica*

(Khejri), *Azadirachta indica* (Neem) and *Acacia nilotica* (babul) in pots have been prepared at AFRI Model Nursery, Jodhpur. Anaerobic composting in pits by using Farm Yard Manure + Dried leaves + Niprovat (containing *Trichoderma viride*) with mulching.

Efficient Strains of AM Fungi and *Rhizobium* for *Acacia nilotica* and *Ailanthus excelsa*

Rhizosphere soil and root samples of *Acacia nilotica* and *Ailanthus excelsa* were collected from various forest nurseries in Rajasthan. Soil samples were

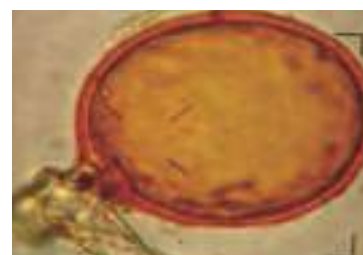
analyzed for pH, EC, (%) organic carbon (% OC) and phosphorous (P). The isolation of AM fungi was carried out and the important genera identified were; *Acaulospora*, *Gigaspora*, *Glomus* and *Sclerocystis*. The different species of *Glomus* were recorded as *G. aggregatum*, *G. fasciculatum*, *G. mosseae*, *G. macrocarpum*, *G. microcarpum* and *G. constrictum*. Out of which, *G. fasciculatum* was dominant species in all the sites of nurseries as well as in plantations. The spore population was varied from site to site and ranged between 163 to 480 propagules per 100 gm soil of



Glomus sp. Collected from *A. nilotica* from Barmer



Acaulospora sp. Collected from *A. nilotica* from Barmer



Glomus sp. Collected from *A. nilotica* from Barmer



Glomus sp. Collected from *A. nilotica* from Pali



Gigaspora sp. Collected from *A. nilotica* from Barmer



Sclerocystis sp. Collected from *A. nilotica* from Pali



Sclerocystis sp. Collected from
A. nilotica from Pali



Sclerocystis sp. Collected from
A. nilotica at Pali

Acacia nilotica and 195 to 670 propagules per 100 gm rhizosphere soil of *Ailanthus excelsa*.

Plant Growth Promoting Rhizobacteria (PGPR)

Qualitative solubilisation efficiency of 64 isolates of *Pseudomonas fluorescens* on *Dendrocalamus strictus* collected from FRI, Dehradun (Uttarakhand), Kalka (Haryana) and Hoshiyarpur (Punjab) was assessed besides quantitative estimation of P solubilisation of 14 isolates from these places; these and 105 more isolates were also qualitatively assessed for HCN and siderophore production for knowing their biocontrol properties. The physico-chemical characteristics of the soil from these sites were worked out to draw relationship between soil and bacterial samples.

A total of 94 isolates of PGPRs (PSB 42, *Azotobacter* 26 and *Azospirillum* 26 isolates) were isolated from the rhizosphere of 18 different shola trees and 51 isolates [18 isolates of Phosphate Solubilizing Bacteria (PSB), 16 isolates of *Azotobacter* sp. and 17 isolates of *Azospirillum* sp.] were obtained from the rhizosphere of *Casuarina equisetifolia*, *Eucalyptus tereticornis* and *Prosopis juliflora* in salt affected areas in Tamil Nadu and Puducherry.

Salt tolerance ability of *Azospirillum*, *Azotobacter* and PSB was tested using 3 different salts viz., sodium chloride, sodium citrate and sodium sulphate under *in-vitro* condition and selected and short listed the potential salt tolerant microbes for nursery application. Fifteen different clones of *Casuarina equisetifolia* were applied with the selected salt tolerant microbes (PGPRs, AM and ECM fungi, Frankia) and it was found that most of the clones inoculated with these microbes had better growth performance over control.

Seedlings of *Ailanthus excelsa*, *A. triphysa*, *Neolamarckia cadamba*, *Gmelina arborea* *Melia dubia* and *Dalbergia latifolia* raised in sterile soil + sand as potting medium were inoculated with selected PGPR isolates and AM fungal biofertilizers (single and multiple inoculations) and maintained in the experimental nursery. It was observed that the seedlings inoculated with PGPR or AM fungi (both single and multiple inoculation) showed significant growth over uninoculated control with respect to shoot and root height, shoot and root biomass, total biomass, volume index, sturdiness quotient, absolute growth rate, relative growth rate and Microbial inoculation effect after 90 and 180DAI. The results also indicated that multiple inoculation of different PGPR and AM fungi showed better growth performance over single inoculation and control.

PGPR isolates (55 No.) were isolated from heavy metal contaminated soil samples and maximum population density of beneficial microbes was recorded in Sarkarperiyapalayam (Tirupur district) soil sample in Tamil Nadu.

Six bacterial strains viz., two species of *Bacillus*, two species of *Klebsiella* viz., *Klebsiella pneumoniae* subsp. *pneumoniae* and *Klebsiella oxytoca*, one species each of *Planococcus* sp. and *Micrococcus luteus* were isolated. The best two dye degraders viz., *Planococcus* sp. and *Bacillus* sp. were further studied for optimization studies for the effect of carbon source, nitrogen source, pH, temperature and percentage of inoculum under *in-vitro*.

16S rDNA Nucleotide sequence of Phosphate Solubilizing Bacterium (*Bacillus cereus*) isolated from the saline soil, Tamil Nadu submitted to European



Molecular Biology laboratory (EMBL) Database and Accession number obtained as Fr878075.

Based on the research findings, a biofertilizer product named "IFGTB Tree Growth Booster - VAM Biofertilizer" was developed and made available to user groups for application in nursery and field.

Frankia

A field trial has been established at Karaikal with Frankia inoculated seedlings of *Casuarina equisetifolia* and *C. junghuhniana* with 4500 seedlings inoculated with 10 different Frankia strains. Frankia inoculated seedlings and cuttings of *C. equisetifolia* and *C. junghuhniana* showed higher

growth (150-300 cm height) than the uninoculated control seedlings.

Rooted stem cuttings of *C. equisetifolia* and *C. junghuhniana* inoculated with Frankia were exposed to 600ppm of elevated CO₂ in Open Top Chambers (OTC). Frankia inoculated rooted stem cuttings were responded significantly and produced root nodules within 25 days. The growth and biomass of the rooted stem cuttings were also higher than the ambient level CO₂ conditions. Whereas, the Frankia inoculated rooted stem cuttings maintained in the open conditions did not show any nodulation even after 30 days.



Root Nodule Formation in *C. junghuhniana* Cuttings Inoculated with *Frankia* at OTC.

EDUCATION VISTAS



3. Education Vistas

3.1 Introduction

The Directorate of Education, being an important arm of the ICFRE, has been mandated to guide and galvanize forestry education in the country through State and Central Universities and

- To nurture FRIDU into an institute of excellence in higher learning in forestry.
- To provide financial support in the form of grant-in-aid to improve gap-filling infrastructure
- To enhance quality of forestry education by continuously striving for improvements in curriculum.
- To provide a framework of quality assurance through a well laid system of accreditation in forestry.
- To integrate the institutions of forestry education with research in ICFRE system to foster mutual symbiosis and outreach.
- To network with the international institutions of repute on faculty and students exchange.
- To enhance employability of the forestry professionals for mainstreaming of forestry across sectors.
- To attract talent into forestry as a profession.
- Provide avenues for capacity building to the scientific and technical cadre of the council and of the sector in general.
- To support policy in forestry through policy research inputs.
- Providing access to international level teaching and learning resources, including books and journals through e-consortium and information system.
- Providing well laid IT enabled environment for academic excellence.
- A well-laid system of accreditation is in place. Efforts are made to bring all the universities imparting forestry education under the aegis of accreditation.
- Development of a very clear road-map for each University for the purpose of future growth in terms of Institutional management, financial resource allocation and utilization, physical infrastructure, faculty and staff, students affairs profile, course delivery, co-curricular and related activities, research and development through a process of peer review.
- Periodical curriculum revision and upgradation, in tune with the requirements of the sector, with wider stakeholder participation, bearing stamp of both the councils (ICAR & ICFRE) for wider acceptability.
- Provide support for gap-filling infrastructure for funding capital investment for forestry education and also attract matching investment from the states as per prescribed guidelines.
- Enhancing employability of the Forestry professionals and facilitating appropriate placements by tie-ups.
- Development of a range of programmes on Capacity Building catering to the requirements of the sector. This also includes the capacity building of Indian Forest Service and, therefore, design, development and execution of Mid-Career Training of Indian Forest Service for phase-III as Lead Training Organization.

3.2. Processes in Forestry Education

The above mandate is achieved by the Directorate through following processes.

- Creating teaching and research infrastructure for Universities giving impetus to Forestry Education, matching higher standards for forestry education.



- Fostering international cooperation in the field of forestry education through networking, faculty and students exchange to bring international wisdom.
- Policy Research Support to the MoEF by hosting the policy research committee at ICFRE and also institution of Policy research Studies to provide inputs to the Ministry.

3.3 Grant-in-Aid to Universities

The National Commission on the Agriculture in its report in 1976 recommended for creation of forestry education facilities in the universities for conducting graduate and post graduate level programs. Initially the universities imparting forestry education were supported by the grants released by ICAR and continue to work under ICAR umbrella. However, after grant of autonomy to the ICFRE, pursuant to its mission objective, ICFRE has been providing grants to develop technical capabilities and strengthen infrastructure for forestry faculties in the universities imparting forestry education at the graduate and postgraduate levels as a gap filling support.

ICFRE has been providing Grant-in-Aid to various forestry research universities/ institutions under Agricultural Universities offering Undergraduate and Postgraduate Courses in forestry only, to strengthen the infrastructure for giving impetus to Forestry Education in the country. During the period April 2011 to March, 2012 Rs. 100.00 lakh have been released to 10 Universities as grant-in-aid.

3.4 ICFRE Accreditation Board

The ICFRE Accreditation Board Meeting was held on 13 October 2011 at Dehra Dun. The peer review reports of the universities alongwith the self assessment were considered in depth and on the recommendation of the Accreditation Board, the Director General, ICFRE approved the accreditation of the following 09 Colleges/Universities and courses in forestry for the period of three years from 18 October 2011, with the grading mentioned against them.

S.No.	Name of University	Accreditation Grade
1.	Department of Forestry, Haryana Agricultural University, Hissar (Haryana)	A
2.	Department of Forestry, College of Agriculture Orissa University of Agriculture & technology, Bhubneshwar (Orissa)	A
3.	College of Horticulture & Forestry Central Agricultural University Pasighat (Arunachal Pradesh)	A
4.	Department of Forestry Natural Resources, Punjab Agricultural University, Ludhiana (Punjab)	A
5.	Department of Forestry, HNB Garhwal University, Srinagar (Garhwal)	A
6.	College of Forestry, Dr. Balasaheb Sawant Konkam Krishi Vidyapeeth, Dapoli (MS)	A
7.	ASPEE College of Horticulture & Forestry Navsari Agricultural University, Navsari (Gujarat)	A*
8.	Faculty of Forestry, Sher-E-Kashmir University, Srinagr (J&K)	A
9.	College of Horticulture & Forestry, Maharana Pratap University of Agriculture & Technology, Jhalawar (Rajasthan)	A

This is in addition to the 9 universities already accredited; thereby, as on date 18 universities have been accredited by ICFRE for forestry education. The process of assessment and peer review has provided a good roadmap to each university to achieve higher levels of academic excellence.

3.5. Policy Research

Two Policy Research Studies entitled "Synergy in Various Institutions in Implementation of the Scheduled



Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006 to Ensure Improved Livelihood Support as also Sustainable Forest Management” & “Analyzing the Linkage between Poverty Alleviation and Forestry Programme” have been completed in the financial year 2011-12.

Organized the fifth meeting of Policy Research Committee in Conference Room No. 403, MoEF, New Delhi on 10 August, 2011.

3.6. HRD Initiatives

- As part of the HRD initiatives for capacity building of scientific personnel, 13 trainings programme (including 01 training of MCT Phase-III – Third Course) were organized in a number of training organizations of repute, in which 227 participants (including 54 participants of MCT) were trained in 17 Institutions.
- In order to provide wide national exposure to the scientists, a total of 115 permissions were issued at the Council level for participation of scientists in national level seminars, workshops, symposia etc.
- Facilitated 71 cases of foreign visits, which were finally approved from the Government of India with funding from a number of sources providing a much needed international exposure to the scientific cadre.

- Organized 04 HRD Committee meetings of ICFRE for the preparation of Committee Report on Policy on Human Resource Development in ICFRE.
- The Directorate of Education also prepared the HRD Plan for Capacity Building for ICFRE for ensuing 12th Five Year Plan by involving experts in various disciplines.
- As a novel initiative, ICFRE prepared first of its kind “**HRD Policy of ICFRE**” to revamp the functioning of the Council. The policy is developed by involving experts from within and outside the Council and also by doing in-house consultations. The document has been placed on the website of the council.

3.7. Mid-Career Training of IFS

ICFRE successfully completed Mid-Career Training Project for IFS officers for phase III (Third Course), by providing best institutional arrangement and partnership with Institutions like Wildlife Institute of India, Dehradun, Forest Survey of India, Dehradun, Indian Institute of Management -Ahmedabad, Colorado State University, Fort Collins, (US) and Swedish University of Agricultural Sciences (SLU)/Swedish Forest Agency, Sweden. Fifty four officers from all over the country participated in the training programme.

ICFRE arranged and organized following training programme for Scientists and IFS Officers from 1 April 2011 to 31 March 2012:

S.No.	Training	Dates	Institution	No. of Participants
1.	Training on Reservation Policy	07 June 2011	SC/ST Commission, Lkw at ICFRE,	22
2.	Training on Forest Biotechnology	11-20 July 2011	NBPGR, New Delhi	17
3.	Training on Planting Stock Improvement: Clonal trials	22 August 11 – 02 September 11	IFGTB Coimbatore	14



S.No.	Training	Dates	Institution	No. of Participants
4	Training of scientific support staff RAI, RAII & TAI on Laboratory Management	05-09 September 2011	TFRI Jabalpur	25
5	Training On Paper & Pulp	22 August-02 September 2011	CPPRI Saharanpur	1
6	Training on Effect of Invasive species/weeds on Productivity of Forest Plantations & Natural forests & different cost effective methods.	13-17 December 2011	K.F.R.I. Peechi, Kerala	10
7.	Training on 'Nanotechnology'	22-25 February 2012	IWST Bangalore	15
8.	Training of scientific support staff RAI, RAII & TAI on Laboratory Management	27 February – 02 March 2012	FRI Dehradun	25
9.	Training on 'Tree Breeding'	27 February to 04 March 2012	Dr. Y.S.Parmar University of Horticulture & Forestry, Solan	6
10	Training on 'Environmental Impact Assessment'	19- 23 March 2012	F.R.I. Dehradun	15
11	Training on 'Cultivation of Medicinal Plants'	19- 23 March 2012	I.H.B.T. Palampur	3

3.8. Grievances Redressal Cell

Grievance Redressal Cell has been functioning in the Directorate of Education under the chairmanship of DDG Education and the cell undertakes various activities for SC/ST and OBCs. During the period under report, the cell received no grievance from the employees. Two Special training workshops for Officers/ Officials of ICFRE (HQ) and FRI, Dehradun were organized on "Reservation Policy" in the Conference Hall, Scientist Hostel, FRI, Dehradun on 7 June 2011 and 27 to 28 March 2012.

3.9. FRI (Deemed) University

Academic course and admission:

The FRI (Deemed) University has been offering the following academic courses on a regular basis:- Two years M.Sc. courses in Forestry, Environment Management and Wood Science & Technology and Cellulose & Paper

Technology, one year courses in Post Graduation Diploma in Natural Resource Management, Diploma in Genetics & Tree Propagation & Biotechnology. Besides, the University offers research programme in forestry leading to award the Doctrate Degree.

In order to provide excellence in academic inputs in the FRI Deemed University, three Chairs of Excellence have been provided in the University. During this year, the guidelines for Operationalization of Chairs of Excellence were prepared and finalized in consultation with known academicians in the field.

Sports Meet

University Sports meet was organized from 22 to 26 March 2012 in order to emphasize the values of healthy body and healthy mind amongst the students.

Placement

Placement brochures have been prepared for all M.Sc. and Diploma courses, with student's profile. Placement



brochures were sent to different Organizations/Industries/ Companies/ NGO's and constant contact was maintained to facilitate Campus Interviews. Campus Interviews were

conducted with different Organizations / Industries / Companies/ NGO's and placement of students for academic year 2011-2012 carried out.

Sr. No.	Institution	Selected Students
1.	Reliance Foundation (Bij)	1. Joystu Dutta 2. Shankar Dubka 3. Anjali 4. Virendra Singh 5. Prabeena Devi
2.	Selections in Indian Forest Service (through UPSC National Competitive Examination)	1. Vaanathi M.M. 2. Rohinini Ballav Saikia 3. Chaman Lal 4. Harajeet Kaur 5. Amrita Dutta 6. Lovit Bhaarti 7. Sanjay Biswal 8. Arpana
3.	M/s Wipro Technologies	Himani Sharma
4.	CDS Examination	Priya Nair
5.	Agriculture Officer	Swagitika Nayak

Ph. D. Course work:

Compulsory courses for Ph.D. were conducted from 15 September to 31 December, 2011 by FRI University. The details of the research scholar's activity is summarized below:

S.No.	Research Scholars registered/submitted/Awarded Ph. D.	No. of students
1	Research Scholars registered for Ph.D	64
2	Research Scholars who submitted the thesis	28
3	Viva voice of the Research Scholars held during the year	38
4	Approval of the RDC for award of Ph. D. Degree	37



Field Visit of Officers and Scientists under Induction Training Hoshiyarpur



Visit of Officers and Scientists under Induction Training at Modern Nursery Unit



Field Visit of Officers and Scientists Arranged by FRI University for Demonstration at Shimla



Visits of FRI Students to Valley of Flowers



Sport Meet by Deemed University FRI



Visit of Officers at DUFRI Campus during Sports Meet



Nursery Visit of DUFRI Students



Field Visit of DU FRI Students



3.10 Trainings Organized for Other Stakeholders

- i) Three days training programme on CDM validation and verification was organized at ICFRE, Dehradun from 3 to 5 July, 2011 with the help of M/S TUV SUD SOUTH ASIA Pvt. Ltd., New Delhi. 20 participants including DG, ICFRE attended the training programme.
- ii) One week compulsory training course for Indian Forest Service officers on "Forest and Climate Change: Opportunities and Challenges of Mitigation and Adaptation" was organized at ICFRE Dehradun from 17 to 21 October 2011. The training course was sponsored by the Ministry of

Environment and Forests, Government of India, New Delhi, and 33 IFS officers of different State Forest Departments participated in the training course. The programme was highly appreciated and rated by the participants.

One week training programme for scientists and technologists on "Climate Change and Carbon Mitigation" was organized at ICFRE, Dehradun from 14 to 18 November 2011. The training programme was sponsored by the Department of Science and Technology New Delhi, and 24 scientists and technologists participated in the training programme. The programme was highly appreciated and rated by the participants.



Participants and Organizers of One Week Compulsory Training Course for Indian Forest Service officers



Participants and organizers of One Week Training Programme for Scientists and Technologists

One week training programme for women scientists and technologists on "Climate Change and Carbon Mitigation" was organized at ICFRE, Dehradun from 06 to 10 February 2012. The training programme was

sponsored by the Department of Science and Technology New Delhi, and 25 women scientists and technologists participated in the training programme. The programme was highly appreciated and rated by the participants.



Participants and Organizers of One Week Training Programme for Scientists and Technologists



Participants and Organizers of Two Days Training Workshop for IFS Officers

Two days training workshop for IFS officers on "The significance and scope of REDD/REDD+ for Indian forest" was organized at ICFRE Dehradun from 13 to 14 February 2012. The training workshop was sponsored by the Ministry of Environment and Forests, Government of India, New Delhi, and 18 IFS officers from different State Forest Departments participated in the training workshop. The programme was highly appreciated by the participants.

Twenty Seven training programmes were organized by FRI to address the needs of stakeholders. The target group trained in these training includes participants from SFDs, officers/Scientists of ICFRE and other related institutions, NGOs, farmers.

Thirty three trainings were imparted during the year to different stakeholders group including officers

from SFDs, Scientists, NGOs, students from universities. This included one week compulsory training course for IFS officers on Forest Genetic Resource Management, training and orientation programme for Forest officers from Maharashtra and Odisha and Tamilnadu, Orientation and training programme for other department officers from TamilNadu. Dr. Alison M Berry, Professor, Department of plant science, University of California, Davis, was invited to IFGTB. The speaker delivered special address on "The current trends on Nitrogen assimilation in *Datisca-Frankia* root nodule symbiosis" as well as Hands on training to JRFs on "Isolation of *Frankia* from root nodules of *Casuarina equisetifolia*" on 2.12.2011.



Training to Horticulture Officers



Twelve trainings were organized by the institute covering the major aspects of its mandate and the target trainees were from SFDs, Scientists, NGOs, students from universities. The training of special mention was on "Advanced Wood Processing and Utilization of Plantation Timbers". Is training was attended by officers from Karnataka State Forests Industries Corporation (KSFIC). Lectures on different aspects of wood science such as introduction of lesser known/alternate species and their trade/local names, methods of storage of logs and sawn timbers, various sawing techniques, importance of knowing different timber properties, defects in wood and grading of logs and sawn timber, finger jointing in wood and its

importance in utilization of small girth plantation timbers, field identification of important timbers, importance of wood seasoning and seasoning schedules of various timber species, seasoning kilns (solar, steam, vacuum press drying, dehumidification drying etc.); other seasoning methods, fundamentals of wood preservation and need for wood preservation, traditional and emerging wood preservatives and operation of preservation plants, prevention and control of wood deteriorating fungi susceptibility of timber to pest attack and enhancement of durability, demonstration and interaction on seasoning kilns, preservation plant etc., were delivered by IWST Scientists.



Trainings and Other Activities at CFRHRD, Chhindwara



Twelve trainings were organized by the CFRHRD, Chhindwara under TFRI, Jabalpur. Target groups were farmers/Non Government Organizations/Women Self Help groups/Women Van Samiti members.

RFRI, Jorhat organized 28 trainings during the year. Target groups included the members from Territorial Army, Eco Task Force (Assam), students of B.Sc. (Forestry), State Forest Department Officials, Eco-development committee members, NGOs and rural people.



Training on "Assessment of Phyto-diversity Dynamics for Conservation in Jeypore Reserve Forest."



Training-cum-workshop Organized "Global Positioning System Application in Forest and Land Resource Survey" for officers' trainees of State environment and forestry training institute (SEAFIT), Dimapur, Nagaland and Nagaland forest department, Govt. of Nagaland.

AFRI, Jodhpur organized 7 trainings during the year for a range of stakeholders including compulsory training for the IFS officers (one week) on the Sustainable development of fragile desert ecosystem from 19 - 23 December 2011. The Institute has been identified as one of important training Institution on desert ecosystem management by the MoEF for the purpose of capacity building of Indian Forest Service.



Six training programmes were organized by HFRI, Shimla during the year for the officials of SFD of Himachal Pradesh and representatives of Panchayati Raj Institutions and Mahila Mandals, and farmers. A number of programme were also organized commemorating International Year of Forests in 2011. Besides, two Interactive Meetings with senior and field functionaries of the State Forest Department were held on various issues Pertaining to Quality Parameters of Nursery Stock of Deodar and Ban Oak on 19 March 2012 in the Shimla Forest Circle & on 21 March 2012 in the Rampur Forest Circle, thereby, maintaining a close coordination with the forest department.



Glimpses of the Training on "Global Positioning System Application in Forest and Land Resource Survey"



Training on "Lac Cultivation through Scientific Method" in Progress



Participants of the Training on "Lac Cultivation through Scientific Method"

Two trainings were organized by IFP, Ranchi during the year. Training on "Lac Cultivation through Scientific Method" was organized for farmers of Simdega district of Jharkhand. Training on "Bamboo Propagation, Cultivation and Management for Sustainable Livelihood" was organised for farmers, field functionaries and participants of ATMA, Katihar (Bihar).

3.11. Important Visits Abroad

ICFRE was represented in a number of international events, conferences, seminars abroad by its scientists and officers, by presenting research papers in important areas of research. A total of 71 cases of visit abroad were approved by the Ministry. Some important events, where ICFRE participated are mentioned below.

- Shri V.R.S. Rawat, Scientist-E Biodiversity and Climate Change Division participated in the UN Climate Change Conference from 6-17 June 2011 at Bonn, Germany.
- Shri V.R.S. Rawat, Scientist-E Biodiversity and Climate Change Division participated in the UNFCCC COP 17 and COP/MOP-7 from 28 November to 9 December 2011 at Durban, South Africa.
- Visit of Shri A.K. Bansal D.G. ICFRE (Additional Charge) and Shri Omkar Singh, DDG (Education) to Swedish University of Agricultural Sciences and Swedish Forest Agency in connection with Mid Career training of Indian Forest Service officers during 18-26 May, 2011.
- A delegation of Ministry led by Dr P. J. Dilip Kumar, Director General Forests, Government of India, including Dr. V. K. Bahuguna, DG, ICFRE, Shri M. S. Garbyal, DDG(Admin), Shri Sandeep Tripathi, DDG (Res), Shri A. M. Singh, DIG, MoEF and Dr. S. S. Negi, Director, FRI visited Edinburgh, UK, for sharing lessons from experience of forest landscape restoration and to hold meeting with the UK Team for current and 2nd Phase of the Project under the UK-India Forest Landscape Restoration (FLR) Project.
- A delegation under the leadership of Dr. V.K. Bahuguna, DG, ICFRE attended IUCN meeting at Bangkok on 01 February 2012 to develop bilateral collaboration of ICFRE with IUCN. Dr. V.K. Bahuguna, Director General, ICFRE elaborated the research programme of ICFRE to all members of IUCN. Both the delegation discussed at length the various possible collaboration programmes for biodiversity conservation. ICFRE agreed to become a member of IUCN and for collaboration in the field of mangroves, bamboos and biodiversity conservation. Specific fields were identified for collaboration viz. – land use practices, NTFP, JFM, water harvesting, fringe



forestry, invasive species, mining and rehabilitation, forest and livelihood, bioprospecting and biopiracy, secret grooves, international networking, black carbon etc.

- As an important international commitment by FRI, Dehradun, Dr. V.K. Bahuguna, Director General,

ICFRE inaugurated a two days training programme on Restoration and Conservation of trees at Ta Prohm Temple on 3 and 4 February 2012. Total 23 participants from APSARA Authority Cambodia attended this training programme.

Extension Panorama



4. Extension Panorama

Introduction

Directorate of Extension aims at dissemination of useful research findings to various stakeholders through its nationwide network, different publications, workshops and training programmes. It coordinates various extension activities of ICFRE institutes and centres and evolves comprehensive extension strategies. It also provides consultancies in EIA and related subjects.

The Directorate is having Media & Publication (now has been redesignated as Media and Extension Division), Statistics Division and Environment Management Division to expedite the mandate of Forestry Extension through various activities, such as, publications like bulletins, brochures, pamphlets, newsletters, forest statistics and annual reports, and workshops, trainings etc. through the country wide network of Van Vigyan Kendras and Demo Villages.

Media and Extension Division looks into the extension activities and strategies being adopted by the Institutes of ICFRE for dissemination of research findings in forestry sector. This division maintains the monthly account of various R&D activities of ICFRE Institutes and keep MoEF apprised of them. The division publishes the Newsletters of ICFRE which is disseminated to ICFRE institutes and State Forest Departments. The reports of ICFRE and its Institutes are collected, compiled, edited and published as the Annual Report of ICFRE, tabled in Parliament. Other publications include Annual Hindi Magazine '*Taruchintan*' and bi-annuals ICFRE Newsletter and Vaniki Samachar. The division has also published a monumental volume on ICFRE Technologies and Processes under the title "Forestry in the Service of Nation : ICFRE Technologies". "Extension Strategies in Forestry Research for ICFRE", "Agroforestry Research at ICFRE",

"Information Booklet of ICFRE" and ICFRE Desk Calender for 2012 were brought out by the division during the period under report.

Work on establishment of Van Vigyan Kendras (VVKs) in collaboration with SFDs and selections of Demo Villages for adoption by ICFRE Institutes have progressed considerably. Twenty six VVKs have been established in different states/UTs. Eight Demo Villages have also been established and maintained in different eco-climate zones of the country.

The division is also rendering services to promote Rajbhasha Hindi and evaluating the progress in implementation of Rajbhasha in the Council and its institutes. Quarterly progress report on the progress of Rajbhasha Hindi is collected from all the eight institutes and headquarters, compiled and submitted to the Rajbhasha Vibhag of MoEF. The division conducts trainings and workshops on the implementation of Rajbhasha Hindi to facilitate greater use of Hindi in official works.

Statistics Division

1. The work on Forestry Sector Report India 2010, sponsored by Ministry of Environment & Forests, Government of India, was completed.
2. The ICFRE-ITTO project 'A sample survey of pulp, paper and hardboard Industry of India' was completed and the report was submitted to ITTO.
3. Two half-yearly issues of Timber Bamboo Trade Bulletin were published.
4. The draft document on the status of survey undertaken under the NOVOD Board sponsored project 'Development of a database on tree borne oilseeds in India' was submitted to the NOVOD Board.
5. Statistical inputs were given to the research scholars of FRI (Deemed) University through consultations.



The compulsory course on Research Methodology and statistical analysis for the PhD scholars of FRI (Deemed) University) was coordinated.

6. Forestry Statistics India 2009 was prepared and submitted. As per directions, the scope of the publication was increased to include data up to March 2010. The publication is now under expansion to include the data as directed.

Environment Management Division undertakes consultancies in the area of environment and forest for sectors like hydropower, mining, infrastructure, roadways and evaluation of natural resources based schemes. Also, coordinates with the EIA Cells established in the sister institutes for undertaking consultancies regionally. The Division has completed - 30 scientific services worth Rs.1147.60 lakhs as on March, 2012 and 16 projects worth Rs. 2232.10 lakhs are underway.

Sustainable Land and Ecosystem Management Project (SLEM)

The World Bank funded project 'Policy and Institutional Reform for Mainstreaming and up-scaling Sustainable land and Ecosystem Management (SLEM) in India' anchored at the Ministry of Environment and Forests, Government of India, and being implemented by the ICFRE, started functioning since August 2009. The implementation period is three years.

SLEM Programme is a joint initiative between the Government of India (GOI) and the GLOBAL Environment Facility (GEF), under the latter's Country Partnership Programme (CPP). The GEF partners associated with the SLEM-CPP include the World Bank, the Food and Agricultural Organization (FAO) and the United Nations Development Programme (UNDP).

The Sustainable Land and Ecosystem Management - Country Partnership Programme (SLEM-CPP) is a joint initiative of the Ministry of Environment and Forests, Govt. of India and the Global Environment Facility (GEF) and consists of seven projects, being

implemented in different states in India with assistance from the World Bank as the lead agency and the UNDP and FAO. The Desertification Cell, MoEF is the national executing agency for the SLEM programmatic approach. ICFRE, Dehradun has been designated as the Technical Facilitation organization for the SLEM programme. All the 7 sub projects have a full fledged Project Management Unit with a Project Manager, Project Director (a senior government officer) and Project Steering Committee (chaired by a senior government officer). However, the responsibility of coordinating the SLEM programmatic approach as a whole and, to ensure SLEM principles are appropriately integrated into our national/ state level policies and programs lies with MoEF. SLEM-CPP is a multi-sectoral approach to land management, biodiversity conservation and climate change adaptation. The genesis of Sustainable Land and Ecosystem Management (SLEM) Program is rooted in the rationale that food security through enhanced agricultural productivity cannot be achieved by further increase in cultivated area. Appropriate land use and sustainable management of the country's natural resources and agro-ecosystems are the avenues to meet the challenges and sustain environmental services.

The objective of the SLEM Programmatic approach is to promote sustainable land management and use of biodiversity as well as maintain the capacity of ecosystems to deliver goods and services while taking into account climate change.

The key achievements under the project during 2011-12 are as follows

1. Workshop/Seminar/Trainings

- Organization of consultative meeting-cum-workshop to discuss on the baseline study with participants of all key stakeholders including project partners.
- Organization of SLEM Role of Forests in Dryland Areas with participants of all key stakeholders including project partners.



- Brainstorming Workshop on Desertification Mapping and Reporting on Impact Indicators on 27 July, 2011.
- Three days training programme on Shifting Cultivation at Rain Forests Research Institute, Jorhat.
- Two days Training Program on Conserving Natural Resources for Sustainable Development in Dry Areas at Arid Forest Research Institute.
- Three days Training Programme on Soil and Water Conservation for Frontline Staff of Forest Department & other beneficiaries at Tropical Forest Research Institute, Jabalpur.

2. Finalization of Baseline Study

The key outcomes/emerging trends of the study will serve as a benchmark of assessments of the status in future. The baseline study conducted by thematic experts through a careful choice of indicators of SLEM components viz. land degradation, biodiversity, impact of climatic change/variability on land use practices as well as policy and institutional framework and monitoring and evaluation framework across the country.

Land Degradation

The water erosion is the most predominant degradation process affecting large number of states. Uttar Pradesh is the worst affected, covering 54% of the TGA, followed by Madhya Pradesh, Karnataka, Jharkhand, Arunachal Pradesh and Meghalaya, covering 44%, 41%, 40%, 32% and 31% of the TGA. Assam with 30% affected area ranks seventh and Maharashtra with 29% degradation ranks eighth.

Soil salinity is another major cause of degradation affecting mainly coastal states. Excessive irrigation in command areas is major cause of secondary salinization in some of the states leading in food grain production. Salinity is highest in Andaman and Nicobar Islands, covering 9% of TGA, followed by Gujarat (8%) and West Bengal (5%). Odisha, Rajasthan, Maharashtra and Haryana each have 1% salinity affected area.

Soil sodicity has been found to affect physical and nutritional characteristics of the lands and ultimately rendering them partially or fully non-productive. Sodic problem is very intensive in Uttar Pradesh, affecting 6% of the TGA, followed by Haryana (4%) and Punjab, Gujarat and Tamil Nadu (3% each). Other states of the country are not much affected by sodicity.

Biodiversity Conservation

Threats to gharial in unprotected areas are due to the factors such as fishing, sand mining, river side cultivation and industrial pollution. Loss of habitat owing to construction of reservoirs and dams, lack of stringent laws, trapping in fishing nets and erroneous superstitions have made them one of the most vulnerable reptiles.

Retention of tropical forest bird communities within human-dominated landscapes critically depends on the maintenance of nearby intact forest. Human Wildlife Conflict in Nanda Devi Biosphere Reserve (NDBR) : Losses to crops from areas near the forest contributed to more than 50% of total losses for each crop in all villages along the PA. Due to existing conservation policies and laxity in implementation of preventive measures, the problems for local inhabitants are on increase. Change in cropping and crop composition, particularly cultivation of medicinal plants (high value low volume crops) are suggested. This is the matter of PAME (Protected Area Management Effectiveness) concern for further integrated study.

Climate Change Adaptation

According to Forest Survey of India (SFR, 2009), tropical moist deciduous forest (33.92%) and tropical dry deciduous forest (30.16%) forms the major part of the forest cover of India. The area and spatial status of 16 Forest Type Group categories spread across the country is considered of which division's upto the order of sub types and its variations along with illustrations, locality factors and floristics will also be available in the near future. In the recent survey, it is observed that Chandar Sal, 8A/C3 Central India, Subtropical Hill Forest, 6/DS1 Cassia auriculata



(pure) Scrub, 5/1S3 Inundation Babul Forest (pure forest) as described by Champion and Seth (1968) is more or less absent as forest type. Climate change can be one of the factors responsible for this.

Policy and Institutional Framework and Socio-Economic Aspects

Budgetary subsidies to agriculture have increased from around 3% of agriculture GDP in 1976–80 to about 7% in 2001–03. During the same period, public investment in agriculture declined from over 4% of agriculture GDP to 2%. Most of the subsidies are on fertilizer, power, and irrigation water and these have actually contributed to the degradation of natural resources.

Though the percentage of population dependent on agriculture has gone down from 77% in 1950 to 67% in 2004, the absolute numbers dependent on agriculture, have increased by 2.44 times between 1950-51 and 2003-04. The States with high levels of degradation also show low Agriculture GDP, even though the population dependence on agriculture is high.

3. National Steering Committee

- The second meeting of the National Steering Committee (NSC) held on 18th April, 2011
- The third meeting of the National Steering Committee (NSC) held on 28th February, 2012

4. Publications/Website

- Published newsletter (Vol.1 No.1 & Vol.2 No.1), Annual Report and Proceeding of the Workshop on SLEM Role of Forests in Dryland Areas.
- Developed SLEM-CPP Website i.e, slem-cpp.icfre.gov.in
- Published proceedings of the Workshop on SLEM: Role of Forests in Dryland Areas.
- Published Annual Report for the period of 1st April 2010 to 31st March, 2011.

National Forest Library and Information Centre (NFLIC)

- The National Forest Library and Information centre (NFLIC) is richest in document collection

on forestry and allied sciences in South and Southeast 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 databases, etc. to its users. During the year, 29,324 books were loaned to the users for outside reading. Besides, 62,523 documents were consulted inside the library.

- The document collection of the NFLIC was enriched by the addition of 1,330 books and

other documents, out of which 691 books were purchased at a cost of Rs.12.59 lakh. The NFLIC subscribed to 83 Indian and 78 foreign periodical titles at a cost of Rs. 71.05 lakh. It also received 425 periodical titles gratis. The NFLIC also provided online accessibility to 47 most useful journals to the regional institutes of ICFRE at a cost of Rs. 58.67 lakh.

A bibliographical database-Forest Science Database was also subscribed for providing access to research articles on forestry from 1939 to up-to-date to the regional institutes and centres of ICFRE at a cost of Rs. 14.59 lakh.

In order to track, analyze, and visualize research on different aspects of forestry and environment science, the NFLIC subscribed Scopus, which is the largest abstract and citation database of peer-reviewed literature and quality web sources with smart tools, at a cost of Rs. 8.49 lakh.

The NFLIC has been selling ICFRE publication through its Book Depot. During the year, 777 books and 13 VCDs were sold to the state forest departments, universities, etc. and a revenue of Rs. 170,846/- earned.

Environmental Information System (ENVIS)

The Ministry of Environment and Forests, Govt. of India established ENVIS Centre on Forestry at the NFLIC. The Centre, during the year, enriched the following six databases by the addition of new references: Indian Forestry Abstracts, Participatory



Forest Management, *Prosopis juliflora*, Poplars, Environment and Forest in Press, Current Forestry Literature, which are accessible through the website of the Centre having URL: www.frienviis.nic.in. Besides, the contents pages of journals, forest cover of India, announcements of forthcoming national and international conferences, seminars, symposia, training courses, etc. were also put up on the website.

Publication: The ENVIS Centre on Forestry published a special issue of ENVIS Forestry Bulletin on Non-Wood Forest Products and five issues of *Environment and Forests News Digest*.

4.1 Report on Van Vigyan Kendras (VVKs) and Demo Village (DV)

FRI, Dehradun

VVKs

Forest Research Institute, Dehradun till date has established six Van Vigyan Kendras (VVKs) in the States and UTs of its working jurisdiction.

At each of the established VVKs, space has been allocated for the trainings and displaying of information in the forms of posters and display boards. Printed copies of handouts and information brochures have also been kept for distribution to the farmers and visitors. Annual training calendars of FRI has also been kept for providing information on different trainings to be conducted at FRI, Dehradun on different issues in a year.

The following trainings were organized during the period under report:

- *Aushadhiya poudhoun kee kheti, upyogita, vyavsayikaran mein smasyaien va samadhan* at VVK Haldwani from 13 to 15 March 2012
- *Sahari Vaniki, Aushadhiya Puodhoun ka sahari parivesh mai sthaapan evam holi kai prayavaran hiteshi rang* at VVK UT Chandigarh from 8 to 10 February 2012

- Eco restoration of Wastelands at Bulloval Shankari, Punjab from 14 to 16 December 2011 and at VVK Pinjore from 4 to 6 January 2012
- Extraction technology of natural dye and aroma therapy and cultivation value addition of medicinal plants for teachers of Chandigarh UT at FRI, Dehradun from 2 to 4 November 2011



Participants at VVK, Pinjore



Training on Nursery Techniques under Demo Village



Training on GPS under VVK Training Programme



- Forest Mensuration at VVK Pinjore from 6 to 8 September 2011
- Urban Plantation: Choice of tree species, Techniques & Specification at VVK, UT Chandigarh from 17 to 19 August 2011
- Land Reclamation through plantation at VVK, NCT Delhi from 29 to 31 August 2011
- Agroforestry – Scope for Livelihood Security at VVK Haldwani from 9 to 11 August 2011
- Dissemination of information & Innovation of FRI technologies: at VVK, Pinjore from 24 to 25 March 2011
- “Mensuration and pruning of Tree” at VVK, Hoshiyarpur from 1 to 3 February 2011



Field Visit under Demo Training



Model Nursery under VVK

- Dissemination of information & Innovation of FRI technologies: at VVK, UT Chandigarh from 22 to 24 February 2011
- Forest Mensuration and tree pruning technique at VVK Haldwani from 8 to 10 February 2011

Demo Village, Shyampur

A model nursery has been developed at Shyampur village near Dehradun during March 2008. This nursery was developed in collaboration with Bagwan Gramodyog Samiti, Shyampur Village. Farmers of adjoining villages of Dehradun, NGOs associated with forestry produces, People of Small scale industries and Students are the beneficiaries.

Trainings on "Nursery and Plantation Technique of Medicinal Plants & Utilization" from 19 to 21 October 2011 and on "Medicinal plants and cultivation of mushroom & utilization" from 27 to 29 March 2012 were conducted at Shyampur, Dehradun.

Model Nursery

- (i) Model nursery at Pinjore and Chandigarh have been established.

Trainings under VVK Capacity Building/Training Programme

Various themes covered in the trainings were:

- Awareness programme on Forestry Research and its utilization



- Propagation, utilization and protection of bamboos
- Importance, utilization and protection of NTFP
- Nursery and plantation techniques
- Collection, storage and protection of seeds
- Forest mensuration and tree pruning techniques.
- Eco restoration of wasteland
- Agroforestry practices

Van Vigyan Kendra, Kanpur Established by CSFER, Allahabad

A training on “Exposure Tour cum Training on Bamboo for Prosperity” was organised at Dehradun, Uttarakhand from 13-17 June, 2011. Training was funded by U.P. Forest Department under NBM programme.

A training and demonstration programme on “Planting Stock Improvement” was organized from 19 March to 21 March, 2012 at Van Vigyan Kendra, Kanpur by CSFER, Allahabad.

Demo Village (DV) Established by CSFER:

The main objective of establishment of demo village is to develop low cost model nursery for demonstration purpose. The vermi-composting unit, training shade, Bamboo treatment tank, hand pump for nursery had been developed on the site. The nursery works are in progress for raising seedlings of Satawar, Kalmegh, Chitrak, Kalabansa, Aonla, Imli, Bel, Teak, Jatropha were maintained in the nursery. The seedlings were distributed to the farmers as per requirement. Bio-fencing of the plot with Jatropha has been also done. The training programmes were conducted in the Demo village (Saidupur) to create awareness for forestry programmes :

A one-day farmers' training-cum-demonstration programme was organized on 19.10.11 at demonstration village, Saidupur of CSFER, Allahabad. The topic of the programme was – *Satawar (Asparagus racemosus) ki Kheti, Upyog evam Prayog Vidhi.*



View of Training Programme in Demo Village

- A one-day farmers' training-cum-demonstration programme was organized on 31.03.12 at demonstration village, Saidupur of CSFER, Allahabad. The topic of the programme was – **Role of Bamboos in Socio-economic Development.** A large number of participants including farmers and women participated in the programme.

IFG TB, Coimbatore

VVK Coimbatore, Tamil Nadu

Skill Upgradation Training Programme on Nursery and Plantation Techniques of Fast Growing Tree Species for Staff and Personnel of Department of Forests and Wildlife, Puducherry was organised on 28.4.2011. A total of 65 persons from the department participated in the training programme.



Training programme on Plantation Technologies was organised to the Foresters' Trainees of Tamil Nadu Forest Academy on 16.06.11 and 17.6.2011. About 50 foresters participated in the training programme.

Training was imparted to farmers on 21-23 June, 2011 at Karaikal on Pest and their management in forest trees organized by Govt of Pondicherry, Department of Forests & Wild life.

16,069 ramets comprising 35 clones of *Casuarina equisetifolia* of IFGTB, produced through VVK with identity was provided to Social Forestry Division, Surat, Gujarat Forest Department along with technology required for establishment of Clonal Seed Orchard (CSO) of *Casuarina*

equisetifolia. IFGTB developed the design of CSO using 35 clones and provided to the Gujarat Forest Department. The department was also supplied with the improved seeds of *Casuarina jhunghuniana* collected from the Seed Orchards managed by the institute for plantation programmes undertaken by the social forestry division.

Published the Book on Biofertilizers and Biomanures in Tamil, cultivation guide on *Gmelina arborea* in Tamil, Frankia, Vana Ariviyal a Tamil quarterly newsletter, Brochure on IFGTB in Hindi and an yield table for *Casuarina*. The same were released by the Hon'ble Minister for Environment and Forests, Govt. of India during Tree Growers Mela 2012.



Training Programme under VVK



VVK, Kuthiran, Kerala

Organised a training Programme for Forest Guard Trainees of Walayar Forest Training School, Kerala on Micro and Macropropagation techniques for quality planting stock production on 26 and 27 March, 2012. 35 Forest Guards participated in the said training programme.



Field Training Programmes under VVK, Port Blair, Andaman and Nicobar Islands

Kandiyur Demo Village

An awareness training programme on "Environment Protection" was organised in April 2011 for the school children of Primary School, Kandiyur Demo Village. A total of 36 students participated in the training programme. A training programme on



Training Programme for Forest Guard Trainees of Walayar Forest Training School, Kerala



VVK, Port Blair, Andaman and Nicobar Islands

Organised field training programmes on vegetation survey for a select front line staff and workers of Diglipur, Mayabunder, Middle Andaman, Baratang and South Andaman Divisions of the Department of Environment and Forests, A&N Islands. Also, organised training programmes to Field Forest Officers on climate change and Forestry, and plantation technologies.



Field Training Programmes under Kandiyur, Demo Village



Biofertilizer production and application, Insect pests and disease management in plantations and nursery was organised to the farmers, women self help group members on 6 January, 2012.

An exposure visit was organised to Erode and Karur for the farmers of Kandiyur on industrial agroforestry. They were shown the plantations taken up by the Tamil Nadu News Print Limited, Karur and Seshasayee Paper Boards, Erode through captive plantations and contract farming on 26 March 2012.

Supply of Improved Seeds

About 14 Kg of improved seeds of Eucalyptus, Casuarinas and Acacias collected from seed orchards of IFGTB, were supplied to farmers, Forest Departments and industries in different states.

Supply of Seeds and Seedlings

Collected about 28 kg of improved seeds of Eucalyptus and Casuarina from seed orchards established by IFGTB in different locations in Southern India and supplied to the industries, farmers and State Forest Departments for raising plantation. The seed orchard seeds showed outstanding growth performance as compared to the local seed source. Earned a revenue of Rs. 2, 21,000.00 during the fiscal year 2011-2012 through seed sale.

IWST, Bangalore

- One day training under VVK, Karnataka was conducted at Kadugodi, Bangalore on 18 August 2011. 23 Deputy Range Forest Officers were trained during the training.
- Under VVK Extension activity, Goa Forest Department Officers/ Farmers/ NGOs/Saw millers/ Wood working industries were given training on the following topics from 23 to 25 February 2012.
 - (i) Field demonstration of preparation of nursery bed for sandal and bamboo propagation
 - (ii) Training on nursery practices, propagation and cultivation for bamboo technique, composting, biofertilizer and nursery pest management

- (iii) Wood processing (Seasoning, Preservation and Protection) – with especial emphasis on Acacia auriculiformis and other secondary species and small girth timber for value addition
- (iv) Field demonstration of bamboo preservation using sap displacement and boucherie unit
- (v) Demonstration of portable distillation unit

TFRI, Jabalpur

Teak of Madhya Pradesh origin was planted in Demo Village, Moiyana for demonstrating existence of relative resistance against teak defoliator and leaf skeletonizer.

Three VVK and one demo village were maintained by the institute, which carried out various activities viz. training, development and maintenance of model nursery and publication of publicity material on various forestry activities. During the period under consideration, Van Vigyan Kendras of the respective states organized training programmes for the farmers, frontline forest officials, NGOs and other stakeholders. Besides, a Demo Village was maintained at Moiyana with the purpose of demonstrating the technologies developed on use of VAM fungi and resistant teak clones, by the institute. The institute also took up extension activities at nearby villages, Jamtara and Barha, for promoting the use of vermicompost and other technologies in the field of NWFP and Agroforestry, under the model developed in the Workshop on **ग्रहियों का उत्थान**, organized on 6th October 2010 by short-listing 10 farmers from selected villages after detailed socio-economic surveys conducted for the purpose.

RFRI, Jorhat

Van Vigyan Kendra (VVK)

Five numbers of Van Vigyan Kendra are operational in five North Eastern States: Assam, Arunachal Pradesh, Mizoram, Nagaland and Tripura. Different activities were performed during the financial year 2011-12 as per ICFRE guidelines.



Van Vigyan Kendra, Tripura

Training programmes conducted by the VVK, Tripura are as follows:

- Trainings on Capacity Building/ Extension of Forestry for JFMC members/ Stake Holders at Van Vigyan Kendra, Agartala from 3-7 January 2012, from 10-14 January 2012, from 17-21 January 2012 and from 30 January to 03 February 2012.
- During the trainings the farmers were informed about the concept and purpose behind the activities of VVK. The topics which were emphasized during the training were:
 - (i) Concept of a business plan, and importance of raw materials identification and sustainable management of NTFPs
 - (ii) Importance of local medicinal plants for healthcare
 - (iii) Capacity building of JFMC members through value addition of Cane and Bamboo



Trainees Visiting Kalibazar Bamboo Furniture Making Unit

- (iv) Capacity building of JFMC members through value addition of local medicinal plants
- (v) Vermi-composting techniques
- (vi) Besides this, visit to various industries like Agarbatti, furniture etc. and research centre were also organized under the programme
 - 1 Bhubanban Agarbatti sticks preparation unit
 - 2 Bamboo sticks making unit, TRIBAC, Gandhigram, Hatipara

- 3 Panchakarma Research Centre
- 4 Vermicompost preparation unit at Research Division, Hatipara
- 5 Kalibazar bamboo furniture making industries
- 6 Tilla Medicinal Nursery, Nehru Park



Visit at Bamboo Stick Making Unit , TRIBAC, Gandhigram, Hatipara.



Visit of Agarbatti Stick Preparation Unit, TRIBC Gandhigram, Hatipara

Maintenance of VVK Nursery:

Following works were done out of the fund released:

- (I) Maintenance of vermicomposting unit
- (II) Maintenance of Bamboo fencing
- (III) Creation of power supply connection of 200 m length
- (IV) Creation of 7 Nos. water supply lifting pump
- (V) Purchase of 1.5 HP water lifting pump
- (VI) Washing of exiting 200 m length water pipe



Van Vigyan Kendra, Nagaland

Training programmes conducted by the VVK, Nagaland are as follows:

1. Training-cum-workshop programme of sustainable management, product diversification and value addition of bamboo and wildlife management on 24-28 February, 2012 at SEFTI, Dimapur, Nagaland.
2. Training-cum-workshop programme of sustainable management, product diversification and value addition of bamboo and wildlife management on 12-16 March, 2012 at Sainik School Punglwa, Peren, Nagaland.

Maintenance of VVK Nursery:

Following works were done out of the fund released:

- i. Raising of fuel wood species
- ii. Soil working, procurement seeds
- iii. Labour charge
- iv. Cost of Manure etc

Demo Village (DV)

Establishment of Extension Camp and Shade house:

A facility as RFRI Extension Camp has been established through participatory initiatives with the people of Demo village. The setup is now fully used for various extension activities under Demo village programme. A Shade house (21m X 10m) has also been constructed with nursery beds supported with vermicompost units. The shade house is being used for various technical activities like bamboo propagation and raising of other quality stock.

Extension of Chilli based Agroforestry Model:

A total of 10,000 plantlets which were raised in RFRI and Demo village nurseries and distributed to all the willing families for cultivation in their home garden under various tree canopies in view of on-farm agroforestry research. The two Agroforestry model were selected for chilli viz. *Mangiun-King* chilli Agroforestry model and *Areca nut- King chilli*

Agroforestry model were promoted. The farmers have been benefited from cultivation of the crop to a great extent.

Raising of Agar (*Aquilaria malaccensis*) Plantations and Cultivation of Muskdana:

Looking into the success of the plantations of 2000 Agar seedlings in different farmers' fields last year, another 2000 seedlings have been planted in July 2011. Agar plants are preferred by almost all the farmers. Some farmers were motivated for cultivation of Muskdana. It is an aromatic plant used in various chemical formulations.

Organizing Liaison Meetings with Visiting Entrepreneurs

A liaison meeting was also held at Demo Village with the leading entrepreneur Shri Raj Singh who visited from Kolkata, West Bengal who later purchased the harvested products from the farmers by way of on spot payments.

Visits:

- Director General ICFRE, Dr. V. K. Bahuguna and several other dignitaries visited Demo village and interacted with the farmers and the local forest officials while inspecting various ongoing demo activities in Demo village.
- Dr. K. von Gadow. Retired Professor, Georg-August-Universität Gottingen, Germany visited Demo village and interacted with the beneficiaries.



Dr. V. K. Bahuguna, Director General, ICFRE visited Demo village



Organizing Training Programme for Technology Transfer:

Training on Low-cost Vermicompost by the Master Trainers from Demo Village:

Two Nos. of demonstration cum training were organized at Borkhaigia and Borchungi village in Jorhat district. The Master Trainers from the demo village demonstrate the process of vermi-composting. The trainings were organized in association with the local NGOs. The Master Trainers from the Demo Village are regularly being invited as a Resource Persons by various Govt. and Non-Govt. Organizations.



RFRI- Demo Village Extension Camp

Training on Air layering of various economic important tree species using *Sphagnum*:

A training was organized in Demo village on January 23, 2012 with field demonstration, More than 20 villagers were actively participated in the training. After training and field demonstration, more than 20 farmers adopted the techniques to multiply the site specific rare but the local trees and shrubs super specialties. The process was applied in more than 200 branches of plants like *Cinnamomum zeylanicum*, *C. tamala*, *Litchi chinensis* and in different species of *Citrus* using *Sphagnum*.



1. Cultivation Bhootjoolakia under Areca nut, 2. Distribution of *Acacia mangium* Seedlings, 3. Cultivation of Muskdana, 4. Demonstration of Vermicomposting to Eco – Task Force of Indian Army



AFRI, Jodhpur

(A) VVK at Bichhawal Nursery, Bikaner (Rajasthan)

Various meetings were conducted with Rajasthan Forest officials regarding VVK works. Under Rajasthan VVK, one hi-tech nursery at Bichhawal, Bikaner (along with a satellite nursery Mohangarh) of SFD Rajasthan were upgraded/renovated in 2009-10.

Maintenance of Hi-Tech Nursery Bichhawal, Bikaner: Maintenance of Hi –Tech nursery Bichhawal, Bikaner has been executed and rice husk, insecticide, seed and PVC pipe were procured for the Hi-Tech nursery.

(i) **Raising of Seedlings:** 3000 quality seedlings of *Prosopis cineraria* and *Dalbergia sissoo* have been raised in Hi-Tech nursery Bichhawal, Bikaner under VVK.

(ii) **Extension activities:** VVK and Demo activities were published in 'AFRI Darpan' (Special issue on VVK/DV), Year 9 Volume 4, Oct–Dec, 2011 and provided to the various stakeholders for wide publicity. Twelve display boards were handed over to ACF, WFP, Jaisalmer to display at the satellite nursery Mohangarh, Jaisalmer for farmers/ stakeholders under VVK, Bikaner.

(iii) **VVK Training:** Three days VVK training was organized at Kishan Bhawan, Srianganagar (Rajasthan) from 14 to 16 Nov, 2011. The total 67 participants (51 forest staffs and 16 farmers) attended training.

(B) VVK at Chhipardi Beedi, Rajkot (Gujarat)

(i) **Maintenance of Hi-Tech Nursery:** Maintenance works of Hi –Tech nursery, Chhipardi Beedi, Rajkot have been executed. Garden pipe, fogger and accessories, fertilizer and insecticide were procured for the Hi-Tech nursery.

(ii) **VVK Training:** Three days VVK training was organized at Sinh Sadan, Sasan Gir, Junagadh (Gujarat) from 17-19 Oct, 2011. The total 65 person (30 forest staffs and 35 farmers) attended the training.

(iii) **Raising of High Quality Seedling:** 2500 high quality seedlings of grafted viz; *Zizyphus mauritiana*, *Embelica officinalis* and *Cordia mixa* and *Casuarina equisetifolia* from seeds/cutting and of each species. Minimum 500 seedlings were raised in the Hi-Tech nursery at Research and Development Centre, Rajkot for farmers/ stakeholders under VVK.

(iv) **Extension Material:** VVK and Demo activities were published in 'AFRI Darpan' (Special issue on VVK/DV), Year 9 Volume 4, Oct – Dec, 2011 and displayed at VVK Rajkot for wide publicity.

(C) Khanwel (Dadra & Nagar Haveli and Daman)

(i) **Establishment of VVK:** MoU was signed between AFRI and Forest Department, Dadra & Nagar Haveli and Daman, UT on 24 Jan, 2012. Van Vighyan Kendra was inaugurated by Shri S. K. Agarwal, CCF, Forest Department, Dadra & Nagar Haveli, and Daman, UT.

(ii) Two days VVK training was organized at Khanvel, Silvassa, UT, DNH from 24 - 25 Jan, 2012. The total 30 participants (15 forest staffs and 15 farmers) attended the training programme.

(iii) **Extension Activities:** Already prepared display boards (Hindi and Gujarati languages) of research findings and technologies developed were displayed at the Rudhana nursery, Khanwel, Silvassa, (DNH) for farmers/stakeholders. Various literature viz; leaflet, pamphlets, brochures and AFRI Darpan were displayed at Rudhana nursery.



VVK trainees at Rudhana Nursery, Khanvel, Silvassa



Demo Village, Salawas, (Jodhpur)

- 1. Establishment and Strengthening:** MoU was signed between Director, AFRI and Sarpanch, Salawas village, Jodhpur for additional land adjoining to the forest nursery (FD), Salawas, Jodhpur on 30 May, 2011. Panchyat land of 1.5 ha was allowed by Salawas Gram Panchayat (GP) for Demo Village (DV) activities. Thus, total 8.68 ha GP & FD land is available for Salawas DV activities.
- 2. Extension Activities:** Van Mahotsav 2011 was observed at the site of Demo Village, Salawas, Jodhpur on 28 July, 2011 with involvement of Salawas Gram Panchyat and SFD Jodhpur. Sh. Malakhan Singh Bisnoi, MLA Luni was the chief guest at the function. Sh. I. A. Mugal CF, Jodhpur and Mrs. Akanksha Choudhry, DFO (WL), Jodhpur were invited as special guests. The programme was organized at demo-village site, Salawas for sensitizing the people about demo village activities carried out by AFRI at Salawas Gram Panchyat. Hundred quality seedlings of *Prosopis cineraria* and *Azadirachta indica* were distributed among the farmers to promote agroforestry and enhance land productivity.
- 3. Demonstration of Developed Technologies/ Models at Demo Site:** The model nursery was constructed. The agroshed, vermi compost, Ditch cum mound as Cattle Proof Trench and live hedge fencing were constructed near SFD nursery, Salawas, Jodhpur for demonstration purposes as well as high quality seedling production for farmer/stakeholders.

The soil and water conservation measures viz.; rubble stone check dam and V-ditches were constructed for demonstrated *In-situ* water conservation and its impact on recharge of ground water and biodiversity. Silvipastoral model of *Cenchrus ciliaris* grass along with *Cordia gharafa* and *Zizyphus numularia* planted with intervention of *in-situ* water conservation were developed for demonstration purposes.

Two day Demo village training was organized at Arid Forest Research Institute, Jodhpur during 26 – 27 Dec, 2011. The total 43 participants (22 forest staffs and 20 farmers) attended the training.

Mass Communication Material and Media

- Information booklets of AFRI published and provided for wider publicity to farmers/ stakeholders.

'AFRI Darpan' – Quarterly Hindi magazine was published. One combined issue (600 copies Jan2011-June, 2011) and two separate issues (600 copies) were published and provided to various stake holders.

Training programmes organized under VVK and Demo Village were published in many daily local news papers (Hindi and Gujarati) for wide publicity among the public.

On the occasion of Van Mahotsav, 500 pamphlets were printed and distributed to the stakeholders.

Brochure (5000) on Khejari mortality problem and its management were also printed for publicity under dissemination of information.

AFRI pamphlet/folder (9000) consists of details of the mandate, thrust area of Institute and technologies/ package, developed by the AFRI were published under VVK/DV scheme for wider extension activities.

Participation in Kisan Mela/Exhibition/Trade Fair etc:

Participated in melas held at Jodhpur and other places in Rajasthan for dissemination of research results and developed technologies of various research activities of the Institute using display material like; posters, panels, books, brochures/leaflets/information booklet etc. to the people, at large, especially the farmers and other end users:

- (a) Participated in the Western Rajasthan Hastshilp Utsav, held at Rawan Ka Chabootra, Jodhpur from 5-15 January, 2012.
- (b) Participated in Science Technology Day celebration at Jhunjhunu on May, 13, 2011, organized by the State DST, Rajasthan.



(c) Participation in 19 National Children Congress held at Jaipur from 26-31 December, 2011.

HFRI, Shimla

HFRI, Shimla is implementing and undertaking extension activities through two VVK's one at Sundernagar, Himachal Pradesh and another at Janipur, Jammu, J&K. The Institute has published the pamphlets 1000 no. each of *Prunus ceresoides* (Pajja), Indian Gypsy Moth-Ek Shatru Keet and *Hippophae ramnoides* (Charma) for the benefit of different stakeholders. Organized a workshop on 'Issues and concerns in forestry: Awareness amongst school children' on 5 June, 2011 and 'Modern Trends in Production of Quality Planting Stock' on 24.06.2011. Also organized and imparted training on 'Sustainable utilization, conservation and cultivation of medicinal plants' to the field functionaries of HPSFD and local farmers at VVK, Sundernagar on 28.03.2012. In an endeavor to augment the rural income and crop diversification, raised the high temperate medicinal plants species viz. *Picrorhiza kurroa*, *Valeriana jatamansi*, *Angelica gluaca* and *Podophyllum hexandrum* at FRS, Bundhar, Kullu (H.P.) and to promote the organic farming established and demonstrated the vermi-compost unit to showcase the different stakeholders. At FRS Tabo, Kaza; through seeds and cuttings raised about 21,000 no. seedlings of different plant species like *Eleagnus angustifolia*, *Hippophae ramnoides*, *Collutea nepalensis*, *Ribes orientalis*, *Rosa webbiana* etc. In addition to this, general maintenance of the nursery activities like watering of the field plantation, fixing up of tullu pumps in the polyhouses in the initial year etc. were also carried out. Established the Poplar Germplasm Bank of Poplar clones (16 No.) and further multiplied for the various end users at VVK, Janipur (J&K). Also raised and maintained the various medicinal and forestry species in the demonstration nursery.

Demo Village, Lanabaka, Himachal Pradesh:

The institute organized a workshop cum villagers meeting at DV Lanabanka, Sirmour (H.P.) on

25.09.2011. During the programme, outside experts were also invited to demonstrate maize silage making and organic farming. On the specific request of villagers, established a mixed plantation of Bamboo sp. and *Paulownia* in the area of 1 ha. in different spacing for checking soil erosion and established a strip plantation of *Valeriana jatamansi* and *Aloe vera* as intercropping with Bamboo and Paulownia in the area of 0.5 ha. as showcase model for checking soil erosion. Maintained the demonstration nursery and plantation by carrying out regular weeding, hoeing and watering etc. Production and maintenance of Vermi-compost unit for showcase to the various stakeholder.

4.2 Technologies Transferred

FRI, Dehradun

FRI, Dehradun transferred the technical know-how for 'An improved binding material for incense stick (Agarbatti)' developed in the laboratory to M/s Anand Agarbatties, Nagpur by charging license fees of Rs. 2.5 lakhs on 29 June 2011.

Bamboo propagation technique was transferred to the farmers of Saidupur (Demo village) during training programme on Bamboos on 31 March 2012 by Scientists of CSFER, Allahabad.

Application of ZiBOC in block boards was initiated at industrial level.



Dr. S.S. Negi, Director, FRI Handing Over the Certificate of Transfer of Technology to M/s Anand Agarbatties, Nagpur



Technology of cultivation of a nutraceutical mushroom *Ganoderma lucidum* transferred to farmers, mushroom growers, NGO and industry (71 No.)

IFGTB, Coimbatore

A product named “**IFGTB – Tree Growth Booster (VAM Biofertilizer)**” was developed and it was released by the Hon'ble Minister for Environment and Forests, Govt. of India during “Tree Growers Mela-2012” organized at IFGTB on 23-02-2012. The product was supplied to various stake holders particularly the SFDs, Farmers and Tree growers.

Sandal + Lemon tree based Silvi-horti Agroforestry system was assessed and transferred.

Transferred seed handling techniques of forestry species to farmers and foresters through posters and trainings during various training programs.

IWST, Bangalore

Standardized technology on 'Arbuscular Mycorrhizal (AM) fungi as bio-fertilizer in Forestry' was given to foresters and NGO's.

TFRI, Jabalpur

Technologies developed in the institute were demonstrated to the farmers, frontline forest officials, NGOs and other stakeholders, by the institute, VVKs and Demo Villages under it. Besides the above, the technologies were also transferred through participation in Kissan Mela, Science Mela and at other allied forums, organized by other agencies, time to time. The activities of the institute were also demonstrated to the distinguished visitors, trainee foresters of different states, University, College and school students and other visiting groups foresters and others from different places. In all, eleven demonstration programmes were organized by the institute during the current year.

Package of practices of turmeric with high yielding variety transferred through demonstration and training programme to the farmers of Jamtara-Paraswara village and Barha village of Jabalpur on 5 July, 2011 during training programme at their field only.



Transfer of Technology through Field Demonstration at Demo Village - Barha of Jabalpur District (M.P.)

Farmers were motivated through training and demonstrations to adopt the bamboo based Silvi-Agri, *Sissoo-mays* Silvi-Agri system and teak-turmeric Silvi-Medicinal.

RFRI, Jorhat

The technologies were transferred to the fields as follows –

- PRA techniques and microplanning
- Bamboo Treatment
- Vermicompost
- Apiculture
- Patchouli agrotechniques
- Trichoderma production and field application
- Mycorrhizal Technology
- Biopesticide production and field application
- Seed handling-grading and sowing techniques
- Technology on Chili based agroforestry model
- Technology on Air layering of various economic important tree species using *Sphagnum*
- Technology on low-cost vermicompost
- Technology on raising of Agar (*Aquilaria malaccensis*) plantations and Cultivation of Muskdana



AFRI, Jodhpur

Developed regression to estimate above ($\sqrt{W} = a + bD$) and below ground ($W = a + bD^2$) biomass of *Prosopis juliflora*. Here D is collar diameter of *P. juliflora* tree and a & b are regression constants.

Package of the practices developed in rain water harvesting in Aravalli has been extended under demo village activities at Salawas for wider publicity and replication by the stake holders.

4.3 Research Publications

Researchers at ICFRE have published 318 research articles in various journals, including 115 articles in the foreign journals. Three hundred seventeen research papers were presented/ published in the proceedings of the conferences/symposia/seminars/workshops. Besides, 17 books/manuals/pamphlets/booklets were published and 54 chapters were contributed in composite books.

The National Centre for Biotechnology Information, USA assigned accession numbers to 26 fungal r-DNA gene-isolates of *Cylindrocladium quinquesepatum*.

4.4 Seminars/Symposia/Workshops

Organized

Seminars

FRI, Dehradun organized National Seminar on recent Advances in Fungal Biotechnology on 22 and 23 September 2011.

IFGTB, Coimbatore organised a National Seminar on Forest Health Management FHM-2012 on 21 and 22 March 2012.

IWST, Bangalore organized one day seminar on "Design Sensitizing Programme" under MSME-DCS for wood based industries at IWST in association with National Institute of Design (NID), Bangalore on 13 September 2011.

HFRI, Shimla organized two day's Seminar on "Insect-Pests and Diseases: Their Incidences and Management in Forest Ecosystem", on 25 and 26 May 2011. The Seminar was attended by about 40 eminent participants and leading experts in the field of Forest Pathology and Forest Entomology from all across India. The Seminar was inaugurated by Sh. Vinay Tandan, IFS, PCCF Himachal Pradesh Forest Department.

Workshops

ICFRE-IDS collaborative workshop on "Strengthening knowledge sharing for effective development in Uttarakhand" was organized at ICFRE, Dehradun from 9 to 12 October 2011.

FRI, Dehradun organized Workshop cum Meeting on Revision of National Working Plan Code on 2 and 3 March 2012.

FRI, Dehradun organized one day National Consultative Workshop on "National Study on Commercial Production of Non Timber Forest Products for Ensuring Fair Economic Returns to Primary Collectors" on 18 July 2011 at Ministry of Environment & Forests, New Delhi.

FRI, Dehradun organized workshop on Climate Change & Forestry Research Needs in Himalayas on 24-25 October 2011.

IFGTB, Coimbatore conducted one day workshop on "Non Detrimental Findings (NDF) study on *Pterocarpus santalinus*" on 29 July 2011.

IFGTB, Coimbatore organised workshop on 'Assessment of Forest Types of India' on 2 February 2012.

IFGTB, Coimbatore organised workshop to prepare the country Report on Forest Genetic Resources for SOW-FGR on 7-8 February 2012.

IFGTB, Coimbatore organised workshop on 'Tree Farming for Sustainable Livelihood' on 23 - 24 February 2012 as part of the Tree Growers Mela 2012.

IWST, Bangalore organized a workshop-cum-interactive-meet with wood sectors of Andhra Pradesh on 29 July 2011 at Andhra Pradesh Forest Academy.



About 70 participants from wood sectors like carpentry, saw mill, artisans, charcoal sectors participated. The workshop was organized by IWST and APFA.

TFRI, Jabalpur organized one workshop-cum-training programme on "Sal heart borer and its management" on 30 November 2011 at Raipur and on 24 February 2012 at Jagadapur.

TFRI, Jabalpur organized one day workshop on "Achanakmar-Amarkantak Biosphere Reserve" on 3 March 2012 at Bilaspur.

TFRI, Jabalpur organized workshop on "*Satat Ajiwika Ke liye Unnatsheel Krishiwaniki Padhatti*" held on 28th September 2011 and Total 13 papers were presented and discussed on the various agroforestry models suitable for different agroclimatic and land conditions. A booklet released during this occasion on the "*Satat Ajiwika Ke liye Unnatsheel Krishiwaniki Padhatti*", eds. Berry, Nanita and Negi, M.S., A TFRI publication. pp1-100.

TFRI, Jabalpur organized two training-cum-workshops of two days duration each on "Development of Value added food products and processing of Mahua flowers" on 2-3 March 2012 and 22-23 March 2012. Target groups were women self help groups from different Van Samitis of Chhindwara District.

TFRI, Jabalpur organized a workshop on "Energy-Mass exchange in vegetative systems" for scientists of ISRO, MPCST, CAZRI, FRI, and TFRI and officers from SFDs and national parks of M.P" on 9-10 June 2011 at TFRI Jabalpur.

RFRI, Jorhat organized a District Level Workshop on 'Bamboo, sponsored by National Bamboo Mission' on 4-5 November 2011.

RFRI, Jorhat organized a Workshop cum Training on Global Positioning System, application in Forest and Land Resource Survey. Sponsored by State Environment & Forestry Training Institute, Dimapur, Govt. of Nagaland from 13-16 February 2012 at RFRI, Jorhat.

RFRI organized the workshop on 'Patch vegetation, Phyto-diversity and Livelihood Security' at Jhanjimukh Jatiya Vidyalaya, Jorhat on 13 February 2011.

AFRI, Jodhpur organized one day workshop on IPR in collaboration with Rajasthan State DST, Jaipur and AFRI, Jodhpur on 25 May 2011.

AFRI, Jodhpur organized a Brainstorming workshop for the formulation of All India Coordinated Programme on Arid and Semi Arid Regions (CP-ASAR) on 4 and 5 August 2011 at AFRI, Jodhpur.

AFRI, Jodhpur organized two days workshop on 'Sustainable Land Ecosystem Management-Country Partnership Programme in India & 3 National Steering Committee (NSC) Meeting 2012 on 27-28 February 2012 at AFRI, Jodhpur.

HFRI, Shimla organized a one day workshop on "Modern Trends in Nursery Techniques" for the field staff of State Forest Department of Himachal Pradesh on 24 June 2011. About 35 field staffs from Shimla, Rampur, Nahan and Bilaspur circle participated in the training programme.

HFRI, Shimla organized a workshop on "Sustainable utilization, conservation and cultivation of important medicinal plants" on 27 July 2011 at DFO Office, Keylong for farmers and field staff of State Forest Department of Himachal Pradesh. About 50 people participated in the programme.

HFRI, Shimla at the behest of ICFRE, Dehradun, hosted a one day Pre-Congress workshop on 17 August, 2011 at Shimla on the specific theme "Forest and Climate Change". This main theme also included sub-themes like Green India Mission: Opportunities and Challenges; Mitigation / Adaptation and Challenges; Eco-system Resilience and Forest Biodiversity; Climate Change Models / Forests and Carbon Fluxes; Carbon Balances: Policy Instruments and India & REDD. The delegates/ participants of the workshop included Officers from Forest Departments of Himachal Pradesh and Jammu & Kashmir, Scientists from Universities, Central Research Organizations, including representatives of Non-governmental Organizations from various parts of the country.

At the end of the workshop, a booklet on "Kalatop Khajjiar Wildlife Sanctuary Chamba, Himachal



Pradesh: An Appraisal to its Plant Diversity" by Dr. RK Verma and Dr. KS Kapoor was released by Sh. Vinay Tandon, Advisor (Forestry) Govt. of Himachal Pradesh.

HFRI, Shimla organized Workshop-cum-Villagers Meeting" with stakeholders of Demo Village Lanabanka on 25 September 2011 at Panchayat Hall of Village Lanabanka, district Sirmour (H.P.). 45 no. of participants took active part in the event.

HFRI, Shimla organized a workshop / meeting on 2 September 2011 for the Network Partners implementing the Network project on "Population Assessment and Identification of Superior Genetic Stock of *Picrorhiza kurroa* Royle ex Benth and *Valeriana jatamansi* Jones by Screening Different Populations from North-Western Himalayas (H.P. and Uttarakhand)".

IFP, Ranchi organized a workshop on "Cultivation of Bamboos for Edible Shoot Production and Processing" on 30 August 2011 for celebrating the 'International Year of Forests- 2011'.

IFP, Ranchi organized workshop on "CPT's Selection of Phasi (*Anogeissus acuminata*)" under the project titled "Silvicultural studies of Phasi (*Anogeissus acuminata*) (Roxb. ex DC.) Guill. & Perr.) in Odisha" funded by Odisha Forestry Sector Development Project, Bhubaneswar, Odisha on 11 January 2012 at OFSDP, Bhubaneswar.



Workshop on "Cultivation of Bamboos for Edible Shoot Production and Processing" in Progress

Symposium

IFP, Ranchi organized a National Symposium on "Assessment and Conservation of Forest Genetic Resources through Biotechnological Interventions" on 19 - 20 December 2011. More than 100 delegates from all over the country participated and presented their papers in the symposium.



Delegates during the Symposium

Conference

An International conference and exhibition on "Art and Joy of Wood-Rediscovering Wood: The key to a sustainable future" was organized by FAO and MoEF from 19 - 22 Oct, 2011 at J.N Tata Auditorium Complex of Indian Institute of Science (IISc), Bangalore. The conference and exhibition was one of the global events to celebrate International Year of Forests with an aim to emphasize the need for greater use of wood for a sustainable future. Local organizers of the conference and exhibition were Institute of Wood Science and Technology and Indian Plywood Industries Research and Training Institute respectively. International Wood Culture Society and International Union of Forest Research Organizations were the other organizations who supported the conference. The Conference was organized with an aim to explore socioeconomic trends affecting use of wood products, challenges and opportunities arising due to immense wood use. The Conference brought together over 270 delegates from 31 different countries that deliberated on social, aesthetic cultural and traditional aspects of wood use focusing on how linkage between wood and society could be used for future development of wood sector.

The conference was inaugurated by Sh. S. Suresh Kumar, Hon'ble Law, Urban Development,



Parliamentary Affairs & BWSSB Minister, Govt. of Karnataka, Sh. Jitendra Choudhury, Hon'ble, Forest and Industry Minister, Govt. of Tripura, presided over the function. Dr. P.J. Dilip Kumar, DG&SS, MoEF, Govt. of India, Dr. V.K. Bahuguna, DG, ICFRE, Dr. R. Michael Martin, Director, FAO, Rome and Dr Howard Rosen IWCS, China, Mr. S.C. Joshi and Dr. C.N. Pandey were other dignitaries during the inaugural function. Number of senior policy makers, researchers, representatives of wood industry from India and world over participated in the conference. A total of 70 oral presentations and 30 poster presentations were made in the conference.

4.5 Consultancies

Environment Management Division has extended consultancy to neighboring country, Royal Government of Bhutan for hydroelectric projects during the said period. Considering the vast experience and quality of expertise available in the council, Honorable Supreme Court of India directed Indian Council of Forestry Research and Education to conduct Macro level EIA for Bellary, Tumkur and Chitradurga for Iron Ore Mine affected districts of Karnataka. The study report was submitted to the Honorable Supreme Court of India within the stipulated time frame and the recommendations framed were implemented *in toto* by Honorable Supreme Court of India. Government of Karnataka has awarded the study of Reclamation and Rehabilitation Plan for the mine affected districts of Bellary, Chitradurga and Tumkur to the Council. Odisha Mining Corporation Limited has signed MoU with ICFRE for undertaking carrying capacity study in Jajpur District of Odisha. ICFRE will conduct Cumulative Environmental Impact Assessment of Hydropower Projects on Sutlej River Basin in Himachal Pradesh based on the MoU signed with Directorate of Energy, Government of Himachal Pradesh. Indian Institute of Technology (IIT), Roorkee, Salim Ali Centre for Ornithology and Natural History, Coimbatore and Directorate of Coldwater Fisheries Research, Bhimtal, Uttarakhand will be the partner organization for the

cumulative impact assessment study on Satluj river basin.

Following are consultancies completed during the current financial year:

A. Completed Consultancies:

1. Comprehensive EIA-EMP for Sankosh Hydroelectric Project (4060 MW), Dagana Dzongkhag (District), Bhutan. THDC India Limited, Rishikesh.
2. Catchment Area Treatment Plan for Kuther HEP (240 MW) in Chamba district, Himachal Pradesh. Jindal South West Energy Limited, Bombay.
3. Macro Level EIA study of the mine affected districts Bellary, Chitradurga and Tumkur of Karnataka, Government of Karnataka.



EIA Team Interacting with Mine Owners in Bellary District



Unmanaged Over Burden Dumps in Bellary District



Catchment Area of River Ravi, Himachal Pradesh

FRI, Dehradun

Demographic and Socio Economic Survey of Jakhol-Sankri HEP (51MW), Mori, Uttarkashi, Uttarakhand

The Jakhol-Sankri Hydroelectric Project (JSHEP) is located in Uttarkashi district of Uttarakhand and envisages utilization of water from river Supin, which is a tributary of river Tons, for power generation on a run of the river type project. The division has undertaken a study on demographic and socio-economic survey of 7 villages falling in the proposed project area covering about 525 households to document a baseline data.



Villagers at Pautalla Village



Sunkundi Village

EIA, EMP and SIA studies of Chirgaon-Majhgaon HEP (60MW), Rohru, Himachal Pradesh

Impact studies for EIA, EMP and SIA for Chirgaon-Majhgaon (60 MW) HEP, Rohru for Himachal Pradesh Power Corporation LTD (HPPCL) have been undertaken by HFRI, Shimla. The Chirgaon-Majhgaon HEP has been contemplated as a power generation development on Pabbar River located in Chirgaon/Rohru Tehsil, About 110 km from Shimla, in Himachal Pradesh. Physical and biological study has been almost completed and the socio-economic survey has been initiated.



The Site for the Barrage and Reservoir



Pabbar River Near Village Shaktinagar (Rohru)

Baseline Survey and SIA of Renuka Dam project, Himachal Pradesh

A total of 3666 households falling in 77 villages in 17 panchayats were surveyed. Out of the total households, 987 households come under Main Project



Affected Families (MPAFs), 1232 households come under Project Affected Families (PAFs) and 1447 were placed under Other Resident Families. The baseline survey report and SIA report have already been submitted to the project authority.



Site for the Renuka Dam

- The officers/ scientists worked in consultancy of “Sal-ANR” awarded by Uttarakhand Forest Department.
- M/s Sunora Tiles Pvt Ltd, Morbi (Gujrat) sponsored research work to evaluate *Prosopis juliflora* for paper making.
- XI and XII Five Year plans of Central Pulp and Paper Research Institute (CPPRI), Saharanpur (U.P.) was evaluated as a part of consultancy and report submitted.
- Ten numbers of steam-heated type kilns were modernized and re-installed at the premises of the U.P. Export Corporation Limited, Saharanpur last year. One year technical service after the completion of the consultancy was done during the year.
- Consultancy on, “Laboratory Testing of Bio-Pesticide *Photobacterium limnescens* Akhurstii Strain K1-52% v/v E.C.” for 10 months (October 2010 to July 2011), from Nirmal Seeds Pvt. Ltd, Pachora- Jalgaon. Maharashtra India.
- Advisory to APSARA Authority, Cambodia and ASI for conservation of trees at Ta Prohm temple, Cambodia.
- Advisory to Bodhgaya Temple Management Committee for maintenance and conservation of Bodhivriksha at Bodhgaya.



Trainees of APSARA Authority, Cambodia in a Workshop for the Treatment of Trees with the Project Team at Siem Reap, Cambodia



Treatment of Wounds in a Tree of *Irvingia malayana* at Ta Prohm Temple, Cambodia

- Advisory for eucalyptus plantations of Birla Lao Pulp & Paper Co., Laos in field May 22 – 27, 2011
- Advisory to Tollygunge Club, Kolkata for status of health of trees and management, Nov. 26-28, 2011.
- Efficacy Testing of Commercialized Biofertilizer and Biopesticides in Growth of *Dendrocalamus strictus* and Management of Diseases of Poplar (International Panacea Ltd., Delhi)
- Consultancy on Mrikula Devi Temple, Udaipur, Lahaul and Spiti district, Himachal Pradesh (ASI, Shimla).

IFGTB, Coimbatore

Assessment of yield of Casuarina plantations raised in Arulmigu Nithyakalyani Perumal Temple Land in Thiruvandanthai for Tamil Nadu Papers and Newsprints Ltd.



IWST, Bangalore

- Dr. O.K. Remadevi and Dr.R. Sundararaj visited Natural Remedy, Bangalore regarding discussions on formulation of biopesticides on 2.8.2011.
- Dr. S.K. Sharma, Head and Scientist-F and Dr. S.R. Shukla, Scientist-E visited office of the the Divisional Forest Officer, T.T. Devasthanam, Tirumala from 17.9.2011 to 18.9.2011 in connection with the inspection of Thandlu to establish their durability and strength.

TFRI, Jabalpur

The institute has been extending services in the form of consultancies to its stakeholders. During the period the services have been provided to NTPC on their request on formulation of Environment policy, strategy and guidelines.

Conducting studies on 'Assessment of green cover and its tangible and intangible benefits and tree cover management plan for NCPP-Dadri Project'.

Conducting studies on 'Assessment of green cover and its tangible and intangible benefits and tree cover management plan for STPP-Korba Project'.

Consultancy was taken from Department of Food Technology, Rashtra Sant Tukdoji Maharaj Nagpur University, Nagpur for development of three value added food products of dried *Madhuca indica* flowers.

RFRI, Jorhat

A consultancy project entitled "Biodiversity Impact Assessment study for the strategic road Flaghill-Dokala, Pangolakha Wildlife Sanctuary in Sikkim State" was awarded to RFRI, Jorhat by BRTF-Ministry of Road Transport and Highways, Government of India.

AFRI, Jodhpur

- Consultancy project on Survey and characterization of soils and vegetation in the proposed land of IIT Rajasthan was carried out of amounting Rs. 2.93 lakh (sponsored by the IIT, Rajasthan, Jodhpur).
- Consultancy for the preparation of project on developing mega shelterbelt in Western Rajasthan amounting Rs. 4.8 lakh was carried out (sponsored by Rajasthan Pollution Control Board.

- Technical consultancy to grow *Jatropha curcus* genotypes in Rajasthan amounting Rs. 8.1 lakh (sponsored Rajasthan State Biofuel Authority).

HFRI, Shimla

A consultancy titled "Preparation of Catchment Area & Treatment Plan for Phina singh Medium Irrigation Project, Nurpur, Distt. Kangra (HP)" to the tune of Rs. 15.00 lakh only was finalized and submitted to the consulting Organization i.e. Executive Engineer, IPH Division, Nurpur, Distt. Kangra (HP).

IFP, Ranchi

- An MoU was signed between IFP, Ranchi and OSFDP, Bhubaneshwar on 15 Nov, 2011 for the consultancy project titled "Silvicultural studies of Phasi (*Anogeissus acuminata*) (Roxb. ex DC.) Guill. & Perr.) in Odisha".
- A project entitled "Identification of Extent of Forest Lands in Forest Fringe villages" funded by National Rainfed Area Authority of India (NRAA) was taken up.
- An European Union Inter-parliamentary delegate visited on 13 April, 2011, the village Sheetal Bhakurar, Lalganj of Vaishali district of Bihar and interacted with farmers who have planted Poplar on their fields under the Planning Commission, Govt. of India sponsored project titled "Integrated Community based Forest Management Project in Bihar".



An European Union Inter-parliamentary Delegation visited the Village Sheetal Bhakurar, Lalganj of Vaishali District



4.6 Technical Services

FRI, Dehradun

- Identification of fungal deterioration in wood for wood based industries
- Phytosanitary certificate issuance
- Identification of diseases
- Identification of fungi
- Supply of fungal cultures
- Rendered various technical services to Indian Pulp and Paper Industries and research organizations.
- 105 number of paper samples received from Employment News New Delhi, NCERT New Delhi, Indian Railways Varanasi, ISRO Ahmedabad, Radex Stationary New Delhi, Rama News Print Bijnor, Sri Krishna Paper New Delhi, Army New Delhi, State Printing
- Roorkee, and Directorate of Education Dehradun were tested for physical and optical properties.
- Revenue generated: Rs. 6.95 lakhs by Wood Processing Division through testing training and drying treatment.
- Medicinal plants seedlings production for distribution as per demand by NWFP Division, FRI.
- “Baseline survey and SIA of Renuka Dam project, Himachal Pradesh” and completed Consultancy of Silviculture Division.
- Rendered various technical services to Indian Pulp and Paper Industries.
- One sample of derivatized starch received from M/s DAVAR Additives, Gwalior was analyzed.
- Ten samples of starch received from M/s Anil products Limited, Ahmadabad were analyzed to ascertain their modification.
- Total 53 samples of 39 clients were tested for moisture contents during the year
- About 950 cft of timber was seasoned for 6 clients during the year

- Mechanical Testing of 62 wood samples from 17 firms were done during the year
- Preservative testing of wood samples were extended to several firms during the year
- Adhesive testing on plywood were carried out for several firms during the year
- Soil samples were analyzed for various divisions of FRI

Technical services provided through the testing of wood and wood products to the firms/ organizations as given below:

1. M/s Rashtriya Chemicals and Fertilizers Ltd., Thal Unit, Raigad, Maharashtra.
2. M/s Common Wealth Games Div. V C.P.W.D. MDC National Stadium New Delhi.
3. M/s HPCL (Lube refinery Mumbai).
4. M/s Polyplex Ltd., Noida.
5. M/s Southern Cooling Tower Pvt. Ltd., Kolkata.
6. M/s Paltech Cooling Towers & Equipments Ltd., Gurgaon.
7. M/s Hindustan Petroleum Corp. Ltd., Mumbai.
8. M/s Sub Divisional Engineer Provl. Sub Div No.1 PWD B & R Panipat.
9. M/s Sterlite Industries (I) Ltd., Tuticorin.
10. M/s North Street Cooling Towers Private Ltd., Ghaziabad.
11. M/s Central Sub Div.-IV C-85 HIG Colony Bhubneshwar ODISHA.
12. M/s Melfrank Engineers, Mumbai.
13. M/s Koolaquo Towers Private Ltd., Kolkata.

- Identification of fungal deterioration in wood for wood based industries
- Phytosanitary certificate issuance
- Mortality in deodar trees at Pithoragrh to DFO, Pithoragarh Forest Division
- Shisham mortality in Hoshiyarpur Forest Division for CF (Research), Punjab Forest Department



- For advisory role in Haryana Forest Department activities like nurseries and plantations
- For teak mortality in Saharanpur for Shiv Shakti Plantations Ltd., Bareilly
- Quarantine Clearance to Bo Tree from Shri Lanka at Gaya Airport
- Disease inquiry of dying poplar trees at Vaishali, Bihar

IFGTB, Coimbatore

IFGTB provided technical advice to Kerala Forest Department in establishment of seed production areas. The team identified 1492 ha of teak plantations out of the 3143 ha area surveyed for conversion into Teak Seed Production Areas

Plant Identification Services Rendered in the Fischer Herbarium

Plant identification services were rendered to the Tamil Nadu Forest Department, various research divisions of IFGTB, College and University students, and farmers as and when requested. About 600 students, scholars and researchers visited the Herbarium for their study / research purpose, during the period under report.

IWST, Bangalore

- Services, such as, wood identification, determination of moisture content, density and strength properties were rendered to various organizations (Govt/No-Govt/PSU/Private etc).
- Several enquiries were attended from Forest department officials and NGO's with respect to entomological and pathological problems in nursery and plantations & timber-in-service and suitable remedial measures were suggested.
- The WBD division of the Institute tested the samples received from Pidilite Industries Ltd., Mumbai for testing of wood preservatives. Test report for one year has been sent on 24.8.11. Suggested control measures for the disease problem of neem tree as per the request from FRO, Bangalore. Testing wood for the presence of fungi to Professional surveyors

Pvt-22.9.11. Supplied cultures for Rubber Board, Kottayam, Kerala- 16.2.12

- Thirteen wood samples received from end users were analyzed for their preservative content and reports were sent.
- A Woods Museum-cum-Interpretation Centre (WMIC) was inaugurated at the Institute of Wood Science and Technology, Bangalore on 4 January 2012 by Dr P.J. Dilip Kumar, IFS, Director General (Forests) , Government of India in presence of Dr. V.K. Bahuguna, IFS, Director General, Indian Council of Forestry Research and Education, Dehradun.

TFRI, Jabalpur

The institute has been providing technical services to various stakeholder, viz., state forest departments, forest development corporations and others of Madhya Pradesh, Chhattisgarh and Maharashtra, relating to the technical advisory services required. During the period, advisory services were provided to Madhya Pradesh and Chhattisgarh State Forest Departments on monitoring and management of Sal Borer and sal mortality in general, as per their request, time to time.

RFRI, Jorhat

Generated revenue by analyzing soil sample of 134 Inf. Btn., ECO (TA), Assam.

AFRI, Jodhpur

- Demonstration of promising genotypes of Jatropha in Rajasthan state and training to farmers and stake holders, State Biofuel Authority, Rajasthan.
- Prepared display materials and demonstrated research findings on forest soils, Biodrainage, rain water harvesting for increasing productivity of degraded Aravalli hills at Van Vigyan Kendra and Kisan mela.
- Disseminated research findings to farmers through lectures organized at different institutions.
- As and when required, provided technical services to SFD, Rajasthan , Gujrat, Ministry of Environment and Forest, New Delhi, Farmers and NGO's in the forestry and allied aspect with particular emphasis



on combating desertification, rehabilitation of degraded land, silviculture, modern nursery, forest protection and tree improvement.

HFRI, Shimla

As per the request made by Sh. Anil Kumar Sharma, Divisional Forest Officer, Kullu, Dr Sumit Chakrabarti, Scientist-E was deputed by the Director of the Institute to study the details on the White grub attack on deodar in Forest Nursery at Mohal (Kullu Forest Division). A report to this effect was submitted for the revival and replanting technique of the affected plants by providing all the silvicultural techniques for replanting technique.

4.7 Activities of Rajbhasha

With a view to promoting the use of Rajbhasha Hindi, ICFRE and its institutes are continuously working in the direction of implementation of Rajbhasha rules and regulations in its day to day functioning. At Headquarters workshops and trainings are organized regularly. ICFRE, Dehradun organized training on Hindi Software "Saransh" on 24 August 2011. Over 70 personnel's of ICFRE attended the training. "Hindi Week" was celebrated from 14 - 20 September 2011. During this event various competitions like "Essay writing, Noting and "Sawarachit kavya Paath" were organized. In the closing ceremony prizes and certificate were distributed to the winners by Dr. V.K.



Hindi Saptah at ICFRE

Bahuguna, DG, ICFRE. Also conducted Rajbhasha Karyanvayan Samiti meetings on regular intervals at the Institutes and at the headquarters. Quarterly Progress Report is being compiled and sent regularly to the Official Language Department of the Ministry of Environment and Forests. To promote the Rajbhasha Hindi, ICFRE is regularly publishing its in-house magazine 'Taruchintan' and Biannual Newsletter 'Vaniki Samachar' in Hindi.

FRI, Dehradun

- Regular reports on Hindi work were submitted in the prescribed format.
- The scientists and staff of the Pathology Division participated in *Hindi Goshthi* on Oct. 3, 2010. Hindi Diwas was organized on 14 .09.11. A Hindi Essay competition was also organized for the officials of CSFER. Dr. V.P. Pandey, Research Assistant I and Dr. Anubha Srivastav Research Officer were awarded with First and Second prizes respectively.
- The *Nagar Rajbhasha samiti* meetings were attended by official representative of CSFER as per schedule.
- Quarterly meetings regarding improvement in Hindi works were also organized regularly in the office.
- Scientific trainings/literature (Pamphlets, brochures handouts etc.) were also developed in Hindi for different target groups.
- The officials of the Division participated in *Hindi Divas*, meeting on '*Rajbhasha Pragiti*, on 22.03.2012 and training on Hindi software '*Saransh*' on 25.08.2011.

IFGTB, Coimbatore

1. Hindi software "Saransh" typing training was conducted
2. Hindi Day was celebrated and competitions for all employees was conducted in connection with Hindi Day celebration
3. Bilingual Name Boards were prepared



4. Bilingual Rubber stamps were prepared for Director, GCR, HO, Stenographer etc
5. Hindi newspaper "Rajasthan Patrika" was purchased and kept in library
6. All the staffs were nominated for Hindi Prabodh, Praveen, Pragma Classes
7. IFGTB Hindi Brochure was prepared
8. Familiarizing the staff with a Hindi Word Daily
9. All the Town Official Language Implementing Committee meeting was attended
10. Official Language Implementing Committee meeting was conducted in every quarter

Hindi Day was celebrated at IFGTB, Coimbatore on 4.11.2011. Competitions were held on Hindi translation, essay writing, Hindi typing, etc and prizes were distributed to the winners.

IWST, Bangalore

IWST, Bangalore organized Hindi Fortnight and Hindi Day Celebration in the Month of September 2011. Written and Oral Competition were organized for the contractual Staff and Shri Rupak Kumar Dutta, IPS Police Headquarters, Bangalore Distributed the Prizes who was the chief guest on the occasion. The meetings of Rajbhasha Karyanvayan Samiti were organized accordingly. Hindi Typing and Stenography trainings were given to Ministerial Staff. This institute is the member office of Nagar Rajbhasha Karyanvayan Samiti, Bangalore and had participated in the meetings



Hindi Day at IFGTB, Coimbatore

from time to time. Workshops were also organized for senior officers.

TFRI, Jabalpur

TFRI, Jabalpur celebrated Hindi Fortnight from 5 September 2011 to 19 September 2011, in which various competitions like *Hindi Prashn Manch*, *Prasashnik Hindi Bhasha Gyan*, *Vaigainik tatha takniki Shabdavali*, Hindi typing, Hindi Debate, Hindi Essay writing etc. were organized. To promote Hindi in official work 10 Personnel's were given First, Second, Third and five Consolation Prize for working in Hindi. A workshop on "*Shodh Patron mein Hindi Takniki Shabdawali ki Aane Wali Kathinaiyan Evam Unka Samadhan*" was organized in the institute on 15 March 2012. The Speaker answered the questions asked by the personnel's related to the Technical works.

RFRI, Jorhat

The Institute organized a workshop on Hindi software Saransh on 15 -16 June 2011. On the first Day training was given to officers and Scientists and on the second day training was given to all other personnel's. This software is unicode based and it has no font problem. The Institute organized a Hindi Workshop on 12 September 2011 in which Dr. Vijay Kumar, HOD, Hindi Department, Jagannath Barua Mahavidhyalaya was invited as guest-speaker. Scientists, Officers and Research personnel's were also present there. A Hindi workshop was conducted in the institute on 22 December 2011. A workshop on Hindi software "*Saransh*" was conducted in the institute on 22 March 2012. Workshop was hosted by Shri Shankar Sharma, Hindi Translator. In this workshop training on the installation of the software was also given to the officers and staff. 22nd Meeting of Narakas was organized at NEIST, Jorhat on 7 March 2011. Office /Representatives and National Bureau of Soil Survey, Life Insurance of India, Indian Overseas Bank, Central Bank, Vijaya Bank, Indian Bank, Uco Bank, National Insurance, Punjab sindh Bank, Rubber Board were present there. Hindi Saptah and Hindi Divas was also celebrated in the



Institute. During the Hindi Saptah various competitions like Dictation, Essay writing, General Knowledge, Slogen were organized. On this occasion Shri, N.K.Vasu, Director, RFRI, Mrs. Emitula Aao, Group Co-ordinator, All the Scientist, Staff and research personnel's were present.

AFRI, Jodhpur

During the year 2011-12 Hindi Correspondence was 75.22 per cent and the noting on the files in Hindi was 84.09 per cent. Total 04 workshops were organized. Head of the Institute attended regular meetings of the Narakas. Website of the Institute was partly made bilingual. Hindi fortnight was celebrated during 14 - 28 September 2011. During this period various competitions were organized to promote Hindi.

Rajbhasha prizes were given to the personnel's for working in Hindi. For the library books worth Rs. 8774 were purchased. Staff of the Institute participated in Workshop/Symposium.

HFRI, Shimla

Keeping in view the Importance of Hindi Divas, Himalayan Forest Research Institute, Shimla celebrated Hindi Divas on 14.09.2011 to promote Hindi in Official Work. All the Scientists, Officers and other Staff were present there. Institute celebrated Hindi Fortnight from 12 September to 25 September. During this Hindi Essay Writing Competition was organized on 25 September 2011. On this occasion the whole staff of the Institute attended the celebration and prizes distributed to first three participants.

IFP, Ranchi

- Shri Binay Kumar Mishra, Dy.C.F. and Shri Ashutosh Kumar Pandey, UDC attended the Hindi Meeting at CIP, Kanke, Ranchi on 29 August, 2011 conducted by Town Official Hindi Language Implementation Committee, Central Office, Ranchi.
- *Hindi Pakhwara* was conducted by the Institute from Sept. 1 - 14, 2011. A meeting of the *Rajbhasha Karyanvayan Samiti* was also held on 15 Sept, 2011

in which emphasis was laid on the usage of Hindi in day - to - day official works.

- Shri Rameshwar Das, Director and Shri A.K. Pandey, UDC attended the Hindi meeting at Town Official Hindi Language Implementation Committee, Central Office, Ranchi at CIP, Kanke on 13 Dec, 2011.
- Shri A. K. Pandey, UDC attended the Hindi meeting at Town Official Hindi Language Implementation Committee, Central Office, Ranchi at CIP, Kanke on 20 Dec, 2011.
- Director, Rajbhasha and his Senior P.A. visited IFP, Ranchi on 22 - 23 Dec, 2011 for supervision of implementation of Hindi Language in official works.

4.8 Awards and Honours

FRI, Dehradun

- Research Paper entitled " Modeling the safe harvest limits and regeneration rate of *Andrographis paniculata*, *Evolvulus alsinoides*, *Phyllanthus urinaria* and *Rauvolfia spentina* under Sal forests of Doon Valley, Uttarakhand" has been awarded Third Prize under Poster Competitive presentations by Neeta Gera & Avinash K.Sharma.
- Paper entitled "Green approaches towards characterization of *Tinospora sinensis*" by V. Kumar, S. Nagar and Y.C. Tripathi, received first Prize for best presentation in Conference on Environmental Conservation, Sustainable Natural Resource Management and Strategies for Regional Development with reference to Uttarakhand, May 01-02, 2011 at Dehradun.
- Paper entitled "Quality, Safety and Efficacy of Herbal Medicines – Phytochemical Approach" by Y.C. Tripathi and Shipra Nagar was awarded first Prize for Best Oral Presentation in the 10th *Symposium on Phytochemistry and Ayurveda: Potential and Prospects* organized by the management of Universities' Journal of Phytochemistry



and Ayurvedic Heights held on on 24 December, 2011 at Dehradun.

- Paper entitled "Search of Modern Anti- diabetic Remedies: Ayurveda Show the Pathway" by S. Nagar, M. Redhu, Y.C. Tripathi and L. Upadhyay received 1 Prize for best presentation in the 10th *Symposium on Phytochemistry and Ayurveda: Potential and Prospects* held on 24 December, 2011 at Dehradun.
- Papers entitled "Structural analysis of *Tinospora sinensis* polysaccharide" by V. Kumar, Y.C. Tripathi and Shipra Nagar and "Effect of *Cassia glauca* leaf extract on gentamycin sulphate induced nephrotoxicity in rats" by M. Redhu, M. Singh, V.K. Varshney and Y.C. Tripathi awarded for best presentations in the *INDO-US Workshop on Green Chemistry for Environment and Sustainable Development* organized by HNB Garhwal University, Srinagar, on 11 – 13 March, 2012 at Dehradun.
- Shipra Nagar, and Praveen Onial, RA-I received 'Young Scientist Award' for Best Oral Presentation of the paper entitled 'Structural Studies on *Tinospora sinensis* Polysaccharide' and 'Utilization of *Tagetes minuta* and *Terminalia chebula* as a source of natural dye,' respectively in the 6th UCOST Congress 2011 held on 14-16 November 2011 at Almora (Uttarakhand).
- Rashmi and Sapana was awarded II Prize on paper entitled 'Value addition of Cheura: A Wonder Tree Borne Oil Seeds, In National Conference on 'Recent Developments in Chemistry and Chemistry Education' held on 16-17 December.
- Paper entitled "Value Addition of *Terminalia chebula* fruits for sustained Livelihood" by Praveen Onial and Rakesh Kumar was awarded first award for best poster presentation in International Conference on Non-Wood Forest Produce for Sustained Livelihood from 17-19 December 2011, at Bhopal.
- Saklani, R., Thapliyal, M. and Veerababu, O. 2011. "Influence of temperature and pretreatments on the germination of seeds of *Buxus wallichiana*-an

alternate species for the woodcraft industry," Won the best oral presentation award in Environmental Science and Forestry discipline during 6th Uttarakhand State Science & Technology Congress, Kumaon University, SSJ Campus, Almora. November 14-16, 2011.

- Dr. Veena Chandra, Scientist-F, won First Prize in First Indian Forest Congress held at Delhi from November 22-25, 2011 for best Poster Presentation entitled "Wild Medicinal Plants in Traditional Health Care System: An Assessment of Jaunsar-Bawar region of Dehra Dun (Uttarakhand)". She was also felicitated by the Prof. H.S. Srivastava Foundation for Science and Society, Lucknow (UP).

IFGTB, Coimbatore

- Dr. Kannan C.S. Warriar received the *Rolla S Rao Award* constituted by the Indian Association of Angiosperm Taxonomy for the best research work on biodiversity conservation for the year 2010.
- Dr. Modhumita Dasgupta, Scientist E has been awarded the *DBT-CREST Award* (Cutting Edge Research Enhancement and Scientific Training Award) for the year 2010-2011 for pursuing advanced research training in the area of tree biotechnology.

IWST, Bangalore

- Dr. O. K. Remadevi was elected as the President of Indian Academy of Wood Science and Dr. R. Sundararaj as Treasurer of the Academy.
- Dr. R. Sundararaj became the member of the National Academy of Sciences, India.
- Dr. V. P. Tewari, Scientist-F has been appointed as Deputy Coordinator IUFRO Div. 4, unit 04.01.03 (Instruments and Methods in Forest Mensuration) by the IUFRO Executive Board.

TFRI, Jabalpur

- Senior Scientist Award for the year 2011-12 to Dr. S.A. Ansari by Foundation for Scientific Forestry India, Institute of Forest Productivity, Ranchi.



- Shri N.D. Khobragade, Scientist –B of the centre received best paper presentation award for the research paper entitled “Effect of organic fertilizer on production of tubers of *Asparagus racemosus* –An important medicinal plant” in National Seminar on Transfer of Biotechnology for Sustainable Development and Environment Protection on 21-22 January 2012, Sponsored by UGC (CRO) Bhopal Organized by Department of Zoology Govt. College, Aron, District Guna (Madhya Pradesh).

Eco-tourism award, a certificate and a cash reward of Rs. 25,000/- in the field of individual innovative works in Tamia & Patalkot has been awarded to Dr. Suneesh Buxy, IFS Director, CFRHRD, Chhindwara by His Excellency Governor Shri Ram Prasad Yadav at Bhopal, M.P.

AFRI, Jodhpur

Dr. Tarun Kant received the Young Scientist Award, 2012 from the Foundation for Scientific Forestry (FSF), Ranchi, during National Symposium on Assessment & Conservation of Forest Genetic Resources through Biotechnological Interventions on 19-20 December, 2011 at Institute of Forest Productivity, Ranchi.

IFP, Ranchi

Shri R. Das, received Life time achievement award for his contributions in community based natural resource management by Global Consortium of Contemporary biologists (2010).

4.9 Special Activities (Such as Van Mahotsava, Forestry Day and Other Occasions)

National Technology Day

FRI, Dehradun observed National Technology Day on 11 May 2011 at the Shatabdi Van Vigyan Kendra (Ranger's College), Dehradun. All the museums of the Institute were open free on this day.

World Environment Day

FRI, Dehradun observed World Environment Day & FRI Foundation Day on 5 June 2011. The plastic and other waste strewn around the campus was collected and disposed off by the officers and staff of the Institute during the cleaning drive which sensitized the residents of the FRI Campus about the problem of the plastic waste and the sources of the waste. A special exhibition was also displayed in front of the Information Centre of the Institute. The exhibition was inaugurated by Dr. V. K. Bahuguna, IFS, Director General, ICFRE. He was accompanied by Dr. S. S. Negi, Director, FRI, and officers and staff of FRI. In the evening a performance of “**Territorial Army Symphony Orchestra**” was also witnessed. The song of FRI composed by them was also played and appreciated by the audience. Entry to all the museums of the Institute were free on this day.

RFRI observed World Environment Day on 5 and 6 June 2011 at Cheniamguri Middle English School, Cheniamguri-Sotai, Jorhat (Assam) with various events.

AFRI, Jodhpur observed World Environment Day on 5 June 2011. On the occasion 50 plants of various arid and semiarid tree species were planted in the arboretum of AFRI and a pamphlet on problem of Khejri mortality and its management was released.

HFRI, Shimla observed "World Environment Day" on 5 June 2011. About 110 people including school



RFRI Observed World Environment Day



children from various schools alongwith their teachers participated in the celebrations. For encouraging the school children, competitions like Quiz Competition, Declamation contest, Slogan writing and Drawing/ painting competition were also organized by the Institute.

World Forestry Day

FRI, Dehardun observed the World Forestry Day. An Exhibition was organized at the FRI Information Centre which included posters and models depicting the achievements of the Institute. The exhibition was attended by students from many colleges and schools, besides farmers and people. RFRI, Jorhat observed World Forestry Day on 21 March 2012 to create awareness among the villagers and public of its vicinity.

Wild Life Week

FRI, Dehardun organized "Wild Life Week" from 1-5 October 2011. On this occasion the students of FRI University had organized an exhibition which was inaugurated by Dr. S.S.Negi, Director FRI, Dehradun.

Vigilance Awareness Week

FRI, Dehardun observed "Vigilance Awareness Week" from 31 October - 5 November 2011. Dr.V.R.R. Singh, Head Silviculture Division, FRI had taken the pledge with all the staff of the Institute. During this function, there was an essay competition on the subject "Kya Lokpal Bill Bhrashtachar Mitane Ka Sahi Vikulp Hai?" A workshop was also organized in the board room of FRI.

IFGTB, Coimbatore observed Vigilance Awareness Week 2011 on 4 November 2011. Issues related to preventive vigilance, Right to information, etc were discussed and deliberated. Essay competitions in Tamil and English were held and prizes were distributed to the winners. IWST, Bangalore celebrated Vigilance Awareness Week on 31 October 2011.

Himalayan Day

FRI, Dehardun observed "Himalayan Day" on 9 September 2011. On this occasion, the faculty guests



Vigilance Awareness Week at IFGTB, Coimbatore

Dr. Rakesh Shah, CCF (Wildlife)Uttarakhand, Dr. Subhash Nautiyal, Head Botany Division, Dr. Rakesh Kumar, HESCO (Himalayan Environmental Studies & Conservation Organization) and Dr. Laxmi Rawat, Head Ecology Division delivered valuable lectures. Acting Director, FRI Dr. V.R.R. Singh and other Officers and Scientists of FRI were also present on that occasion. Smt. Jayshree Ardey, Head Extension Division welcomed all the guest and faculty members and Shri R.B. Singh, Scientist-B, Extension Division proposed a vote of thanks to all.

International biodiversity day

IFGTB, Coimbatore observed the international Biodiversity Day by organizing various programmes to the school and college students on 22 May 2011. A Mini Marathon was organised for both men and



Mini Marathon Event Inaugurated by Dr. C. Sylendra Babu, IPS, Commissioner of Police, Coimbatore



Shri J.C. Kala, IFS, Former DGF & SS, MoEF

women. Along with the international Biodiversity Day celebrations the *Centenary of Fisecher Herbarium* was also celebrated and Souvenir was released. Fischer Herbarium established in 1911 has collections made by C.E.C. Fischer, P.F. Fyson etc., About 3312 species are available in the herbarium.

IWST, Bangalore celebrated International Biodiversity day on 20 May 2011.

TFRI, Jabalpur observed World Biodiversity Day on 23 May 2011 at Jamtara village to create awareness about biodiversity among the local people .

RFRI observed International Day of Biological Diversity on 22 - 23 May 2011 at Chandra Kamal Bezbarua High School, Boloma, Jorhat (Assam).

AFRI, Jodhpur observed International Biodiversity Day on 22 May. On this occasion, 50 plants of various arid and semi-arid tree species *Capparis decidua*, *Mangifera indica*, *Saraca indica*, *Pithecellobium dulce*, *Annona squamosa*, *Prunus dulcis*, *Annona reticulata* were planted in the arboretum of AFRI. AFRI's quarterly Hindi magazine '*AFRI Darpan*' (having special issue on Forest Genetic & Tree Breeding Division) was released on this occasion.

Van Mahotsav

- TFRI, Jabalpur observed Van Mahotsava at CII, Skills Training Park Imlikheda, Chhindwara on 23 - 24 July 2011. RFRI, Jorhat observed the 62 '*Van Mahotsav*'



Ceremonial Plantation by Sh. P. J. Parmar & Dr. T. S. Rathore at Arboretum, AFRI

on 7 July 2011. IFP, Ranchi organized one day workshop on "*Van Mahotsav*" on 13 June 2011.

- AFRI, Jodhpur celebrated Van Mahotsav on 28 July 2011 with involvement of Salawas gram panchyat and SFD Jodhpur. The whole programme was celebrated at Demo-Village site, Salawas for sensitizing people about demo village and activities carried out by AFRI at Salawas Panchyat. Ceremonial planting of various tree species seedlings at demo-village was carried out by chief guest Sh. Malakhan Singh Bisnoi, MLA Luni, Sh. Omaram Patel Sarpanch Salawas, Sh. Hazari Singh, a social worker, and AFRI officials. A pamphlet in Hindi about Van Mahotsav and Information Booklet of AFRI (Hindi) were also released on the occasion by the chief guest and Director, AFRI. One hundred fifty quality seedlings of Khejri, Rohida, Sissoo & Karanj were



distributed to the farmers of Demo Village for the planting on the occasion.

World Day to Combat Desertification

AFRI, Jodhpur observed World Day to Combat Desertification on 17 June 2011. The theme was 'Forests keep dry lands working'. A brief programme was organized by AFRI Jodhpur on this occasion. On this occasion, Ceremonial Plantation of more than 50 plants of various arid and semi-arid tree species were planted in the premises of UBI Bank, Basni branch, Saraswati nagar, Jodhpur. A pamphlet on "World day to combat desertification" was also published and distributed to the stakeholders.

IWST, Bangalore observed the Kannada Rajyotsava Day on 30 November 2011.



Ceremonial Plantation on the Occasion of "World Day to Combat Desertification"

Indian Forest Congress (IFC) 2011

The Indian Council of Forestry Research and Education organized First Indian Forest Congress (IFC) from 22 to 25 November 2011. The IFC was inaugurated by Ms. Jayanthi Natarajan, Hon'ble Minister of Environment & Forests in New Delhi. Ms. Jayanthi Natarajan, in her inaugural address called for more scientific analysis of the issues relating to forest management in the country, in the midst of ever burgeoning pressure on the forests and climate change threat. She urged for developing reliable data at the state level on Forest Biomass, increment, Non-Timber Forest Products, Eco-tourism, etc. She asked the experts to evolve innovative solutions for human-wildlife conflict, development of forest certification in the country and to assess the tangible and non-tangible benefits from the forests.

Dr. M.S. Swaminathan, Member of Rajya Sabha welcomed the initiatives of the ICFRE to organize the



The DG, ICFRE Welcoming the Honorable Minister



Ms. Jayanthi Natarajan, Hon'ble Minister of Environment & Forests, GoI Addressing the Inaugural Session of IFC 2011



First Forest Congress. He stressed the need for the ICFRE to conduct focused research on Coastal Mangroves, Hills and Dry Zones of the country. Many Van Vigyan Kendras need to be established in the country to promote Agro forestry, he added. He also asked ICFRE to initiate projects on developing technologies for the mining rehabilitation as these areas need immediate interventions.



Dr. M.S. Swaminathan Member of Rajya Sabha

Dr. V.K. Bahuguna, DG, ICFRE, in his address emphasized that massive investment in forestry sector is imperative not only for the forest management, but also for ensuring food and water security in the country.

Ms. Caitilin Wiesen, Country Director of UN DP-India stated that UNDP is supporting the efforts of mainstreaming the biodiversity conservation and forest



Ms. Caitilin Wiesen, Country Director of UNDP

based livelihoods. She welcomed the theme areas selected for the Congress and pledged support of UNDP to ICFRE.

During the congress, the Hon'ble minister released a galaxy of books on forestry including "Forestry in the Service of Nation: ICFRE technologies"- a book encompassing the history and innovations of over hundred years of forestry research in India, "Voices from the Field" and "Status of JFM in India" all published by ICFRE. These books provide glimpses of innovations in the field of forestry and contribution of forestry for the welfare of the people. Over 550 participants from over 50 organizations participated in this gala event which simultaneously held different sessions in 28 sub-themes of 4 themes and the best presentations were awarded. The event concluded with the adoption of New Delhi Forest Charter 2011.



Participants of 1st Indian Forest Congress 2011

4th Tree Growers Mela 2012

IFGTB, Coimbatore organised the 4th Tree Growers Mela 2012 on 23 - 24 February 2012. The Mela was inaugurated on 23 February 2012 by Smt. Jayanthi Natarajan, Hon'ble Minister of State (Independent charge), Ministry of Environment and Forests, Government of India. More than 1000 farmers from



IFGTB, Coimbatore Organised Tree Growers Mela 2012

Tamil Nadu, Puducherry and Palakkad District of Kerala participated in the mela. Dr. V.K. Bahuguna, IFS, Director General, Indian Council of Forestry Research and Education presided over the function. Hon'ble Minister also declared open the Exhibition on Agroforestry and Farm Forestry Technologies, wherein, more than 30 forestry research organizations, wood based industries, bio-manures and bio-fertilizers industries, farm equipments and implements, organic products, Irrigation agencies, Tree Growers, hitech nurseries involved in planting stock production, Self help groups, etc participated. A workshop on Improved tree farming for enhancing livelihood was organised.

Advance Research Centre for Bamboo & Rattan

The Hon'ble Chief Minister of Mizoram, Pu Lal Thanhawla inaugurated the new building complex of

Advance Research Centre for Bamboo & Rattan on March 16, 2012 at Bethlehem Venthlang, Aizawl, Mizoram in a glittering function in presence of Pu S. Hiato, Minister for Industries, Govt. of Mizoram and Dr. V.K. Bahuguna, DG, ICFRE. Other Dignitaries who were present on the occasion included Dr. R. Lalthantlunanga, Vice Chancellor, Mizoram University; Pu R. Vanchhawang, Addl. PCCF, Mizoram; Pu L.R. Thanga, Principal Secretary to the Chief Minister, Mizoram; Shri R. Deori, Superintending Engineer, CPWD, Officers of other Central/State Government Departments etc. Shri N.K. Vasu, Director, RFRI, Jorhat welcomed all guests present in the inaugural ceremony and felicitated distinguished guests at the Dias with traditional *phulam gamosa*. Ms Imtienla Ao, Director, ARCBR presented a brief account of ARCBR from its inception from 29 November, 2004.



Dr. V.K. Bahuguna, DG, ICFRE Receiving the Hon'ble Chief Minister of Mizoram



Pu Lal Thanhwala, the Hon'ble Chief Minister of Mizoram Inaugurating the ARCBR Complex



Dr. V. K. Bahuguna, DG, ICFRE Addressing the Gathering



New ARCBR building

DISTINGUISHED VISITORS

- Her Excellency Smt. Pratibha Devisingh Patil, President of India visited FRI, Dehradun on 11 June 2011. During the visit Several VIPs and dignitaries were also present.



Dr. V.K. Bahuguna, DG, ICFRE Apprising Smt. Pratibha Devisingh Patil, President of India During Her Visit to ICFRE and FRI, Dehradun

- Shri R. Gopal Krishnan, Additional Secretary to Prime Minister, New Delhi visited FRI, Dehradun on 5 May 2011.
- Shri M. K. Narayanan, Governor of West Bengal, Kolkata visited FRI, Dehradun on 23 June 2011.
- A team of the Planning Commission consisting of Ranjan Chatterjee, Senior Advisor and Dr. Biswajeet Banerjee,, Director (Forestry) visited ICFRE on 19 January 2012 and held an interactive meeting with the senior officials and Scientists of ICFRE and FRI.
- A four member delegation from the SAARC forestry Centre, Thimpu visited ICFRE on 1 March 2012. The delegation consisted of Dr. Sanjay Wangchuk, Director SAARC Forestry centre, A.K.Lal, Head Passang Narbu, SFM specialist, and Chado Tshering, PFM specialist.



- A 6 member delegation, headed by President, Chinese Academy of Forestry, Beijing, China visited FRI, Dehradun on 19 December 2011.
- Mr. Steve Watkins and Dr. K.S. Murali from RARE Organization visited FRI, Dehradun on 12 September 2011 and brief information on developed technology was given to him.
- Dr. V.K. Bahuguna, Director General, ICFRE, Dehradun visited AFRI, Jodhpur from 20 - 21 June 2011. The Director General inaugurated mist chamber and renovated nursery facilities on 21 June 2011. He also addressed and took meeting with all the officers, Scientists and other officials of the institute.
- A group of nine African countries accompanied by Central Academy for state Forest Service Dehradun (CASFOS), total 18 participants under India-Africa Forum under a training programme on "Combating Desertification and Climate Change" visited AFRI, Jodhpur and met the Director, AFRI.
- Dr. VK Bahuguna, Director General, ICFRE during his visit to HFRI, Shimla inaugurated the newly constructed MD Chaturvedi Memorial Training Complex in the premises of the Institute on 5 December 2011. Interacting with the media, he said that the complex would be equipped with the latest gadgets and will provide a platform for dissemination of technologies developed by the Institute to the target groups including the State Forest Department.

44th BOG Meeting of ICFRE

44th meeting of ICFRE Board of Governors was convened on 24 June 2011 at Board Room of FRI, Dehradun. The meeting was chaired by the Secretary, MoEF, New Delhi. The meeting was attended by the DG, ICFRE, Dehradun and other members of the Board.



44th BOG Meeting of ICFRE, Dehradun

**ADMINISTRATION
AND
INFORMATION TECHNOLOGY**



Administration and Information Technology

5.1 Introduction

The Directorate of Administration is responsible for creation and maintenance of the administrative infrastructure in the foreground of which the other functions of the ICFRE are conducted. The functions of the directorate include budgeting, accounts, drawal and disbursement of the money, pension related matters, recruitment of scientists through Recruitment Board of ICFRE, provisioning other human resources on contract basis, various procurements and also information technology related services across all the institutes and centres of ICFRE. The activities of the Division can be summarized as given below:

5.1.1 E-Governance Activities

The ICFRE has taken lead in implementing the e-Governance programme envisaged by the Ministry of Environment & Forests, New Delhi in terms of IT Infrastructure and Capacity building. The usage of PCs has percolated to the level of LDCs at ICFRE Hqtrs.

Apart from the above other initiatives taken in this direction are:

- Development of Indian Forestry Research and Information System (IFRIS)
- Establishment of ICFRE Server Farm (Data Centre)
- Integration of ICFRE with National Knowledge Network (NKN) under Government of India project.
- Upgradation and Extension of Local Area Network of FRI under NMEICT arrangement.

5.1.2 Development of IFRIS

Indian Forestry Research & Information System (IFRIS) was conceptualized with the aim to implement a comprehensive IT Solution with the following objectives:

- To translate some of the present working manual systems into automated systems

- To increase / improve access, efficiency, transparency and accountability of services
- To enhance the responsiveness of ICFRE through workflow automation and knowledge management
- To enhance the ease of convenience of users, stakeholders in accessing the information and services provided by the ICFRE.

IFRIS broadly comprises of two main parts viz.; Indian Forestry Research Management Information System (IFRIMS) and Indian Forestry Research Administration Information System (IFRAIS). Some key research web enabled services and records include:

- Research Project Database (on-going/completed) including externally funded
- Grants and Research Proposals
- Role based access to information/reports
- Downloadable Summary of Research Reports
- Personal Information, Pay Roll and Financial Accounting System
- Real time availability of information on centralized data repository
- Emailing and messaging system with contact list
- News, Events and Calendar of programs
- Tender Notices and Offices orders
- Feedback/Grievance Redressal and Audit Trails

Project Institutional Framework has become an effective platform wherein Institute Apex Committee meetings, Technical Committee Meetings and ICFRE Apex Committee are being regularly conducted to highlight the expectations and concerns of the stakeholders.

The IFRIS has made following significant achievements:

- Repository of concept note and detail project is around 353 projects since 2009 and 134 added during 2011-12.
- Employee Self Service Portal is having 2100 employees data. 16090 leave transactions were made by 1630 employees during 2011-12.



- Around 5861 digitized document are available in Electronic Document Management System (EDMS).

Module-wise new features added to IFRIS by ICFRE internal team are:

Personal Information Management System

- Addition of Paternity, Maternity, EOL, Child Care Leave, and Station Leave. Earlier CL, HPL, RH and EL options were only available to PIMS. Paternity, Maternity, EOL, Child Care Leave and Station Leave options were added to PIMS so that employees can apply most of leave online only.
- Extension of Leave: Now extension of leave is configured in PIMS. System is taking care of the gap between extension leaves.
- Addition of Departure and Joining Facility: Departure and joining report facility before and after availing leave is added.
- Employee Leave Report Institute wise: Report regarding leave taken by employees of a particular institute between some particular dates.
- ACR uploading downloading facility: ACR can be uploaded and downloaded from PIMS. Employees can see their ACR if uploaded from their PIMS account.
- Pay Slip: Employees can see their pay slip of any month from their PIMS account.
- Half yearly calculation and year end mapping: Half yearly calculation and year end mapping is changed. Now all leaves are updated according to mapping rules with one click.

Payroll Management system

- Xlxs file upload support in PMS: PMS is made MS Office 2007 file compatible and can upload xlxs file.
- Payroll process Track (for security purpose): Payroll can be tracked as it can be checked, who has processed the salary of a particular batch.
- Income Tax Report: Report can be taken for all

employees of an institute regarding Income Tax deducted upto the running month.

- GPF Report: Report can be taken for all employees of an institute regarding GPF deducted including recoveries in a particular month.
- GPF Installments: GPF installments can be added in payroll and same will be reflected in pay slip and pay bill.

Financial Accounting System

- Budget reallocation was taking lot of time and not saving the entries properly: Budget reallocation was time consuming as system was saving only after allotting all budgets. Now you can save the budget allocation at any point and after some time again start from that particular point.
- Enterprise task sorting: My task list is sorted by many options.
- Receipt and Payment Report: Receipt and payment report format was changed and same is added to FAS.
- Budget request allowing for other institutes after budget allocation to one: Budget allocation was possible after getting budget request from all institutes. Now budget can be allotted without waiting for the other institutes budget request.
- All vouchers redesign template: All voucher are redesign and templates are changed so that maximum of voucher can come in one page itself.

5.1.4 ICFRE Server Farm (Data Center)

The ICFRE Server Farm is hosting the IFRIS Application and other allied key services like:

- Messaging Service
- Web Service
- Database Service
- Proxy Service
- DNS Service
- DHCP Service



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- FTP Service
- Backup Service
- Internet Service
- MPLS-VPN-Service
- Videoconferencing
- Antivirus Service
- Helpdesk Service
- CA EMS

These services are being provided to the regional institute through MPLS-VPN with BSNL as service provider. The availability of MPLS link to various institute from 1.4.2011 to 31.3.2012 is as follows:

S. No.	Institutes	MPLS Availability (in%)
1.	ICFRE, Dehradun	99.37
2.	AFRI, Jodhpur	92.88
3.	IWST, Bangalore	98.33
4.	TFRI, Jabalpur	92.21
5.	IFGTB, Coimbatore	98.83
6.	RFRI, Jorhat	96.06
7.	HFRI, Shimla	95.91
8.	IFP, Ranchi	81.74
9.	Van Vigyan Bhawan	92.09
10.	CFRHRD, Chhindwara	76.78
11.	FRC, Hyderabad	91.53
12.	CSFER, Allahabad	94.04

The ICFRE Mail Services are providing Internet & Intranet Mail Services to all the employees of ICFRE/FRI & other institutes. The Mail Servers are running on HP Blade Servers with Active- Passive Clustered Environment for High Availability. The Mail Services are running on IBM Lotus Domino 8.0 Platform & provide Lotus Notes as well as Domino Web Access Features to more than 1408 Users, across ICFRE/FRI & all MPLS Institutes. All the messaging data are being stored to the Centralized SAN Storage.

E Mail Account Status from 1 April 2012 to 31 March 2012

Total Mail ID Created	Disable Mail IDs	Deleted Mail IDs	Group Created
87	22	31	14

E-Mail Transaction from 1 April 2012 to 31 March 2012

S.No.	Month	Mails
1.	April-2011	34104
2.	May-2011	36899
3.	June-2011	40603
4.	July-2011	76613
5.	August-2011	43195
6.	September-2011	45556
7.	October-2011	45591
8.	November-2011	52606
9.	December-2011	54345
10.	January-2012	50610
11.	February-2012	43920
12.	March-2012	41654
Total		565696

Apart from development of the ICFRE Website in Hindi it is being consistently monitored and upgraded with a dynamic home page hosting all the current and critical information of ICFRE and its Institutes.

Various Websites Hosted on ICFRE Web Server

http://www.icfre.org	http://www.icfre.gov.in
http://hindi.icfre.org	http://hindi.icfre.gov.in
http://afri.icfre.org	http://afri.icfre.gov.in
http://frc.icfre.org	http://frc.icfre.gov.in
http://ifgtb.icfre.org	http://ifgtb.icfre.gov.in
http://iwst.icfre.org	http://iwst.icfre.gov.in
http://tfri.icfre.org	http://tfri.icfre.gov.in
http://rfri.icfre.org	http://rfri.icfre.gov.in
http://hfri.icfre.org	http://hfri.icfre.gov.in
http://ifp.icfre.org	http://ifp.icfre.gov.in
http://vanvigyanbhawan.icfre.org	http://vanvigyanbhawan.icfre.gov.in
http://cfrrhd.icfre.org	http://cfrrhd.icfre.gov.in
http://frc-2011.icfre.org	http://frc-2011.icfre.gov.in
http://frc-2012.icfre.org	http://frc-2012.icfre.gov.in



Indian Poplar Commission (IPC 2012) portal is developed by ICFRE internally for effectively conducting the IPC event. The IPC portal has facility of online registration, online abstract submission, online review and online payment etc.

The ICFRE website is being updated regularly and the frequency of updations done in various section from 01 April 2011 to 31 March 2012, is shown in the below given table :

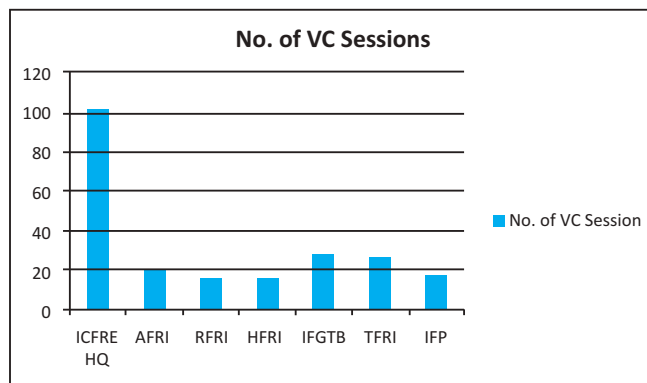
Name of Institutes	Number of updates in ICFRE Website
ICFRE, HQ	558
FRI, Dehradun	577
TFRI, Jabalpur	25
IWST, Bangalore	45
RFRI, Jorhat	60
IFGTB, Coimbatore	52
AFRI, Jodhpur	11
IFP, Ranchi	14
HFRI, Shimla	18
FRC, Hyderabad	06
VVB	02
Total updates	1368

5.1.5 Video Conferencing

- Video conferencing services at ICFRE have been started from May 2008 and till date more than 700 videoconferencing sessions has been successfully completed.
- Video conferencing services among ICFRE Institutes carried through MPLS VPN tunnel.
- Video Conferencing facility is also available for outside participant through public network.
- Video conferencing rooms at ICFRE are fully equipped with high resolution End Point, Plasma Display Unit & Audio input/output devices which

gives the excellence performance during videoconferencing sessions & users can see and hear each other in real-time, allowing natural conversations.

Status of no of Video Conferencing sessions across ICFRE from 1 April 2011 to 31 March 2012 is as below:



The ICFRE Server Farm hosts the back-end Oracle RDBMS Database for the **IFRIS** Applications. The Database Servers are running on Itanium Servers and are Active-Passive Clustered for High Availability through Service Guard Clustering Feature. The Database servers are connected to Centralized SAN Storage. The ICFRE Proxy Service provides Secure & Fast Internet Services to the users of ICFRE/FRI. The Proxy Service utilizes the Red Hat Squid Proxy Services on RHEL 5.3 Platform. Several rules & access lists are defined on the basis of keyword & URL Filtering, to prevent explicit content, from being accessed. A detailed reporting of Access Logs is also being maintained through Squid Analysis Report Generator (SARG).

Based on its architectural design, the type of the services hosted and the monitoring system planned the ICFRE Data Centre has been granted an ISO 27001-2005 Certified Data Centre and Services station.

IT Division is providing services through its framework of servicedesk (24X7) and IFRIS Service (9X5) in terms of hardware, software user request for internet services. During 2011-12, total numbers of 1216 service request were received.



5.1.6 National Knowledge Network

ICFRE has taken a lead in adoption and utilization of connectivity obtained under NKN Project at national level through its proactive initiatives.

One Gbps internet leased line connectivity to Universities under National Mission on Education through Information Communication Technology (NMEICT) Project for creation of National Knowledge Network (NKN), was obtained for FRI University from BSNL.

Efforts made by the ICFRE management have resulted in ICFRE Institutes and Centres being included in the NKN Programme. Following is the status of NKN at institutes:

S.No.	Institute	Status of NKN
1.	ICFRE, Dehradun	Link Functional
2.	IWST, Bangalore	Link Functional
3.	FRC, Hyderabad	Link Functional
4.	RFRI, Jorhat	Link Functional
5.	AFRI, Jodhpur	Link Functional
6.	IFP, Ranchi	Link Functional
7.	HFRI, Shimla	Link Functional
8.	CSFER, Allahabad	Link Functional
9.	IFGTB, Coimbatore	Link Functional
10.	WBC, Visakhapatnam	Link Functional
11.	TFRI, Jabalpur	OFC terminated
12.	ARCBR, Aizwal	Work yet to start

ICFRE looks at the NKN arrangement as a substitute to its MPLS-VPN through which all the services as described herein are provided to the ICFRE Institutes/Centres/FRI University, through its ISO 27001:2005 Certified Data Centre at Dehradun and envisages an early configuration of the NKN connectivity to ICFRE and its Institutes/Centres and the FRI University as a replacement to its existing MPLS-VPN arrangement

5.1.7 Upgradation and Extension of LAN Under NMEICT Arrangement

A proposal was received from BSNL for provisioning of LAN connectivity to Universities under NMEICT- NKN at 25% of actual cost. Based on the survey for Upgradation and Extension of LAN at FRI is being planned for more than 20 locations viz; FRI University, Scientists Hostel, Visiting Scientist Hostel, 100 Students Hostel, New Forest Hospital etc.

5.2 Sevottam

Sevottam is an assessment improvement framework targeted to improve the quality of services to the citizens. Based on the guidelines issued by the Administrative Reforms, ICFRE has made Citizen Charter and the same has been loaded on the website to improve Council and its Institutes public interface. The Council using the framework of Sevottam is committed to continuously improve quality of service in ICFRE (HQ) and its Institutes.

The Sevottam framework consists of three components viz. The Citizens' Charter, Public Grievance lodging and redressal mechanisms and service delivery capability. Citizen Charter has been uploaded on the website of ICFRE describing the three components.

The Council interacts with citizens and its clients in a variety of ways. When it comes to IT, the interface is through the ICFRE websites and the email services-particularly its own email system that the organization has installed. The websites and email systems are managed on a 24x7 basis throughout the year and across various institutes of ICFRE all over the country.

5.2.1 Action taken to formulate the Charter for the Department and its subordinate formation:

Citizens' Charter is available on the website of the ICFRE (www.icfre.gov.in). For providing information to



the public and clients, Directorate of Administration of ICFRE largely relies on the web-based tools, dissemination of information through a variety of means –including IT interface, Citizens' Charter, responses to citizens by way of the tools that come under the purview of Right To Information Act and through workshops and seminars conducted by the organization.

The subordinate formations of ICFRE consist of its regional Institutes and Centres across the country. The websites of these Institutes are integrated with the main website of ICFRE and are hosted in the same server. As the work of institutes of ICFRE merges into the overall work of ICFRE, the Citizens' Charter of ICFRE on the website mentioned above provides the requisite information that is applicable to the institutes also besides showing pertinent information about various institutes.

5.2.2 Action taken to implement the Charter

As stated earlier, the Citizen's Charter is on the website of ICFRE. It provides the bird's-eye view of ICFRE including its vision, mission, objectives, functions, services and service standards. The Charter also provides the grievance redressal mechanism and contact information of persons who should be approached for registering, and receiving responses on, specific grievances in each institute of ICFRE.

5.2.3 Details of Training Programmes, Workshops, etc. held for proper implementation of Charter:

Providing information about the organization to various public functionaries is one of the main objectives of the Citizens' Charter. To achieve this, a large number of training programmes and workshops etc. were held by ICFRE and its institutes to enhance the public interface of ICFRE. The details of training programmes organised by ICFRE and its institutes are listed below:

- International Conference and exhibition on the “Art and Joy of wood” held during 19-22 October 2011 at IWST, Bangalore
- SLEM workshop: Role of Forests in dryland Areas on the occasion of world day to combat desertification on 17 June 2011 at ICFRE, Dehradun
- Forest Genetic Resources Management Network (FGRMN) held at IFGTB, Coimbatore during 9-10 March 2011
- Insect Pests and diseases. Their incidence and management in Forest Ecosystem on 25-26 May 2011 at HFRI, Shimla
- Workshop on Energy Mass exchange in vegetative system held at TFRI, Jabalpur, 9-10 June 2011
- Review of JFM Programme implementation Meeting of PCCF/s at FRI(ICFRE), Dehra Dun, 27-18 June 2011
- Training programme on Climate Change & Carbon Mitigation, 14-18 November 2011
- Nomination Form of Training on climate change and carbon mitigation, 14-18 November 2011
- Short term training programme on “Ecological restoration of mined lands” at FRI from 25-29 July 2011
- Training held at IFP Ranchi on bamboo propagation, cultivation and management for sustainable livelihood for farmers of Bihar from 25-29 July 2011
- Specialized training programme on planting stock improvement, clonal trials / testing at IFGTB from 22 August - 2 September 2011
- Five days ecological restoration training at FRI, Dehra Dun from 5-9 September 2011
- Open Source Quantum GIS Training for Scientist of IFGTB, Coimbatore on 18-22 October 2011
- Training programme on “Climate Change and Carbon Mitigation” for women scientists & technologists working in Govt. Sector. Invitation letter, Nomination Form, and Training Schedule.



- Training on Innovative Techniques for Urban Forestry at IFGTB on 1 - 2 March 2012
- Training programme in Hindi for women scientist on 'Climate Change and Carbon Mitigation' inaugurated at ICFRE on 6 February 2012
- Workshop on preparation of country report on Forest genetic resources 7-8 February 2012 at IFGTB, Coimbatore
- IFP Ranchi organized a three days training programme on 'Scientific Lac Cultivation' from 7 - 9 December 2011 at IFP Ranchi
- IFP Ranchi organized one day workshop on Candidate Plus Tree Selection in *Anogeissus Acuminata* on 11 January 2012 at Bhubaneswar
- Training on Innovative Techniques in Urban Forestry organized by IFGTB Coimbatore on 1 – 2 March 2012
- One day consultative workshop on rural livelihood improvement through lac cultivation at IFP, Ranchi on 27 February 2012
- One day training on Herbarium Preparation was organized by IFP Ranchi under the project on Reassignment of Forest Types in India
- National Seminar on Forest Health Management organized by IFGTB on 21-22 March 2012
- Forester Trainees of 61 batch from Assam Forest School, Guwahati visited RFRI, Jorhat on 26 March 2012

5.3 Welfare Measures:

The Grievance redressal cell for SC/ST/ OBC employees of ICFRE(HQ) was formed vide Secretary,

ICFRE, order no 63-37/2010-ICFRE dated 23 February 2011. The Deputy Director General (Education) functions as the Chief Liaison officer for SC/ST/ OBC. The details of meetings organised by the Grievance Redressal Cell and training programmes regarding welfare measures are listed below:

- Organized quarterly meeting for the quarter April to June, 2011 of Grievances Redressal Cell of ICFRE (Hqr.) on 15 June 2011 in the Chamber of DDG (Education)
- Organized quarterly meeting for the quarter July to September, 2011 of Grievances Redressal Cell of ICFRE (Hqr.) on 29 September 2011 in the Chamber of DDG (Education)
- Organized quarterly meeting for the quarter October to December, 2011 of Grievances Redressal Cell of ICFRE (Hqr.) on 28 December 2011 in the Chamber of DDG (Education)
- Organized quarterly meeting for the quarter January to March, 2012 of Grievances Redressal Cell of ICFRE (Hqr.) on 29 March 2012 in the Chamber of DDG (Education)
- Organized one day Trainings for Officers/ Officials ICFRE(Hq) and FRI, Dehradun on "Reservation Policy" on 7 June 2011 in the Conference Hall, Scientist Hostel, FRI, Dehradun.
- Organized two day Training for Officers/ Officials of ICFRE(Hq) and FRI, Dehradun on "Reservation Policy" on 27 & 28 March 2012 in the Conference Hall, Scientist Hostel, FRI, Dehradun

Audited Annual Accounts



Audited Annual Accounts



G.K. PATET & CO.
CHARTERED ACCOUNTANTS

AUDIT REPORT

We have audited the attached Balance Sheet of INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION, DEHRADUN as at 31st March, 2012 and the annexed Income & Expenditure Account and Receipt & Payment Account for the year ended on that date. The accounts of various unit/project of the institute are consolidated while preparing financial statements. These Financial Statements are the responsibility of the Council's Management; Our responsibility is to express an opinion on these financial statements based on our audit.

We have conducted our audit in accordance with the accounting standards generally accepted in India. These standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatements. An audit includes examining on test basis evidence supporting the accounting and disclosures in the financial statements. An audit also includes assessing the accounting principles and significant estimates made by the management as well as evaluating the overall financial statements presentation. We believe that our audit provides a reasonable basis of our opinion.

In our opinion and to the best of our information's and according to the explanations given to us the said accounts give a true and fair view, read along with significant accounting policies as Schedule 25 and Notes on Accounts as Schedules 26 annexed herewith

- (i) In the case of the Balance Sheet of the state of affairs of the above named Council as at 31st March, 2012
- (ii) In the case of the Income & Expenditure Accounts, of the Deficit for the year ended on 31st, March, 2012.

DATED: 18.09.2012
PLACE : DEHRADUN

FOR G.K.PATET & CO.,
CHARTERED ACCOUNTANTS



(G.K.Patet) Partner
Chartered Accountant
M.No.015736





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

BALANCE SHEET AS ON 31ST MARCH, 2012

(Amount-Rs.)

CORPUS/CAPITAL FUND AND LIABILITIES	SCHEDULE	CURRENT YEAR AS ON 31.03.2012		PREVIOUS YEAR 31.03.2011
CORPUS/CAPITAL FUND	1		1,513,614,733	1,596,660,322
RESERVES AND SURPLUS	2		-	-
EARMARKED/ENDOWMENT FUNDS	3			
> One Time Special Grant		205,358,441		-
> Project Unspent Balance		211,213,548		285,368,742
> Corpus Fund Unspent Balance		8,270,576	424,842,565	-
SECURED LOANS AND BORROWINGS	4		-	-
UNSECURED LOANS AND BORROWINGS	5		-	-
DEFERRED CREDIT LIABILITIES	6		-	-
CURRENT LIABILITIES AND PROVISIONS	7			
(A) CURRENT LIABILITY:			58,630,986	11,594,039
(B) PROVISIONS:			-	-
TOTAL			1,997,088,284	1,893,623,303

ASSETS	SCHEDULE	CURRENT YEAR AS ON 31.03.2012		PREVIOUS YEAR 31.03.2011
FIXED ASSETS	8		1,286,514,176	1,362,754,107
INVESTMENTS-FROM EARMARKED/ENDOWMENT	9			
> F.D.R.(For One Time Special Grant)			80,000,000	80,000,000
> F.D.R.(With Institutes)			-	-
INVESTMENTS-OTHERS	10		-	-
CURRENT ASSETS, LOANS, ADVANCES ETC.	11		630,574,108	450,869,197
MISCELLANEOUS EXPENDITURE			-	-
> (to the extent not written off or adjusted)				
> (items under reconciliation)				
TOTAL			1,997,088,284	1,893,623,303
SIGNIFICANT ACCOUNTING POLICIES	25			
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	26			

Dr. V.K. RAHUGUNA, (Director General, ICFRE)

Dr. S.P. SINGH, (Dy. Director General, Admin., ICFRE)

PRAMOD PANT, (Asstt. Director General, Admin., ICFRE)

V.R. SRINIVASAN, (Fin. Advisor & Chief Accounts Officer, ICFRE)

VIJAY DNASMANA (Section Officer, Budget, ICFRE)

AS PER OUR SEPARATE REPORT OF EVEN DATE ANNEXED
FOR G.K. PATEL & CO.,
CHARTERED ACCOUNTANTS



(G.K. PATEL) Partner
Chartered Accountant
Membership No. 15736
DATED: 18.09.2012
PLACE DEHRADUN



Annual Report 2011-12


INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st. MARCH, 2012

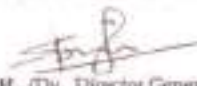
(Amount Ru.)			
INCOME	Schedule	Current Year 31.03.2012	Previous Year 31.03.2011
Income from sales/services	12	6,242,867	8,279,681
Grants/Subsidies	13	1,065,000,000	993,200,000
Fees/Subscriptions	14	23,500	290,296
Income from Investments (Income on Invest. from earmarked/endow.	15	-	-
Income from Royalty, Publications etc.	16	505,527	461,169
Interest Earned	17	12,275,386	9,170,913
Other Income	18	47,336,610	53,297,123
	18		
Increase/ (decrease) in stock of finished goods and works-in-progress	19	-	-
		-	-
Total(A)		1,131,383,890	1,064,699,182.63

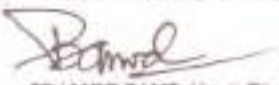
EXPENDITURE	Schedule	Current Year 31.03.2012	Previous Year 31.03.2011
Establishment Expenses	20	835,614,554	811,955,380
Other Administrative Expenses etc.	21	292,216,297	318,746,214
Expenditure on Grants, Subsidies etc.	22	1,392,381	19,999,967
Interest	23	-	-
Depreciation(Net Total at the year end-corresponding to Schedule 8)		121,482,096	130,568,268
TOTAL(B)		1,250,705,328	1,281,069,829
Balance being excess of Income over Expenditure(A-B)		(119,321,438)	(216,370,646)
Transfers to Special Reserve(Specify each)		-	-
Transfer to/ from General Reserve		-	-
BALANCE BEING DEFICIT CARRIED TO CORPLUS FUND		(119,321,438)	(216,370,646)
SIGNIFICANT ACCOUNTING POLICIES	25		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	26		

Annexure No.16 and 17 required breakup (Revenue Account breakup)

AS PER OUR SEPARATE REPORT OF EVEN DATE ANNEXED
FOR G.K.PATEL & CO.,
CHARTERED ACCOUNTANTS


Dr. V.K.B. HUGUNA, (Director General, ICFRE)


Dr. S.P. SINGH, (Dy. Director General, Admin., ICFRE)


PRAMOD PANT, (Asstt. Director General, Admin., ICFRE)


V.J. SRINIVASAN, (Fin. Adviser & Chief Accounts Officer, ICFRE)


VIJAY DHASMANA (Section Officer, Budget, ICFRE)



(G.K.PATEL) Partner
Chartered Accountant
Membership No. 15736
DATED: 18.09.2012
PLACE: DEHRADUN



Annual Report 2011-12

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st, MARCH, 2012

Amount-(Rs)

SCHEDULE 1-CORPUS/CAPITAL FUND:	CURRENT YEAR 31.03.2012		PREVIOUS YEAR 31.03.2011	
Balance as at the beginning of the year	1,596,660,521.83		1,368,254,507.18	
Op. Balance of Capital Fund Account			295,528,948.72	
Op. Balance of General Fund Account				
Less: Provision for Salary Payable March, 2011	(44,862,550.00)	1,551,797,971.83		1,663,783,455.90
Add: Revenue Received From DDO's		59,642,949.68		56,294,712.35
Add: Contributions towards Corpus/Capital Fund				
Plan Account	50,000,000.00			111,800,000.00
Nrh East	30,000,000.00	80,000,000.00		40,000,000.00
Less: Balance of net income/expenditure transferred from the Income and Expenditure Account (Deficit)		(119,321,438.11)		(216,370,646.07)
LESS: Revenue Receipt paid to D.G. ICFRE by the DDO's		(58,504,750.48)		(58,847,000.35)
BALANCE AS AT THE YEAR-END		1,513,614,732.92		1,596,660,521.83

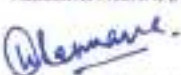
SCHEDULE 2-RESERVES AND SURPLUS:	CURRENT YEAR 31.03.2012		PREVIOUS YEAR 31.03.2011	
1. Capital Reserve:				
As per last Account	-	-	-	-
Addition during the year	-	-	-	-
Less: Deductions during the year	-	-	-	-
2. Revaluation Reserve:				
As per last Account	-	-	-	-
Addition during the year	-	-	-	-
Less: Deductions during the year	-	-	-	-
3. Special Reserves:				
As per last Account	-	-	-	-
Addition during the year	-	-	-	-
Less: Deductions during the year	-	-	-	-
4. General Reserve:				
As per last Account	-	-	-	-
Addition during the year	-	-	-	-
Less: Deductions during the year	-	-	-	-
TOTAL		-		-


Dr. V.R. BAHUGUNA, (Director General, ICFRE)


Dr. S.P. SINGH, (Dy. Director General, Admin., ICFRE)


PRAMOD PANT, (Asstt. Director General, Admin., ICFRE)


V.R. SRINIVASAN, (Fin. Adviser & Chief Accounts Officer, ICFRE)


VIJAY DHASMANA (Section Officer, Budget, ICFRE)

AS PER OUR SEPARATE REPORT OF EVEN DATE ANNEXED
FOR G.K. PATET & CO.,
CHARTERED ACCOUNTANTS



(G.K. PATET) Partner
Chartered Accountant
Membership No. 15736
DATED: 18.09.2012
PLACE DEHRADUN



Annual Report 2011-12

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2012

Amount-(Rs)

SCHEDULE 3-EARMARKED/ENDOWMENT FUNDS	FUND -WISE BREAK UP				TOTALS	
	ONE TIME SPECIAL GRANT	PROJECT ACCOUNTS	INTEREST CORPUS FUND	Fund	Current Year	Previous Year
a) Opening balance of the funds	99,600,022	185,768,720	-	-	285,368,742	143,463,899
b) Additions to the Funds:						
i) Donations/ grants						
One Time Special Grant (General)	138,000,000	-	-	-	138,000,000	180,000,000
ii) Income from investments made on account of funds	-	-	8,270,576	-	8,270,576	-
iii) Other additions (specify nature)	-	-	-	-	-	-
iv) Project Receipts	-	235,163,749	-	-	235,163,749	311,280,743
TOTAL(a+b)	237,600,022	420,932,469	8,270,576	-	666,803,067	555,244,642
c) Utilization/Expenditure towards objectives of funds						
i) Capital Expenditure:						
- Fixed Assets	14,986,986	-	-	-	14,986,986	-
- Others	-	-	-	-	-	-
Total ...	14,986,986	-	-	-	14,986,986	-
ii) Revenue Expenditure:						
- Salaries, Wages and allowances etc.	-	-	-	-	-	-
- Rent	-	-	-	-	-	-
- Other Administrative expenses	17,254,595	-	-	-	17,254,595	389,978
- Project Payments	-	309,718,921	-	-	309,718,921	269,475,922
Total	17,254,595	309,718,921	-	-	326,973,516	369,875,900
Total(c)	32,241,581	309,718,921	-	-	341,960,502	369,875,900
NET BALANCE AS AT THE YEAR END(a+b-c)	205,358,441	111,213,548	8,270,576	-	424,842,565	285,368,742

Notes

- 1) Disclosures shall be made under relevant heads based
- 2) Plus Funds received from the Central/State

[Signature]
Dr. V.K. BAHUGUNA, (Director General, ICFRE)

[Signature]
Dr. S.P. SINGH, (Director General, Admin., ICFRE)

[Signature]
PRAMOD PANT, (Asst. Director General, Admin., ICFRE)

[Signature]
V. J. SUDHIVASAN, (Fin. Adviser & Chief Accounts Officer, ICFRE)

[Signature]
VIJAY DHASMANA (Section Officer, Budget, ICFRE)

*AS PER OUR SEPARATE REPORT OF EVEN DATE ANNEXED FOR C.R. PATEL & CO., CHARTERED ACCOUNTANTS



C.R. PATEL Partner
Chartered Accountant
Membership No. 1836
DATED: 18.03.2012
PLACE: DEHRADUN

**INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN****SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st, MARCH, 2012**

Amount-(Rs)

SCHEDULE 4-SECURED LOANS AND BORROWINGS:	CURRENT YEAR 31.03.2012		PREVIOUS YEAR 31.03.2011	
	1. Central Government	-	-	-
2. State Government(Specify)	-	-	-	-
3. Financial Institutions				
a) Term Loans	-	-	-	-
b) Interest accrued and due	-	-	-	-
4. Banks:				
a) Term Loans	-	-	-	-
-Interest accrued and due	-	-	-	-
b) Other Loans(specify)	-	-	-	-
-Interest accrued and due	-	-	-	-
5. Other institutions and Agencies	-	-	-	-
6. Debentures and Bonds	-	-	-	-
7. Others(specify)	-	-	-	-
TOTAL	-	-	-	-
Note: Amount due within one year				





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st, MARCH, 2012

Amount-(Rs)

Schedule 5-UNSECURED LOANS AND BORROWINGS	Current Year 31.03.2012	Previous Year 31.03.2011
1. Central Government	-	-
2. State Government	-	-
3. Financial Institutions	-	-
4. Banks:	-	-
a) Term Loans	-	-
b) Other Loans (specify)	-	-
5. Other Institutions and Agencies	-	-
6. Debentures and Bonds	-	-
7. Fixed Deposits	-	-
8. Others(specify)	-	-
TOTAL	-	-
Note: Amount due within one year		

SCHEDULE 6-DEFERRED CREDIT LIABILITIES:	Current Year 31.03.2012	Previous Year 31.03.2011
a) Acceptances secured by hypothecation of capital equipment and other	-	-
b) Others	-	-
TOTAL	-	-
Note: Amounts due within one year		





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st, MARCH, 2012

Amount-(Rs)

SCHEDULE 7-CURRENT LIABILITIES AND PROVISIONS	CURRENT YEAR 31.03.2012		PREVIOUS YEAR 31.03.2011	
A. CURRENT LIABILITIES				
1. Acceptances	-	-	-	-
2. Sundry Creditors:				
a) For Goods	-	-	-	-
b) Others	-	-	-	-
3. Advances Received	-	-	-	-
4. Interest accrued but not due on:				
a) Secured Loans/borrowings	-	-	-	-
b) Unsecured Loans/borrowings	-	-	-	-
5. Statutory Liabilities:				
a) Overdue	-	-	-	-
b) Others	-	-	-	-
6. Other Current Liabilities				
Security & EMD Account	10,219,052	10,219,052	10,637,160	10,637,160
<u>Amount Payable to Controller ICFRE</u>				
GPF Subscription/ Refund	221,583		219,811	
CSLIS	346		(1,228)	
Pension Contribution	66,190		66,190	
New Pension Scheme	12,355	300,474	9,600	254,373
<u>Amount Payable to PAO NEW DELHI</u>				
GPF Subscription/ Refund	358,692		28,313	
CGEGIS	11,980		11,980	
Any Other Recovery	128,451	499,123	128,451	168,744
<u>Amount Payable to Other Units</u>				
Saving Fund	64,071		64,071	
Death Claim	44,013		44,013	
Advance Recovery	511		(1,589)	
CGEIS	1,031	109,626	551	107,046
<u>Amount Payable to Others</u>				
L.I.C.	3,447		-	
T.D.S./Service Tax/ Professionals Tax	27,341		16,526	
Payable to Controller ICFRE	2,035,453		-	
Misc. Recoveries	(3,710,574)		370,190	
Inter Unit Account	-	(1,644,333)	-	386,716
<u>Salary Payable Account</u>				
Op. Balance	44,862,550			
Less: Salary Actually paid in April, 2011	(52,749,848)			
(7,887,298)	(7,887,298)			
Add: Salary Payable for March, 2012	57,034,342	49,147,044		
TOTAL(A)		58,630,986		11,594,039
B. PROVISIONS				
1. For Taxation				
2. Gratuity				
3. Superannuation/Pension				
4. Accumulated Leave Encashment				
5. Trade Warranties/Claims				
6. Others(Specify)				
TOTAL(B)				
TOTAL(A+B)		58,630,986		11,594,039





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATIONAL INSTITUTIONS
SCHEDULE FORMING PART OF BALANCE SHEET AS AT THE MARCH 2012

DESCRIPTION	GROSS BLOCK			DEPRECIATION		NET BLOCK	
	Cost reduction As at beginning of this year	Additions during the year	Deletions during the year	As at the beginning of the year	On Addition during the year	On Deductions during the year	Total up to the Year-end
A. Fixed Assets							
1. LAND							
a) Freehold	4,201,000	1,925,000	-	-	-	-	6,126,000
b) Leasehold	-	-	-	-	-	-	-
2. BUILDINGS							
a) On Freehold Land	994,384,009	3,428,000	-	49,759,220	140,000	-	994,384,009
b) On Leasehold Land	-	-	-	-	-	-	-
c) Structures on land not belonging to the entity	-	-	-	-	-	-	-
3. PLANT MACHINERY & EQUIPMENT							
a) Structures on land not belonging to the entity	-	-	-	-	-	-	-
b) Scientific Machinery	141,331,358	26,863,136	-	24,172,794	3,014,740	-	165,118,358
c) IT Equipment	31,290,077	3,000,400	-	24,574,637	424,487	-	30,290,837
4. VEHICLES	13,992,141	1,000,000	-	2,998,824	1,000,000	-	11,993,317
5. FURNITURE/FIXTURES	13,128,294	1,694,220	-	1,102,810	84,711	-	13,128,299
6. OFFICE EQUIPMENT	47,580,294	3,075,147	-	33,137,494	230,000	-	49,580,294
7. COMPUTERS/PERIPHERALS	-	-	-	983,896	-	-	983,896
8. ELECTRIC INSTALLATIONS	1,544,276	1,000,000	-	2,544,276	153	-	3,088,552
9. LIBRARY BOOKS	47,671,464	-	-	2,150,739	-	-	45,520,725
10. OTHER FIXED ASSETS	-	-	-	-	-	-	-
TOTAL OF CURRENT YEAR	3,985,138	48,342,140	-	117,308,608	3,460,492	307,224	1,280,581,276
PREVIOUS YEAR	1,362,754,107	-	-	1,467,994,272	-	-	1,362,754,107
TOTAL	1,366,739,245	48,342,140	-	1,485,307,280	3,463,972	307,531	1,283,945,107

(Sum to be given in front of assets on later purchase items included above)

Dr. V. KRISHNA, Director General, ICFRE
 Prasad Patil, Joint Director General, ICFRE
 Dr. S. P. Singh, Joint Director General, ICFRE
 V. B. RAO, Joint Director General, ICFRE
 Dr. V. KRISHNA, Director General, ICFRE
 Prasad Patil, Joint Director General, ICFRE
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**INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN****SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st, MARCH, 2012**

Amount-(Rs)

SCHEDULE 9-INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011
1. In Government Securities > F.D.R.(For One Time Special Grant)	80,000,000.00	80,000,000.00
2. Other Approved Securities	-	-
3. Shares	-	-
4. Debentures and Bonds	-	-
5. Subsidiaries and Joint Ventures	-	-
6. Others(to be specified)	-	-
TOTAL	80,000,000.00	80,000,000.00

SCHEDULE 10- INVESTMENTS-OTHERS	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011
1. In Government Securities > F.D.R.(With Institutes)		-
2. Other approved Securities	-	-
3. Shares	-	-
4. Debentures and Bonds	-	-
5. Subsidiaries and Joint Ventures	-	-
6. Others(to be specified)	-	-
TOTAL	-	-





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st, MARCH, 2012

Amount-(Rs)

SCHEDULE II -CURRENT ASSETS,LOANS, ADVANCES ETC.	CURRENT YEAR		PREVIOUS YEAR	
	31.03.2012		31.03.2011	
A.CURRENT ASSETS:				
1.INVENTORIES:				
> Stores and Spares	-	-		
> Loose Tools	-	-		
> Stock in trade	-	-		
> Finished Goods	-	-		
> Work-In- Progress	-	-		
> Raw Materials	-	-		
2.Sundry Debtors:	-	-		
> Debts Outstanding for a period exceeding six months	-	-		
> Others				
4.Cash balances in hand(including cheques/drafts and	577,479	577,479	1,952,464	1,952,464
5.Bank Balances:				
a)With Scheduled Banks:				
> On Current Accounts	385,549,647		309,985,415	
> On Deposit Accounts(includes margin money)	35,000,000	420,549,647	11,162,500	321,147,915
> On Savings Accounts				
b)With non-Scheduled Banks:				
> On Current Accounts	-	-	-	-
> On Deposit Accounts(includes margin money)	-	-	-	-
> On Savings Accounts	-	-	-	-
6.Post Office-Savings Accounts	-	-	-	-
TOTAL (A)		421,127,126		323,100,379





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2012

Amount - (Rs)

SCHEDULE II - CURRENT ASSETS, LOANS, ADVANCES (TC-Cont.)	CURRENT YEAR 31.03.2012		PREVIOUS YEAR 31.03.2011	
B. LOANS, ADVANCES AND OTHER ASSETS				
1. Loans:				
a) Staff Advance				
Forest Advance	2,468,910		983,729	
Festival Advance	1,246,340		882,996	
Car advance	483,020		320,726	
Scooter Advance	628,858		1,790,985	
Cycle Advance	253,176		258,306	
House Building Advance (HBA)	5,123,203		6,748,349	
TA Advance	738,973		339,403	
LTC Advance	381,877		966,107	
TTA Advance	1,573,039		822,508	
Medical Advance	341,261		209,685	
Pay Advance	268,960		128,270	
Computer Advance	741,514		466,700	
Etc. (Please specify)	46,480	14,071,633	35,838	14,153,802
b) Other Entities engaged in activities/ objectives similar to that of the Entity				
c) Other (Specify)				
2. Advances and other amounts recoverable as cash or in kind or for value to be received:				
a) On Capital Account				
CPWD	480,281		480,281	
CCU - (North East)	70,752,000		40,752,000	
CCU - (Plan Account)	56,914,334		56,914,334	
CCU - (Plan Account)	31,000,000		592,768	
KVS Account	8,270			
SCIENTIFIC EQUIPMENTS	385,755	379,440,640	-	98,719,381
b) Prepayments				
c) Others				
Amount Recoverable From Controller ICFRE				
GPF Advance	1,801,454		3,171,065	
DCEG	4,236,746		4,082,913	
Provisional Pension	188,130		188,130	
GPF Part/Final Payment	3,253,634	9,479,984	2,030,425	9,472,535
Amount Recoverable From FAO NEW DELHI				
GPF Advance	2,591,225		2,561,727	
CCEGIS	965,296		965,296	
DCEG	526,853		1,553,133	
Provisional Pension	282,136		282,136	
GPF Part/Final Payment	(7,871)	4,367,640	26,400	5,388,713
Amount Recoverable From Other Units				
DDOs (Premium for the month March)	-		-	
Deputation & Others	-		12,168	
Service Tax	-		-	
GPF Subscription	13,514	13,514	2,220	14,388
3. Income Accrued:				
a) On Investments from Endowed/Endowments Funds				
b) On Investments-Others				
c) On Loans and Advances				
d) Others (includes income due unrealized - Rs)				
	2,083,590	2,083,590	-	-
4. Claims Receivable				
TOTAL (B)		299,446,982		127,768,838
TOTAL (A+B)		630,574,108		450,669,197



**INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN****SCHEDULES FORMING PART OF INCOME EXPENDITURE ACCOUNT****FOR THE YEAR ENDING 31st, MARCH, 2012**

SCHEDULE 12 - INCOME FROM SALES/SERVICES	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011
1) Income from Sales		
a) Sale of Finished Goods	-	-
b) Sale of Raw Material	-	-
c) Sale of Scraps	-	-
2) Income from Services		
a) Labour and Processing Charges	-	-
b) Professional /Consultancy Services	-	-
c) Agency Commission and Brokerage	-	-
d) Maintenance Services(Equipment/Property)	-	-
e) Others(Specify)	-	-
f) Shairing Cost received from Other Users of KV	6,242,867	8,279,681
TOTAL	6,242,867	8,279,681

	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011
SCHEDULE 13 -GRANTS/SUBSIDIES (Irrevocable Grants& Subsidies Received)		
1) Central Government		
- To Plan (GC-General)	800,000,000	738,200,000
- To Non Plan (GC-General-KV)	245,000,000	245,000,000
- To North East (GC-General)	20,000,000	10,000,000
2) State Government	-	-
3) Government Agencies	-	-
4) Institutions/Welfare Bodies	-	-
5) International Organisations	-	-
6) Others(Specify)	-	-
TOTAL	1,065,000,000	993,200,000





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULES FORMING PART OF INCOME EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st, MARCH, 2012

Amount-(Rs)

SCHEDULE 14 - FEES/SUBSCRIPTION	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011
1) Entrance Fees	-	-
2) Annual Fees/Subscription	-	-
3) Seminar/Program Fees	-	-
4) Consultancy Fees	23,500.00	290,296
5) Others(specify)	-	-
Total	23,500.00	290,296
Note - Accounting Policies towards each item are to be disclosed		

SCHEDULE 15-INCOME FROM INVESTMENTS (Income on Invest. from Earmarked/ Endowment funds transferred to Funds)	Investment from Earmarked Fund		Investment -Others	
	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011
1) Interest				
a) On Govt. Securities	-	-	-	-
b) Other Bonds/ Debentures	-	-	-	-
2) Dividends				
a) On Shares	-	-	-	-
b) On Mutual Fund Securities	-	-	-	-
3) Rents	-	-	-	-
4) Others(Specify)	-	-	-	-
TOTAL	-	-	-	-
TRANSFERRED TO EARMARKED/ENDOWMENT FUNDS				





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULES FORMING PART OF INCOME EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st, MARCH, 2012

(Amount - Rs.)

SCHEDULE 16 - INCOME FROM ROYALTY, PUBLICATION ETC.	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011
1) Income from Royalty	-	-
2) Income from Publications	505,527	461,169
3) Others (specify)	-	-
4) Revenue Received (House Licence Fees, Guest House, Mandap etc.	-	-
TOTAL	505,527	461,169

SCHEDULE 17 - INTEREST EARNED ETC.	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011
1) On Term Deposits:		
a) With Scheduled Banks	10,100,690	7,842,894
b) With Non-Scheduled Banks	-	-
c) With Institutions	-	-
d) Others	-	-
2) On Saving Accounts:		
a) With Scheduled Banks	-	-
b) With Non-Scheduled Banks	-	-
c) Post Office Savings Accounts	-	-
d) Others	-	-
3) On Loans:		
i) Interest accrued during the year		
a) Employees/Staff	325,343	-
ii) Interest earned during the year		
a) Employees/Staff	1,849,353	1,328,019
4) Interest on Debtors and Other Receivables	-	-
TOTAL	12,275,386	9,170,913
Note - Tax deducted at source to be indicated		





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULES FORMING PART OF INCOME EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH, 2012

(Amount - Rs.)

SCHEDULE 18 - OTHER INCOME /PRIOR PERIOD ITEMS:	CURRENT YEAR 31.03.2012		PREVIOUS YEAR 31.03.2011
1) Profit on Sale/disposal of Assets			
a) Owned assets		-	-
b) Assets acquired out of grants, or received free of cost		-	-
2) Export Incentives realized		-	-
3) Fees for Miscellaneous Services		-	-
4) Miscellaneous Income		45,578,363	53,297,123.43
5) Prior Period Income		-	-
(i) Accrued interest income of earlier years		1,758,247.00	-
TOTAL		47,336,609.77	53,297,123.43

SCHEDULE 19 - INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS	CURRENT YEAR 31.03.2012		PREVIOUS YEAR 31.03.2011
a) Closing stock			
- Finished Goods		-	-
- Work-in-progress		-	-
b) Less: Opening Stock			
- Finished Goods		-	-
- Work-in-progress		-	-
NET INCREASE/(DECREASE) [a-b]		-	-

SCHEDULE 20 - ESTABLISHMENT EXPENSES	CURRENT YEAR 31.03.2012		PREVIOUS YEAR 31.03.2011
a) Salaries and Wages			
NON PLAN (General Component-General)			
By Salaries (Technical Staff)	124,964,131		
By Salaries (Non Technical Staff)	91,287,368		
By Grant to KV (Salaries)	33,031,000	249,282,499	248,310,763
Plan (General Components-General)			
By Salaries (Technical Staff)	364,033,499		
By Salaries (Non Technical Staff)	191,643,811	555,677,310	492,222,728
b) Allowances and Bonus		-	-
c) Contribution to Provident Fund		-	-
d) Contribution to other Fund (specify)			
Revenue Paid to Pension Cell ICFRE out of Own Revenue		15,900,000	63,036,889
e) Staff Welfare Expenses		-	-
f) Expenses on Employees' Retirement and Terminal Benefits		-	-
g) Other (specify) Shairing cost		14,754,745	8,385,000
TOTAL		835,614,554	811,955,380





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULES FORMING PART OF INCOME EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH 2012

SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES ETC.	CURRENT YEAR		31.03.2012	PREVIOUS YEAR 31.03.2011
				(Amount - Rs.)
a) Purchases				
b) Labour and processing expenses				
c) Cartage and Carriage Inwards				
d) Electricity and power			33,426,436	34,872,556
e) Water Charges			2,331,927	2,125,447
f) Insurance				
g) Repairs and maintenance				
> Minor Works/Maintenance	29,325,698			62,759,313
> M & S (Lab Contingencies)	7,829,088		37,354,786	9,109,242
h) Excise Duty				
i) Rent, Rates and Taxes				
> Rent building / Equipment	492,690			427,268
> Municipal Tax	1,342,443		1,835,133	1,515,077
j) Vehicles Running and maintenance				
> Fuel	6,215,979			6,535,130
> Repair	3,613,446			3,992,087
> Road Taxes / Insurance	975,117		10,804,542	1,061,956
k) Postage, Telephone & Communication Charges				
> Telephone charges	3,261,587			3,510,513
> Postal / Stamp Charges	817,709		4,079,216	875,744
l) Printing and Stationery				
> Printings & Publications	2,643,675			1,941,861
> Stationery	2,101,992		4,745,667	2,481,134
m) Traveling and Conveyance Expenses				
> T.E. (Technical Staff)	10,291,273			10,975,887
> T.E. (Non Technical Staff)	8,275,620			9,110,123
> O.E. (Technical)			18,536,893	
n) Expenses on Seminar / Workshops				
> Seminar / Conference / IODD	5,603,860			7,251,635
> Extension - Normal	1,144,953			1,440,684
> V.V.K. & Demo Villages	4,955,154			6,746,972
> DOE	520,253			742,927
> Field Research Expenses	33,020,722		45,244,862	30,937,366
o) Subscription Expenses				
p) Expenses on fees				
> Fellowship/Scholarship/cash Awards			23,954,322	32,645,936
q) Auditors Remuneration			88,240	
r) Hospitality Expenses				
s) Professional Charges			2,193,470	2,814,453
t) Provisions for Bad and Doubtful Debts/ Advances				
u) Irrecoverable Balances Written-off				
v) Packing Charges				
w) Freight and Forwarding Expenses				
x) Distribution Expenses				
y) Advertisement and Publicity			2,680,022	2,463,294
z) Maintenance of Equipments				
> Scientific	3,609,219			3,685,777
> Office	3,180,223			3,392,063
> I.T. Equipments / Services	16,399,528		23,188,972	21,190,089
aa) Others (specify) Municipal Tax				
ab) Contingency Expenditure			35,173,918	48,480,540
ac) Medicines / X-ray			6,630,733	5,633,936
ad) Liveries			96,351	120,612
ae) Newspaper Bill			444,004	472,222
af) North East Expenditure			19,386,762	9,194,429
TOTAL			292,216,297	318,746,214





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ANNEXURE OF PLAN NORTH EAST EXPENDITURE

FOR THE YEAR ENDING 31.03.2012

PARTICULARS	AMOUNT
By Salaries (Technical Staff)	-
By Salaries (Non Technical Staff)	-
By Salaries (Research KVS)	-
Plan (General Components)	
By Salaries (Technical Staff)	-
By Salaries (Non Technical Staff)	-
By T.E (Technical Staff)	2,082,105
By T.E (Non Technical Staff)	-
By O.E. (Technical)	-
Maintenance of Vehicle	-
- Fuel	266,032
- Repair	376,321
- Road Taxes / Insurance	79,567
Electricity Charges	-
Telephone charges	-
Maintenance of Equipments	-
- Scientific	79,149
- Office	50,750
- I.T. Equipments / Services	99,742
Others	-
- Water Charges	-
- Stationery	184,706
- Contingency Expenditure	5,668,159
- Legal / Consultancy charges	15,000
- Municipal Tax	-
- Medicines / X-ray	-
- Liveries	-
- Postal / Stamp Charges	-
- Advertisement	-
- Seminar / Conference / HRD	291,432
- Newspaper Bill	-
- Extension -Normal	149,884
- V.V.K. & Demo Villages	1,747,697
- Rent building / Equipment	-
Plan (Research)	
By Fellowship/Scholarship/cash Awards	4,004,708
Printings & Publication	9,890
Field Research Expenses	985,100
By M & S (Lab Contingencies)	1,320,211
By Minor Works/Maintenance	1,976,309
Conveyance Advances	-
HBA	-
TOTAL:	19,386,762





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULES FORMING PART OF INCOME EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st, MARCH, 2012

(Amount - Rs.)

SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC.,	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011
a) Grants given to Institutions/Organisations (Pension Cell ICFRE) > Grants to Universities	1,392,381	19,999,967
b) Subsidies given to Institution/Organisations		
TOTAL	1,392,381	19,999,967

Note - Name of the Entities, their activities along with the amount of Grants/Subsidies are to be disclosed

SCHEDULE 23 - INTEREST,	CURRENT YEAR 31.03.2012	PREVIOUS YEAR 31.03.2011
a) On Fixed Loans	-	-
b) On Other Loans (including Bank Charges)	-	-
c) Other (specify)		
TOTAL	-	-





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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN
RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31st MARCH 2012

RECEIPTS	T. AMOUNT	PAYMENTS	T. AMOUNT
I. Opening Balances			
a) Cash in hand	1,952,464.15		80,338,966.00
b) Bank Balances	509,965,614.64		290,238,297.72
c) Investment accounts	91,162,500.00		3,992,801.25
d) In deposit accounts			208,718,921.11
e) Savings accounts			32,243,581.00
II. Grants Received			
a) From Government of India			
Plan (C.C. General) Project / Revenue	800,000,000.00		
Non-Plan (C.C. General)	245,000,000.00		
Non-Plan (SV)	20,000,000.00		
North East (General Component)	50,000,000.00		
One Time Special Grant	30,000,000.00		
Plan (Research/Creation of Assets)			
North East (Capital Assets)			
b) From State Governments			
c) From other sources (Project Receipts)			
III. Income on Investments			
a) Earned/Unearned/Endowment			
b) Own Funds (Chs. Investments)			
IV. Interest Received			
Interest Received from Schedule Banks			
Other Receipts			
V. Other Income (Specify)			
VII. Amount Borrowed			
Revenue Receipt Payable to own Revenue Account No.			
Revenue Receipt from D.D./DB			
Securities / EMD / Plan (GC)			
Sharing Cost Received from Other users of KVS			
Reimbursement from PAO (F) New Debt			
Reimbursement from Controller, ICFRE			
Recovery from Staff on behalf of PAO (F) New Debt			
Receipt from Staff on behalf of other Officer			
Recovery from Staff on behalf of Controller ICFRE			
Recovery of Advances from Staff on behalf of ICFRE			
Recovery from Staff on behalf of Others			
Inter Unit Transactions			
Recovered from AO FR from Revenue Corporation			
TOTAL	2,480,715,966.81	TOTAL	2,480,715,966.81

FOR OUR SEPARATE REPORT OF REVENUE ACCOUNTS

FOR BALANCE SHEET & CO.

FOR PAYMENT ACCOUNTS



G.K. PATEL Chartered Accountant
Membership No. 13156
DATED: 18.09.2012

Dr. S. SINGH Director General, Admits, ICFRE

V. R. SRINIVASAN, (Fin. Advisor & Chief Accountant Officer, ICFRE)

Dr. V. K. BAHUGUNA Director General, ICFRE

PRAMOD PANT, (Asst. Director General, Admits, ICFRE)

VIJAY DHASMANA (Section Officer, Budget, ICFRE)




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**BALANCE SHEET OF CONTROLLER,PENSION CELL, OF
(GPF, GSLIS, PENSION SCHEME AND NEW PENSION SCHEME,)
INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN
AS ON 31ST MARCH, 2012**

SCHEDULE 24

(Amount-Rs.)

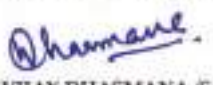
CORPUS/CAPITAL FUND AND LIABILITIES	SCHEDULE	CURRENT YEAR AS ON 31.03.2012		PREVIOUS YEAR AS ON 31.03.2011	
PENSIN CELL FUND ACCOUNT					
GENERAL PROV.FUND A/C	24 -A	426,385,158		310,585,735	
GSLIS A/C	24 -A	552,911		688,022	
PENSION A/C	24 -A	1,048,943,904		833,144,894	1,144,418,651
NEW PENSION FUND A/C	24 -A	2,584,991	1,478,466,964	-	
TOTAL			1,478,466,964	1,144,418,651	1,144,418,651
FIXED ASSETS			-		-
CURRENT ASSETS LOANS & ADV. INVESTMENTS-OTHERS			1,463,969,302		1,109,271,640
CASH & BANK BALANCES:			14,497,662		35,147,011
TOTAL			1,478,466,964	-	1,144,418,651
SIGNIFICANT ACCOUNTING POLICIES		25			
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS		26	-		-


Dr. Y.K. BAHUGUNA, (Director General, ICFRE)


Dr. S.P. SINGH, (Asst. Director General, Admin., ICFRE)


PRAMOD PANT, (Asstt. Director General, Admin., ICFRE)


V.R. SRINIVASAN, (Fin. Adviser & Chief Accounts Officer, ICFRE)


VIJAY DHASMANA (Section Officer, Budget, ICFRE)

"AS PER OUR SEPARATE REPORT OF EVEN DATE ANNEXED"

FOR G.K.PATET & CO.,
CHARTERED ACCOUNTANTS



(G.K.PATET) Partner
Chartered Accountant
Membership No. 15736
DATED: 18.09.2012
PLACE: DEHRADUN



Annual Report 2011-12

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN DETAILS OF PENSION FUND AS ON 31ST MARCH 2012

SCHEDULE - 24 "A"

(As Per Annexure 'B')	GPF	GSLIS	PENSION	NEW PENSION	TOTAL
Opening	310,585,735.25	688,021.96	824,867,956.75	8,276,937.00	1,144,418,650.96
Add : Excess Of Income Over Expenditure	100,498,874.00	27,689.00	308,988,253.00	350,570.00	409,865,386.00
Add : Tfd. from General Fund	0.00	0.00	0.00	0.00	0.00
Saving Fund under GSLIS		486,448.00			486,448.00
Death Claim		279,272.00			279,272.00
Received from PAO	995,156.00		38,973,404.00		39,968,560.00
Subscription/contribution	101,039,516.00	1,569,344.00			102,608,860.00
New Pension Scheme/LSPC			226,339.00	5,632,867.00	5,859,206.00
Misc. receipts	182,865.13	0.00	0.00		182,865.13
TOTAL:	102,217,537.13	2,335,064.00	39,199,743.00	5,632,867.00	149,385,211.13
Less :					
Death Claim Paid		320,932.00			320,932.00
Saving Fund		541,995.00			541,995.00
Subscription to LIC		1,614,133.00			1,614,133.00
GPF Advance Reimbursement	29,245,591.00				29,245,591.00
GPF Part/Final Payment	47,306,400.00				47,306,400.00
GPF Final Payment	10,040,196.00				10,040,196.00
Pensionary Benefit paid			100,297,809.70	11,675,383.00	111,973,192.70
DCRG			15,007,510.00		15,007,510.00
ISO Charges/Miscellaneous Payments	324,801.00	20,804.00	8,806,729.00		9,152,334.00
TOTAL:	86,916,988.00	2,497,864.00	124,112,048.70	11,675,383.00	225,202,283.70
TOTAL	426,385,158.38	552,910.96	1,048,943,904.05	2,584,991.00	1,478,466,964.39

AS PER OUR SEPARATE REPORT OF EVEN DATE ANNEXED

FOR G.K.PATET & CO.
CHARTERED ACCOUNTANTS

Dr. V.K. BAHUGUNA, (Director General, ICFRE)

Dr. S.P. SINGH, (Asstt. Director General, Admin., ICFRE)

PRAMOD PANT, (Asstt. Director General, Admin., ICFRE)

V. S. SRINIVASAN, (Jr. Adviser & Chief Accounts Officer, ICFRE)

VIJAY DHASMANA (Section Officer, Budget, ICFRE)



(G.K.PATET) Partner
Chartered Accountant
Membership No. 15736
DATED: 18.09.2012
PLACE: DEHRADUN



INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULE 24-"B"

FENSION-INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH 2012

INCOME		AMOUNT
GRANT IN AID		
Received through DDC(ADMIN)		-
Received from Revenue ICFRE		15,900,000.00
Interest		293,068,253.00
	TOTAL:.....	308,968,253.00
EXPENDITURE		AMOUNT
Expenditure		-
Excess Of Income Over Expenditure		308,968,253.00
	TOTAL:.....	308,968,253.00

GPF-INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH 2012

INCOME		AMOUNT
Interest & Dividend		100,498,874.00
	TOTAL:.....	100,498,874.00
EXPENDITURE		AMOUNT
Excess Of Income Over Expenditure		100,498,874.00
	TOTAL:.....	100,498,874.00





INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

SCHEDULE 24-"B"

GSLIS-INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH 2012

INCOME		AMOUNT
Interest		27,689.00
	TOTAL:.....	27,689.00
EXPENDITURE		AMOUNT
Excess Of Income Over Expenditure		27,689.00
	TOTAL:.....	27,689.00

NEW PENSION ACCOUNT INCOME & EXPENDITURE A/C FOR THE YEAR ENDING 31ST MARCH, 2012

INCOME		AMOUNT
Interest		350,570.00
	TOTAL:.....	350,570.00
EXPENDITURE		AMOUNT
Excess Of Income Over Expenditure		350,570.00
	TOTAL:.....	350,570.00





CONTROLLER PENSION CELL, (GPF, GSLS, PENSION SCHEME AND NEW PENSION SCHEME,) INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN RECEIPTS & PAYMENTS ACCOUNT FOR THE YEAR ENDING 31st March 2012					
RECEIPTS	AMOUNT	TOTAL AMOUNT	PAYMENTS	AMOUNT	TOTAL AMOUNT
Opening Balance as on 01.04.2011					
Cash in hand			GPF reimbursement to DDO's	29,245,591.00	
Cash at Bank	35,147,008.91		GPF Part Final payment	47,306,400.00	
F.D.R. ACCOUNT	1,509,271,840.18	1,144,418,649.09	GPF Final payment	10,040,196.00	
Amount recd. From DOG Admin.(Revenue)		15,500,000.00	Death Claims paid	320,932.00	
Amount received from PAO (F) on account of GPF transfer	995,156.00	995,156.00	Saving fund paid	541,965.00	
Amount received from Various DDO'S on account of GPF Subscription	101,039,516.00	101,039,516.00	Amount of premium to LIC for GSLS Subscript	1,614,133.00	
Amount received from Others on account of refund of excess GPF Payments	226,339.00	226,339.00	Pensionary benefit paid	111,973,192.70	
Closer of New Pension Accounts Bank & FDR Interest	5,532,867.00	5,532,867.00	Reimbursement of DCRIG, Pension to Various DDO's	15,007,510.00	
Amount received on account of Saving Funds under GSLS	393,965,257.00	393,965,257.00	ISO Charges	31,264.00	
Amount received on account of Death Claim under GSLS	496,448.00	496,448.00	Miscellaneous Payments(GPF Ac)	9,130,951.00	225,202,154.70
Subscripton from various DDOs	279,272.00	279,272.00	Closing Balance as on 31.03.2012		
Pro-rata Pensionary benefit received from PAO (F)	36,973,404.00	36,973,404.00	Cash-in-hand		
Amount received from Various DDO's on account of Pension Contribution	1,569,344.00	1,569,344.00	Name of Component		
Misc. Receipts	182,867.00	182,867.00	Cash at Bank with different institues/units		
			Plan (GC) / Revenue / Project	14,497,662.21	
			Name of Component		
			FDR's	1,463,969,302.18	1,478,466,064.30
TOTAL:		1,703,669,119.09	TOTAL:		1,703,669,119.09
DR. V.R. BHARADWAJ, (Director General, ICFRE)			'AS PER OUR SEPARATE REPORT OF EVEN DATE ANNEXED' FOR G. K. PATET & CO., CHARTERED ACCOUNTANTS (G.K. PATET) Partner Chartered Accountant Membership No. 15736 DATED: 18.09.2012 PLACE DEHRADUN		
DR. S.P. SINGH, (Dy. Director General, Admin., ICFRE)					
FRAMOD PANT, (Asstt. Director General, Admin., ICFRE)					
V.R. SRINIVASAN, (Fin. Adviser & Chief Accounts Officer, ICFRE)					
VIJAY DHASMANA (Section Officer, Budget, ICFRE)					



INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION, DEHRADUN
SCHEDULES FORMING PART OF ACCOUNTS
FOR THE YEAR ENDING 31ST. MARCH 2012

SCHEDULE- 25. SIGNIFICANT ACCOUNTING AND MANAGEMENT POLICIES

- (i) **Method of Accounting:-** The financial statements have been prepared as of going concern under historical cost convention. The following items of financial statement have been recognized on accrual basis of accounting:-
- a. Salary
 - b. Prior period Incomes
 - c. Accrued interest on advances to staff.

The remaining items of the financial statement have been recognized receipt / cash basis.

- (ii) The income with respect to interest accrued on loans to staff pertaining to prior periods but recognized in current year have been shown under "Prior Period Items" in Income & Expenditure A/c.

2. Quantification of the effect of change in accounting policy:-

a. The organization was earlier following the policy of accounting the salary on paid basis. However in the FY under audit it has accounted for the salary of March 2012 of Rs. 5,70,34,342.00 on accrual basis.

Further an opening balance Rs. 4,48,62,550.00 as provision of salary payable for March 2011 has also been credited in the financial statements by the organization by debiting the head Corpus Fund by the same amount.

The net result of these entries has resulted in decrease in Surplus in the Income & Expenditure Account by Rs. 42,84,494.00

b. The interest on staff advance was earlier being accounted on receipt basis. However during the current year the interest income of Rs. 20,83,590.00 has been recognized on accrual basis. The change in accounting policy from cash to accrual basis has increased the surplus reflected in the Income & Expenditure by Rs. 20,83,590.00

The interest Accrued may be broken down as under:-

Interest Accrued on staff Advances during the year	-	Rs. 3,15,343.00
Interest Accrued on staff Advances upto 31/03/2012	-	Rs. 20,83,590.00
		Rs. 17,58,247.00





The difference in the two amounts i.e. 17,58,248.00 reflects interest accrued relating to previous year. Accordingly it has been shown under the head of prior period item in the Income & Expenditure A/c.

3. **Fixed Assets:-**

(i) The fixed assets are carried at cost of acquisition or book value less accumulated depreciation.

(ii) Depreciation is being charged in written down value basis and depreciation is routed through Income & Expenditure A/c.

4. **Transaction in foreign exchange :-** Transaction in Foreign Currencies are recorded at exchange rates prevailing on the date of transaction.

5. **Employees Retirement benefits:-** Pension, leave encashment etc. are being accounted on cash basis. accordingly no provision for the same is being made in the books of Accounts

Dr.V.K.BAHUGUNA, (Director General, ICFRE)

Dr. S.P.SINGH, (Dy. Director General, Admin.,ICFRE)

PRAMOD PANT, (Asstt. Director General Admin., (ICFRE)

V.R.SRINIVASAN, (Fin. Adviser & Chief Accounts Officer, ICFRE)

VIJAY DHASMANA (Section Officer, Budget, ICFRE)

FOR G.K.PATET & CO.
CHARTERED ACCOUNTANTS



(G.K.Patet) Partner)
Chartered Accountant
Membership No.015736
DATED : 18.09.2012
PLACE : DEHRADUN



INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION, DEHRADUN
SCHEDULES FORMING PART OF ACCOUNTS
FOR THE YEAR ENDING 31ST, MARCH, 2012

SCHEDULE: 26. CONTINGENT LIABILITY AND NOTES ON ACCOUNTS:-

1. **Contingent Liabilities:** - No Provision for contingent liabilities, if any has been done in the books of accounts.
2. **Taxation:** - As informed to us, the organization is registered u/s 12aa of income Tax Act, 1961 and exempt from income tax as per the provision of the act.
3. **Project Balance:** - The opening balance of units, balance outstanding under various projects and inter unit balances are subject to confirmation and reconciliation.
4. **Pension Fund:** - The amount recoverable from controller has been arrived on the basis of data produced by the units after reconciliation of the same with the books of the controller pension cell.
5. An amount of Rs. 12,168.00 has been adjusted from the head deputation & other against Misc. recoveries.
6. The following Accounts though existing in earlier year have been made part of and incorporated in the books of ICFRE during the current year.

AD, FRI (PROJECT)	
Rest House Scientific	8,27,426.00 (Six Entry)
VAN VIGYAN BHAWAN (NEW DELHI)	
Service Charges	19,72,520.00
	15,69,437.00
H.F.R.I, SHIMLA -	
Rest House	57,826.00
Nursery	3,00,106.00
EMDAC	4,18,801.00
HOFD	25,558.00

7. The heads of current assets and current liabilities is subject to third party confirmation and reconciliation.
8. The advances given to external agencies such as KV is treated as expenditure in the year of advance itself irrespective of non-receipt of utilization certificate. It has been informed to us that generally UCs are received in the next financial year.
9. Format of financial statement (non - profit organization) is forwarded to us.





G.K. PATET & CO.

CHARTERED ACCOUNTANTS

- (a) Corresponding figures for the previous year have been regrouped in the new format of Financial Statement for the Central Autonomous Bodies. Figures have been regrouped / rounded off / adjusted.
- (b) To adhere for the format the previous year closing balances of capital fund and general fund are merged and shown under corpus / capital fund.
- (c) GPF, Pension and CSLIS accounts are separated and annexed at schedule 24 as stated by the management.
10. During the year the system of recognizing interest on accrual basis in advances to staff has been done for five institutes of the Council as informed to us.
11. The entries on accrual basis have been incorporated in the financial statements at Head Office Level by the management during consolidation of account and we have relied on them.
12. The grant is recognized in the books of receipt basis. The grant received by the organization has been accounted for in following manners during the year -
- The grant under plan (GC-General), Non-Plan (GC-General), (KV) & Plan North East (GC) General amounting to total of Rs. 106.50 crores is routed through Income & Expenditure A/c.
 - The grant received as contribution towards capital / corpus totaling Rs. 8 crores (Plan & North East) is directly transferred to Corpus A/c in balance sheet.
 - The grant received as one time special grant during the year of Rs. 13.80 crores has been shown as one time special grant under Earmarked/Endowment fund in the balance sheet.
13. During the previous year 2010-11 amount of Rs. 81,94,356 and 4,13,262.85 booked as expenditure have been received back by the organization in Financial Year 2011-12 Due to which the grant in aid has been increased by Rs. 86,07,618.85 during the year.
14. Schedule 1 to 26 are annexed to and form an integral part of the balance sheet as at 31st March 2012 and the income & expenditure Account for the year ended on that date.

Dr. V.K. BAHUGUNA, (Director General, ICFRE)

Dr. S.P. SINGH, (Dy. Director General, Admin., ICFRE)

PRAMOD PANT, (Asstt. Director General Admin., (ICFRE)

V.R. SRINIVASAN, (Fin. Adviser & Chief Accounts Officer, ICFRE)

VIJAY DHASMANA (Section Officer, Budget, ICFRE)

FOR G.K.PATET & CO.
CHARTERED ACCOUNTANTS



(G.K. Patet) Partner
Chartered Accountant
Membership No. 015736

DATED : 18.09.2012

PLACE : DEHRADUN

Annexure



Annexure - I

Members of Board of Governors as on 31st March 2012

Shri T. Chatterjee

Secretary to the Govt. of India and
Chairman, BOG of the ICFRE,
Ministry of Environment and Forests,
Paryavaran Bhawan, CGO Complex,
Lodi Road, New Delhi. 110 003.

Dr. P.J. Dilip Kumar,

Director General of Forests and
Special Secretary to the Govt. of India,
Vice Chairman, BOG of the ICFRE,
Ministry of Environment and Forests,
Paryavaran Bhawan, CGO Complex,
Lodi Road, New Delhi. 110 003.

The Director General,

Indian Council of Forestry Research and Education,
Dehra Dun

**The Additional Secretary and Financial
Advisor,**

Ministry of Environment and Forests,
Paryavaran Bhawan, CGO Complex,
Lodi Road, New Delhi. 110 003.

The Director General,

Indian Council of Agricultural Research,
Krishi Bhawan,
New Delhi

The Director General,

Council for Scientific and Industrial Research,
2, Rafi Marg, Anusandhan Bhawan,
New Delhi.

The Chairman,

University Grants Commission,
Bahadur Shah Zafar Marg,
New Delhi.

The Director,

Wildlife Institute of India,
Chandrabani, Clement Town,
Dehra Dun

The Director,

Indian Institute of Forest Management,
Nehru Nagar, Bhopal (M.P.) – 462 003

The Director,

Indira Gandhi National Forest Academy,
P.O. New Forest, Dehra Dun- 248 006

The Secretary to the Govt. of India,

Department of Science and Technology,
Technology Bhawan,
New Mehrouli Road, Delhi.

The Director General,

Forest Survey of India,
Kaulagarh Road, Dehra Dun

Dr. A.K. Pathak,

Vice Chancellor,
Navsari Agriculture University,
Navsari (Gujrat) - 396 450
Fax No. 02637- 282554

Dr. S.K. Sharma,

Vice Chancellor,
C.S.K. Himachal Pradesh Krishi Vishwavidyalaya
Palampur, Kangara- 176 061.

The President,

North Indian Plywood Manufactures Associations,
Venus Plywood Pvt. Ltd.
V. Raowalim Pathankot Road,
Jalandhar- 144 004.
Fax – 0181- 290391

The Principal Chief Conservator of Forests,

Tripura forest Department,
Aranya Bhawan, Nehru Complex,
Agartala (Assam) – 797 001

The Principal Chief Conservator of Forests,

Karnataka State, 18th Cross,,
Aranya Bhawan, Malleswaram, Bangalore

The Director,

Institute of Forest Genetics and Tree Breeding,
Coimbatore

The Director,

Himalayan Forest Research Institute, Shimla

The Deputy Director General (Education),

ICFRE, Dehra Dun

Dr. Gurudev Singh, Scientist 'F',

IFGTB, Coimbatore.



Annexure - II

Right To Information

A Public Information Officer and Appellate Authority are functioning in Public Authority, ICFRE under the RTI Act 2005. A Transparency Officer is also functioning in ICFRE as mandated under the RTI Act.

During the year 2011-12 detail of RTI applications and RTI Appeals on quarterly basis is stated below.

RTI Application Request	No. of applications received as transfer from other P/Asu/s 6(3)	Received during the month (including cases transferred to other Public Authority)	Number of cases transferred to other Public Authorities u/s 6(3)	Decisions where requests /Appeals rejected	Decisions where requests /Appeals accepted
1 st Quarter	12	68	06	–	64
2 nd Quarter	20	69	10	–	57
3 rd Quarter	18	64	10	–	67
4 th Quarter	06	52	02	–	53
Total	56	253	28	–	241
			–	–	
RTI First Appeals			–		
1 st Quarter	–	03	–	–	03
2 nd Quarter	–	19	–	01	16
3 rd Quarter	–	10	–	–	09
4 th Quarter	–	–	–	–	01
Total	–	32	–	01	29



NAME AND ADDRESS OF PUBLIC INFORMATION OFFICERS AND APPELLATE AUTHORITIES UNDER THE RIGHT TO INFORMATION ACT 2005 IN ICFRE AND ITS INSTITUTES

Headquarters/Institutes	Appellate Authorities	Public Information Officers	Subject matter(s) allocated
Indian Council of Forestry Research and Education (ICFRE Hq.), P.O. New Forest Dehradun-248 006	Shri S.D. Sharma, Asstt. Director General (Stat.) Phone (O) : 0135-2224865, 0135-2752229, (R) 2102104 E-mail : sdsharma@icfre.org, adg_stat@icfre.org	Dr. Devendra Kumar, Scientist C, ICFRE Phone (O) :0135-2224835, (R) 0135-2224626 E-mail : devendra@icfre.org	All matters related to ICFRE Hqrs., Dehradun
Forest Research Institute, P.O. New Forest, Dehradun-248 006	Dr. S.S. Negi, Director Forest Research Institute P.O. New Forest Dehradun- 248006 Phone: 0135-2224444, 2755277 Fax: 0135- 2756865 E-mail: negiss@icfre.org dir_fri@icfre.org	Shri A.S. Rawat, Registrar/ Group Coordinator (Research), FRI P.O. New Forest Dehradun- 248 006 Phone : 0135-2224316, 0135-2752670, Fax: 0135-2756865 E-mail: groupco_fri@icfre.org	Establishment, Administrative & all other matters
Centre for Social Forestry and Eco-Rehabilitation (CSFER), 3/1, Lajpath Rai Road, New Katra, Allahabad-211 002	Dr. S.S. Negi, Director Phone: 0135-2224444, 2755277 Fax: 0135- 2756865 E-mail: negiss@icfre.org dir_fri@icfre.org	Shri A.S. Rawat, IFS Group Co-ordinator (Research) Phone:0135-2224316 0135-2752670 E-mail: groupco_fri@icfre.org	All matters related to CSFER, Allahabad
Institute of Forest Genetics and Tree Breeding, Forest Campus, P.B.No 1061 R.S.Puram, Coimbatore - 641 002.	Dr. N. Krishnakumar, Director, IFGTB, Coimbatore, Phone: 0422-2484100 Fax. 0422-2430549 E-mail: dir_ifgtb@icfre.org	Shri T.P. Raghunath, Group Coordinator (Res.), IFGTB, Coimbatore Phone: 0422-2431540 (O)	All subjects related to this Institute
Institute of Wood Science & Technology, PO Malleswarum, Forest Research Lab. Bangalore – 560003, Karnataka	Shri S.C. Joshi, Director, IWST Bangalore Phone : 080-23341731, 080-23345965 (R) E-mail: dir_iwst@icfre.org	Dr. B.N. Mohanty, Group Coordinator (Res.), IWST Bangalore, Phone: 080-23340115 (O) 080-22190104	All matters related to IWST, Bangalore and FRC, Hyderabad
Head, Forest Research Centre Dulapally, Hakimpet (P.O.) Hyderabad-500 014	Shri. S.C. Joshi, Director, IWST Bangalore, Ph : 080-23341731, 23345965 (R)	Dr. G.R.S. Reddy, Scientist-E Phone: 040-23095921	All matters related to FRC, Hyderabad



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Tropical Forest Research Institute, Jabalpur P.O. – R.F.R.C, Mandla Road, Jabalpur – 482 021 (M.P)	Dr. U. Prakasham, Director TFRI, Jabalpur RFRC Mandla Road, Jabalpur. Phone : 0761-4044002, 2840483 (O) Fax: 0761-4044002, 2840484 E-mail: dir_tfri@icfre.org	Dr. Rupnarayan Sett, Scientist-D TFRI Jabalpur. Phone: 0761-5044003 (O)	All matters related to TFRI, Jabalpur
Centre for Forestry Research and Human Resources Development (CFRHRD), P.O. Kundalikala, Poama, Chhindwara (M.P.) - 480001	Dr. U. Prakasham, Director TFRI, Jabalpur RFRC Mandla Road, Jabalpur Phone : 0761-4044002, 2840483 (O) Fax: 0761-4044002, 2840484 E-mail: dir_tfri@icfre.org	Dr. Rupnarayan Sett, Scientist-D TFRI Jabalpur. Phone: 0761-5044003 (O)	All matters related to CFRHRD, Chhindwara
Rain Forest Research Institute Post Box No. 136, Deovan, Sotai, A.T. Road, Jorhat- 785 001(Assam)	Dr. N.K. Vasu Director, RFRI Jorhat. Phone: 0376-2350273(O) Fax. 0376-2350274 E-mail: dir_rfri@icfre.org	Shri Gautam Bannerjee, DCF, RFRI, Jorhat Phone: 0376-2350272 (O)	All matters related to RFRI, Jorhat
Advanced Research Centre for Bamboo and Rattans (ARCBR), P.O. Box 171, Kulikawn Aizwal-796001 (Mizoram)	Dr. N.K. Vasu Director, RFRI Jorhat Phone: 0376-2350273 (O) Fax: 0376-2350273 e-mail: dir_rfri@icfre.org	Shri Gautam Banerjee, DCF Public Information Officer (PIO) Phone: 0376-2350272 (o) Fax: 0376-2350274	All matters related to ARCBR, Aizwal
Arid Forest Research Institute, P.O. Krishi Upaz Mandi, New Pali Road, Jodhpur, 342005	Dr. T.S. Rathore, Director, AFRI Jodhpur Phone: 0291-2722764 , 0291-2742549 Fax. 0291-2722764 E-mail: dir_afri@icfre.org	Shri M.R. Baloch, Head Agroforestry & Extn. and Silviculture Div. AFRI Jodhpur. Phone: 0291-2727271 Fax: 0291-2722764	All matters related to AFRI, Jodhpur
Himalayan Forest Research Institute, Conifer Campus, Panthaghati, Shimla – 171 009 (Himachal Pradesh)	Dr. V.R.R. Singh, Director, HFRI, Shimla Phone : 0177-2626778 (O), 0177-2624392 (R) Fax : 0177-2626779 E-mail: dir_hfri@icfre.org	Dr. K.S. Kapoor, Coordinator (Res.), & Head, Division of Ecology & Biodiversity Conservation HFRI Shimla -171 009 Phone: 0177-2626801(O) Fax. 0177-2626779 E-mail: kapoorks@icfre.org	All matters pertaining to HFRI, Shimla
Institute of Forest Productivity Aranvodaya, Gumla, N.H.-23, P.O. Lalgutwa Ranchi-835 303 (Jharkhand)	Shri Rameshwar Das, Director, IFP Ranchi, Ph-0651-2548505(O) E-mail: dir_ifp@icfre.org	Group Coordinator (Res.) IFP Ranchi, Phone: 0651-3296974 (O), Fax- 0651 – 2546044 E-mail: dasr@icfre.org	All matters related to IFP, Ranchi



Annexure-III

Email and Postal addresses of ICFRE and its Institutes

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bahugunaifs@yahoo.com
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Deputy Director General (Administration)

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Deputy Director General (Research)

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Director (Project and International Cooperation)

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Secretary, ICFRE

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**Assistant Director General
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**Assistant Director General
(Media and Publication)**

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PD (SLEM)

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**Director
Forest Research Institute, Dehradun**

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**Director
Institute of Forest Genetics and Tree
Breeding, Coimbatore**

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**Director
Tropical Forest Research Institute,
Jabalpur**

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Fax : 0761 - 4044002, 2840484



Director

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Director

Arid Forest Research Institute, Jodhpur

P.O. Krishi Upaz Mandi,
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Fax: 0291-2722764

Director,

Himalayan Forest Research Institute, Shimla

Conifer Campus, Panthaghati,
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E-mail: dir_hfri@icfre.org
Phone: 0177-2626778, 2626801
Fax: 0177-2626779

Director

Institute of Forest Productivity, Ranchi

Aranvodaya,
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Director

**Centre for Forestry Research and Human Resources
Development (CFRHRD)**

P.O. Kundalikala, Poama,
Chhindwara (M.P.)-480001

Director

**Centre for Social Forestry and Eco
Rehabilitation (CSFER)**

3/1, Lajpath Rai Road, New Katra,
Allahabad-211 002

Director

Forest Research Centre (FRC),

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Phone: 040-23194188, 23095921
Fax: 040-23095926

Director

**Advanced Research Centre for Bamboo
and Rattans (ARCBR)**

P.O. Box 171,
Kulikawn Aizwal-796001
(Mizoram)
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Annual Report 2011-12



CITIZEN CHARTER

Indian Council of Forestry Research and Education

(An Autonomous Body of Ministry of Environment and Forests, Govt. of India)

P.O. New Forest

Dehradun

Website: www.icfre.gov.in

As on 31st March 2012



Annual Report 2011-12



डॉ० वी०के० बहुगुणा, भा.व.से.

महानिदेशक, भा.वा.अ.शि.प.

एवं कुलाधिपति, व.अ.सं. विश्वविद्यालय

Dr. V.K. Bahuguna, IFS
Director General, ICFRE
and Chancellor, FRI University

पर्यावरण एवं वन मंत्रालय, भारत सरकार
भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद्

(आईएसओ 9001:2000 प्रमाणित संस्था)

पो.ऑ. न्यू फॉरेस्ट, देहरादून-248 006 (उत्तराखण्ड)

Ministry of Environment and Forests,
Government of India

Indian Council of Forestry Research and Education


(An ISO 9001:2000 Certified Organisation)

P.O. New Forest, Dehra Dun - 248 006 (Uttarakhand)

Foreword

It gives me great pleasure to present Citizen Charter to all our stakeholders. Preparation of this Charter is a sincere endeavour by us towards fulfilling our commitment of providing an efficient, useful and responsive forestry research input. The success of this Charter will depend greatly on the proactive response that it receives from the stakeholders for deriving the assured level of success.

We need and look forward to your co-operation for success of our efforts.


(Dr. V. K. Bahuguna)
Director General,
ICFRE.

दूरभाष/Phone : 0135-2759382 (O)
PABX : 0135-2224855/2224333(O)
: 0135-2754748 (Res.)
: 0135-2224509 (Res.)

ई-मेल/e-mail : bahugunaifs@gmail.com
: bahugunaifs@yahoo.com
: dg@icfre.org
फैक्स/Fax : 0135-2755353



Introduction

Indian Council of Forestry Research and Education (ICFRE), an apex body in the national forestry research system, has been undertaking the holistic development of forestry research through need based planning, promoting, conducting and coordinating research, education and extension covering all aspects of forestry. The Council deals with the solution based forestry research in tune with the emerging issues in the sector, including global concerns such as climate change, conservation of biological diversity, combating desertification and sustainable management and development of resources. Topical research by the Council enhances public confidence in the ability of forest managers and researchers to successfully handle challenges related to natural resource management. The ICFRE is an ISO 9001:2000 certified organization.

Vision

To generate, preserve, disseminate and advance knowledge, technologies and solutions for addressing the issues related to forests and promote linkages arising out of interactions between people, forests and environment on a sustained basis through research, education and extension.

Mission

1. Updating, developing and providing knowledge, skill, technology and experiences to support development in forestry sector in accordance with priorities of National Forestry Research Plan (NFRP) and National Forest Policy for sustainable forest development.
2. ICFRE as model organization to undertake, coordinate, promote and aid forestry research, extension and education.
3. Developing packages of technology and practices according to the needs of different stakeholders so as to contribute towards sustainability and promote these technologies through aggressive marketing.
4. Focusing research efforts on priorities as identified in NFRP and attaining global leadership in few emerging strategic areas.
5. Optimizing the use of research resources e.g. financial, human and infrastructure through establishing and nurturing symbiotic networking with ICFRE providing a core of such network at national and regional level.

Objectives

1. To undertake, aid, promote and co-ordinate forestry research, education and its application.
2. To extend the research findings from lab to land.
3. To develop & maintain a National Forest Library & Information Centre.
4. To provide consultancy services in the field of forestry research, education and training, and in allied sciences.

Function

1. To undertake, aid, promote and coordinate forestry education, research and applications thereof.
2. To develop and maintain a National Library and Information Centre for forestry and allied sciences.
3. To act as a clearing-house for research and general information related to forests and wildlife.
4. To develop forestry extension programmes and propagate the same through mass media, audiovisual aids and extension machinery.
5. To provide consultancy services in the field of forestry research, education and allied sciences.
6. To undertake other jobs considered necessary to attain these objective.

Services

1. Planting stock improvement programme of different species.
2. Conservation of natural forests and bio-diversity and eco-restoration of ecologically fragile and disturbed areas.



3. Development and extension of Social forestry/Agro-forestry models.
4. Utilization of non-conventional woods and weeds for manufacture of forest products.
5. Developing the technology for reclamation of wastelands.
6. Geological, geomorphological and micro-morphological studies on skeletal and sodic soils.
7. Development of technology for eco-friendly preservatives.
8. Technology development and research on forest based livelihood.

Service Standards			
S.No.	Services	Responsible Person	Process
1.	<p>Directorate of Administration Management of Information Technology (IT) & e-Governance in Indian Council of Forestry Research and Education (ICFRE).</p> <p>Operation of Pension cell, Procurement cell, Estate management, Budget management and Drawing and Disbursement Office</p>	<p>Shri Pramod Pant, IFS Deputy Director General Administration E mail: ddg_admin@icfre.org Phone No: 0135-2758295</p>	<ul style="list-style-type: none"> ● Provide IT services through the framework of help desk to the ICFRE (Hq) & Institutes telephonically and email. ● e-Governance services through Intra Net Portal for Research Information System (RIS), Employee Self Service Portal (ESS), Financial Accounting System (FAS) etc. ● Provide feedback system through freely accessible ICFRE Website. ● Receive proposals for providing pensionary benefits, their processing and final disbursement. ● Procurement of stores, IT consumables, Annual Maintenance contracts etc. ● Receipt of budget requirement from ICFRE Institutes. ● Allocation of budget for undertaking forestry research, education and extension activities of the Council. ● Receive bills of employees for various claims and process them for payment.
2.	<p>Directorate of Research Coordinating stakeholders and Research Advisory Group (RAG) meetings of the Institutes and Coordinating & conducting Research Policy Committee (RPC) meeting</p> <p>Research Planning, processing and formulation of new research projects including the review/monitoring of the ongoing research projects in commensurate with rolling research plans of all the institutes of ICFRE</p>	<p>Shri. Sandeep Tripathi Deputy Director General (Research) E mail: ddg_res@icfre.org Phone No: 0135-2755277</p>	<ul style="list-style-type: none"> ● Receive research proposals for inclusion in Research Advisory Group (RAG) meetings ● Preparation of calendar of RAG Meetings of the Institutes ● Prioritization of research proposals in RAG meetings. ● Approval of research projects in Research Policy Committee (RPC) Meeting. ● Budget allocation of finally approved projects. ● Follow up action for new Research Projects ● Monitoring of research projects by the council & also by External Experts ● Quinquennial review of research activities. ● Review of ongoing projects in the RPC meeting under Five year research rolling Plan for change request, if any. ● Review comments and modifications ongoing Research Projects are communicated to the Director of the institute for compliance. Modification or midterm corrections are taken to RAG and then to RPC. ● Scrutiny of Project Completion Reports



S.No.	Services	Responsible Person	Process
3.	<p>Directorate of Education To provide financial support in the form of Grant-in-Aid to universities for strengthening the infrastructural facilities; enhancing teaching and research facilities to provide forestry education in the country. To accreditate the universities providing forestry education</p> <p>To conduct training for Scientific Cadre, Managerial Cadre & Technical Cadre under Human Resource Development plan (HRD).</p> <p>To review and analyze the existing forest policies, statutes and their framework.</p> <p>To look into the grievances of SC/ST/OBC employees</p>	<p>Shri Omkar Singh, IFS Deputy Director General (Education)</p> <p>Email:omkar@icfre.org; ddg_edu@icfre.org Phone No:0135-2758571</p>	<ul style="list-style-type: none">● Inviting proposals for Grant-in- Aid to the Universities, scrutiny and sanction of grants through the process of accreditation committee meetings.● Obtaining utilization certificates for the grants released to the universities, scrutiny and acceptance of UCs.● Monitoring the utilization of grants released to the universities.● Process proposals of Domestic and International travel of the Scientists/officers for approval of competent authority/MoEF attending Training/ Seminar/ Workshop from Institutes/ICFRE.● Accreditation proposal in the standard format received from the Universities and peer review process of the universities.● Accreditation of forestry courses and issue of accreditation certificate on the recommendations of the accreditation Board of ICFRE and approval of Director General, as per Accreditation Guidelines.● Implement HRD plan, based on the budget allotted, by inviting nominations and finalizing training institutions for training the Scientific/ Managerial/Technical cadre of the Council.● ICFRE hosts the Policy Research Committee of MoEF to provide policy research inputs based on the suggestions of the committee by conducting Policy Research study on the suggested topics and follow up.● Functional Grievance Redressal Cell for SC, STs and OBCs in ICFRE headquarter.
4.	<p>Directorate of Extension Development and dissemination of forestry extension programmes</p> <p>Provide consultancy/technical services in the field of forestry, environment and allied sciences.</p> <p>Collection, validation and dissemination of statistics pertaining to the forestry sector of India.</p> <p>Implementation of Rajbhasha in the Council.</p> <p>Coordination of SLEM-TFO</p>	<p>Shri Saibal Dasgupta, IFS Deputy Director General Extension</p> <p>Email: ddg_extn@icfre.org Phone No: 0135-2750693</p>	<ul style="list-style-type: none">● Development of extension strategy.● Compilation and editing of information for preparing Annual Report/ Timber Bamboo Trade Bulletin/ Forestry Statistics/ Half Yearly Newsletters/ Taruchintan and their regular publication.● Transfer of technologies through Van Vigyan Kendra and Demo villages.● Providing consultancies on environment and forestry sector● Including EIA/EM studies on Hydropower, mining, infrastructure etc. and preparation of R&R Plan.● Activities for implementation of Rajbhasha including organizing meetings and training workshops, Compilation and preparation of Tri-monthly Progress Report etc.● Activities pertaining to SLEM-TFO including organizing workshops and publication of Newsletter and other important documents.



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S.No.	Services	Responsible Person	Process
5.	<p>Director, (Projects & International Cooperation)</p> <p>Act as a facilitator between the ICFRE Institutes and potential national and international donor agencies for formulation of research projects in the identified thrust areas for funding.</p>	<p>Dr. N.S. Bisht, IFS Director Projects & International Cooperation</p> <p>Email: dir_res@icfre.org Phone No: 0135-2756497</p>	<ul style="list-style-type: none">● Receipt of research projects/All India Coordinated Projects (AICPs) proposals from ICFRE Institutes; its scrutiny, finalization and processing for necessary approval and external funding.● Signing of Memorandum of Understanding (MoUs)/ Agreements of collaborative projects and execution by ICFRE Institutes.
6.	<p>Chief Vigilance Officer</p> <p>Coordinating Vigilance activities in ICFRE and its Institutes.</p> <p>Increasing transparency, accountability and reducing discretion.</p>	<p>Shri Sandeep Tripathi, IFS Chief Vigilance Officer</p> <p>Email:sandeeptrip@icfre.org; dir_res@icfre.org Phone No: 0135-2756497</p>	<ul style="list-style-type: none">● Identification of activities vulnerable to corruption and building up suitable preventive and vigilance mechanism.● Causing enquiry in major instances of loss caused to the exchequer by officials by their acts of omission or commission and erring officers to sternly deal with.
7.	<p>Secretary, ICFRE</p> <p>General administration and personnel management of ICFRE.</p> <p>Representation of Society in all legal suits or proceedings</p>	<p>Dr. Sudhanshu Gupta, IFS Secretary, ICFRE</p> <p>Email:sudhanshu@icfre.org; sec@icfre.org Phone No: 0135-2758614</p>	<ul style="list-style-type: none">● Establishment and personal matters of Employees.● Conduct of Board of Governors (BOG) and Society meetings.● Issue advertisements relating to vacant posts.● Receipt of proposals, processing of information regarding personnel management of Scientists/ Officers of ICFREtimeframe.
8.	<p>Biodiversity & Climate Change Division</p> <p>Undertake scientific programme on forests, biodiversity and climate change and capacity building.</p>	<p>Dr. Renu Singh, IFS Head Biodiversity & Climate Change Division</p> <p>Email:renusingh@icfre.org; head_bcc@icfre.org Phone No: 0135-2750296</p>	<ul style="list-style-type: none">● Develop synergies between ICFRE headquarters and its regional research institutes to enhance technical knowledge in the field of forests and climate change.● Proposals for organizing training/workshop on climate change, biodiversity and forest are received from the MoEF, ICFRE and other organizations.● Training programme prepared as per requirement and organize the same for the scientists/ officers of the Council and other organizations.



S.No.	Services	Responsible Person	Process
9.	Recruitment Board To carry out recruitment to the Group 'A' and 'B' Scientific and Administrative posts in ICFRE	Shri R.K. Dogra, IFS Assistant Director General (Recruitment Board) Email: adg_rb@icfre.org Phone No. 0135-2755399	<ul style="list-style-type: none"> ● Receipt of applications from the candidates after issuance of advertisement for recruitment to various posts. ● Scrutinize the received applications and issue of call letters to eligible candidates. ● Conduct of written examination and interview. ● Declaration of final results.
10.	Public Information Officer Supply of information under the Right To Information Act, 2005 to the citizens.	Dr. Devendra Kumar, Public Information Officer Scientist E, Statistics Division, Phone (O) : 0135-2751270, Appellate Authority Shri S.D. Sharma, IFS Assistant Director General Statistics Phone (O) :0135-2752229, E-mail : sdsharma@icfre.org, adg_stat@icfre.org	<ul style="list-style-type: none"> ● Provide information on receipt of the request in a time bound period regarding matters related to Indian Council of Forestry Research and Education (ICFRE) Headquarter, Dehra Dun.

Employee's Grievances Redressal Cell

(a) Forest Scientist Association Shri Sudhir Kumar President, Forest Scientist Association, Scientist-F, Directorate of Extension, ICFRE Phone No. 0135-2751859	(b) Technical Staff Association Shri A.K. Gazwal President, Technical Staff Association, RA-I, Wood Preservation Discipline, Forest Products Division, FRI Phone No: 0135-2224429
(c) Ministerial Staff Association Shri Sanjeev Khugshal President, Ministerial Staff Association, Head Clerk, Budget section, ICFRE Phone No: 0135-2224874	(d) SC/ST/OBC Employees Welfare Association Dr. Anup Chandra President, SC/ST/OBC Employees Welfare Association, Scientist-C, Botany Division, Forest Research Institute Phone No: 0135-222 4489

Grievances Redressal Mechanism

Grievance redressal cell has been constituted in Indian Council of Forestry Research and Education (ICFRE) (Hq) to redress the grievances of SC/ST/OBC employee working in ICFRE (Hqr). In order to redress their grievances, quarterly meeting is held at ICFRE (Hq). Sh Omkar Singh, Dy. Director General (Education), ICFRE (Tel: 0135-2758571) is the Chief Liaison Officer of ICFRE (Hqrs.). The other members of

Grievances Redressal Cell are Shri Sudhir Kumar, Liaison Officer for Scheduled Caste, Shri B.D. Joshi, Liaison officer for Scheduled Tribe and Shri Senthil Kumar, Liaison officer for Other Backward Class.

There is also a mechanism to receive and attend to the grievances of the citizens. Such grievances can be addressed to the Secretary, ICFRE, Post Office, New Forest, Dehradun-248006.



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Tel No: 0135-2758614
Fax: 0135-2750298

A suggestion box has also been placed in the premises of ICFRE (Hq) for giving suggestions by the Citizen.

Tel No: 0135-2758614
Fax: 0135-2750298

Escalation of Grievance: In case the common grievances are not attended to or the remedy offered is not satisfactory, the appeal can be addressed to the Director General, ICFRE, Post Office, New Forest, Dehradun-248006.

Tel No: 0135-2759382
Fax: 0135-2755353

List of Stakeholders

S. No.	Stakeholders
1.	General public at large
2.	State Forest Departments
3.	NGOs, Industries, Villagers, Farmers, Students
4.	Universities and other Academic Institutions imparting forestry education
5.	All Central Ministries/ Departments
6.	All Officers of All India Services
7.	All Central And State Government Employees

Institutes Under ICFRE

S.No.	Research Institutes	Address	Telephone No.	Email
1.	Forest Research Institute (FRI) Dehradun	PO. New Forest, Dehradun (Uttarakhand)	0135-2755277	dir_fri@icfre.org
2.	Arid Forest Research Institute (AFRI) Jodhpur	P.O. Krishi Upaz Mandi New Pali Road, Jodhpur – 342005 (Rajasthan)	0291-2722549	dir_afri@icfre.org
3.	Tropical Forest Research Institute (TFRI), Jabalpur	P.O. R.F.R.C., Mandla Road, Jabalpur (MP) - 482 021	0761- 2840483	dir_tfri@yahoo.co.in
4.	Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore	P.B. No. 1061, R.S. Puram P.O., Coimbatore-641002 (Tamil Nadu)	0422 - 2431942	dir_ifgtb@icfre.org
5.	Himalayan Forest Research Institute (HFRI), Shimla	Conifer Campus, Panthaghati, Shimla - 171 009. (HP)	0177-2626778	dir_hfri@icfre.org



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S.No.	Research Institutes	Address	Telephone No.	Email
6.	Rain Forest Research Institute (RFRI), Jorhat	P. Box No. 136, Deovan, Sotai, Jorhat-785001 (Assam)	0376-2350273	director.rfri@gmail.com
7.	Institute of Forest Productivity (IFP), Ranchi	Aranyodya, Ranchi-Gumla, NH 23 P.O. Lalgutwa, Ranchi-835303, (Jharkhand)	0651-2948505	dir_ifp@icfre.org
8.	Institute of Wood Science & Technology (IWST), Bangalore	18th Cross, P.O. Malleswaram Bangaluru- 560 003 (Karnataka)	080 - 23341731	dir_iwst@icfre.org

Research Centres Under ICFRE

S.No.	Research Centre	Address	Telephone No.	Email
1.	Center for Social Forestry & Eco-Rehabilitation, Allahabad	Head, Centre for Social Forestry and Eco-Rehabilitation, 311-Lajpat Rai Road Allahabad-211 001 (Uttar Pradesh)	0532-2440795	chandrav@icfre.org csferald@yahoo.com head_csfer@icfre.org accounts_csfer@icfre.org
2.	Forest Research Centre, Hyderabad	18th Cross, P.O. Malleswaram Bangaluru- 560 003 (Karnataka)	040-23095921	mlrao@icfre.org head_frc@icfre.org accounts_frc@icfre.org
3.	Forestry Research & Human Resource Development Centre, Chhindwara	Head, Centre for Forestry Research & Human Resource Development, Poama, Post. Kendalikala, Poama Depot, Parasia Road, Chhindwara Pin -480001, (Madhya Pradesh)	07162-254463	dir_cfrhrd@rediffmail.com head_cfrhrd@icfre.org accounts_cfrhrd@icfre.org
4.	Advanced Research Centre for Bamboo and Rattan, Aizwal, Mizoram	Incharge, Advanced Research Centre for Bamboo & Rattan, Kulikawn, P.O. No. 171, Aizawl-796001 (Mizoram)	0389-2301157	imtienla@icfre.org



Conclusion

As part of the Performance Monitoring and Evaluation System (PMES) for Government Departments, ICFRE has formulated the Citizen Charter for the Council. Constant feedback/ suggestions from the recipients/ stakeholders regarding services delivered are most welcome as this would enable us to improve the service delivery mechanism and make us more responsive to your needs.

Feedback/suggestions on the Charter can be sent to–

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Secretary, ICFRE
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Tel. No.0135- 2758614
Email: sec@icfre.org

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List of Abbreviations

Annexure - V

ACA	-	Ammonical Copper Arsenic
ADG	-	Assistant Director General
AWTC	-	Advanced Wood Working Training Centre
BAU	-	Birsa Agricultural University
BGT Div.	-	Biotechnology, Genetics & Tree Improvement Division
BSI	-	Botanical Survey of India
CBNRM	-	Community Based Natural Resource Management
CCA	-	Copper Chrome Arsenic
CCB	-	Copper Chrome Boron
CCF-II	-	Country Cooperation Framework –II
CF	-	Conservator of Forests
CPT	-	Candidate Plus Tree
CSIR	-	Council for Scientific and Industrial Research
CSO	-	Clonal Seed Orchard
CTIS	-	Commercial Timber Information System
CTPS	-	Chanderpura Thermal Power Station
DBT	-	Department of Biotechnology
DDG	-	Deputy Director General
DFID	-	Department for International Development
DG	-	Director General
DNA	-	Deoxyribo Nucleic Acid
DVC	-	Damodar Valley Corporation
E-mail	-	Electronic mail
EBC Div.	-	Ecology & Biodiversity Conservation Division
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
ERS	-	Environmental Research Station
ETP	-	Entire Trans planting



EWI	-	Earth Watch Institute
FDA	-	Forest Development Agencies
FMS Div.	-	Forest Management & Silviculture Division
FRC	-	Forest Research Centre
FRI	-	Forest Research Institute
FRO	-	Forest Range Officer
FS	-	Fibre strength
FSI	-	Forest Survey of India
FTA	-	Forestry Training Academy
FT-IR	-	Fourier Transform Infrared
FYM	-	Farm Yard Manure
GC/MS	-	Gas Chromatography Mass spectrometry
GLC	-	Gas liquid chromatograph
GoI	-	Government of India
GPR	-	Guaiacol peroxidase reagent (GPR)
GPS	-	Global Positioning System
GUI	-	Graphical User Interface
HARP	-	Horticultural & Agro forestry Research Programme
HPLC	-	High power liquid chromatograph
HRD	-	Human Resource Development
ICFRE	-	Indian Council of Forestry Research & Education
IDRC	-	International Development Research Centre
IFGTB	-	Institute of Forest Genetics & Tree Breeding
IFP	-	Institute of Forest Productivity
IFRIS	-	Indian Forestry Research Information System
IINRG	-	Indian Institute of Natural Resins and Gums
ILRI	-	Indian Lac Research Institute
ISM	-	Indian School of Mines
IT	-	Information Technology
ITTO	-	International Tropical Timber Organization



IWST	-	Institute of Wood Science and Technology
JFMC	-	Joint Forest Management Committee
JRF	-	Junior Research Fellow
JSFDCL	-	Jharkhand State Forest Development Corporation Ltd.
LAN	-	Local Area Network
MC	-	Moisture content
MoEF	-	Ministry of Environment & Forests
MOU	-	Memorandum of Understanding
MTE	-	Mid Term Evaluation
MW	-	Microwave
NABARD	-	National Bank Agriculture & Rural Development
NAP	-	National Afforestation Programme
NBM	-	National Bamboo Mission
NGO	-	Non Government Organization
NMBA	-	National Mission of Bamboo Application
NMPB	-	National Medicinal Plant Board
NTFP	-	Non Timber Forest Produce
NWFP	-	Non Wood Forest Products
PEG	-	Poly Ethylene Glycol
PF	-	Project Formulation
QPM	-	Quality Planting Material
RAPD	-	Random Amplified Polymorphic DNA
RBD	-	Randomized Block Design
RPC	-	Research Policy Committee
RS	-	Remote Sensing
RT	-	Room Temperature
SASVPESY	-	Samudai Adharit Samanvit Van Pravardhan Evam Sanrakshan Yojna
SEPC	-	Shellac Export Promotion Committee
SFD	-	State Forest Department
SLR Div.	-	Soil & Land Reclamation Division



SPA	-	Seed Production Areas
TBO	-	Tree Borne Oilseed
TC	-	Tissue Culture
TEM	-	Transmission Electron Microscopy
TFT	-	Thin Film Transistor
TLC	-	Thin-layer chromatograph
UNDP	-	United Nation Development Programme
UV IR	-	Ultra violet infrared
VMG	-	Vegetative Multiplication Garden
VPC	-	Vegetative Propagation Centre
VPN	-	Virtual Private Network
WB	-	West Bengal