Annual Report 2010-2011

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun
Uttarakhand, India

ANNUAL REPORT

2010-11

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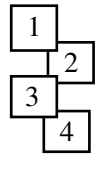
Published by:
Media and Publication Division
Directorate of Extension
Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun- 248 006 (Uttarakhand), India

Print at :
New Art Press, Dehradun

Front Cover:

1. *Malaxis Muscifera*
2. *Dactylorhiza hatagirea*
3. Bamboo Shoots
4. Bamboo Product (Bari)



Back Cover: Teak Based Agroforestry
Inset : Field Level Biopesticidal Applications

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(पर्यावरण एवं वन मंत्रालय, भारत सरकार की एक स्वायत संस्था)
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(An autonomous body of Ministry of Environment and Forests, Government of India)
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FOREWORD

Indian Council of Forestry Research & Education (ICFRE) is the premier forestry research organization undertaking programmes aimed at a holistic development of forestry research, education and extension for sustainable management and development of forestry resources in the country. The various activities of the Council focus on various synergistically linked domains that reflect the cross-sectoral nature of forest management.

I am delighted to present this Annual Report before our forestry sector organizations, other partners, stakeholders, and people at large. The year 2010-11 has been demanding and exciting with a number of new developments. Considering the domain expertise available with the officers and scientists, ICFRE has been awarded the status of Designated Operational Entity (DOE) by United Nations Framework Convention on Climate Change (UNFCCC) for validation, verification and certification functions of Afforestation and Reforestation projects under Clean Development Mechanism (CDM).

The Council, in pursuance of its regular plan programme, approved 168 new projects including 32 externally aided projects to cater to the need of various target groups. During the year, 130 projects were completed including 40 externally aided ones. Clones of eucalypts and casuarinas developed by the Council were released to the field aiming at enhancing farmers' income especially through their agroforestry practices. The Council undertook a wide range of consultancy works also right from conservation of heritage sites to conducting environmental impact assessment for various developmental projects.

Technologies and protocols developed in the fields of silviculture, biotechnology, agroforestry, tree improvement, wood technology, forest products, and environmental management practices by the Council were extended to various user agencies through training courses, workshops and awareness programmes including the activities of Van Vigyan Kendras and Demo Villages. Further, for better outreach of the research findings, the Council evolved Extension Strategies in Forestry Research 2010.

Countrywide, forestry education is promoted by providing Grants-in-Aid to various universities/ institutions imparting forestry education with a view to strengthening their infrastructure to augment teaching and research capabilities. Towards this end, ICFRE released financial support to the tune of ¡ 204.00 lakh to 10 universities during the year.

In order to meet the new emerging challenges in the field of forest management, ICFRE is going to fine tune its research programme to meet the aspirations of the people.

I am sure the report will provide an insight into research, education and extension activities of the Council undertaken during the year 2010-11 and will be of immense use to the readers.

(Dr.V.K. Bahuguna)

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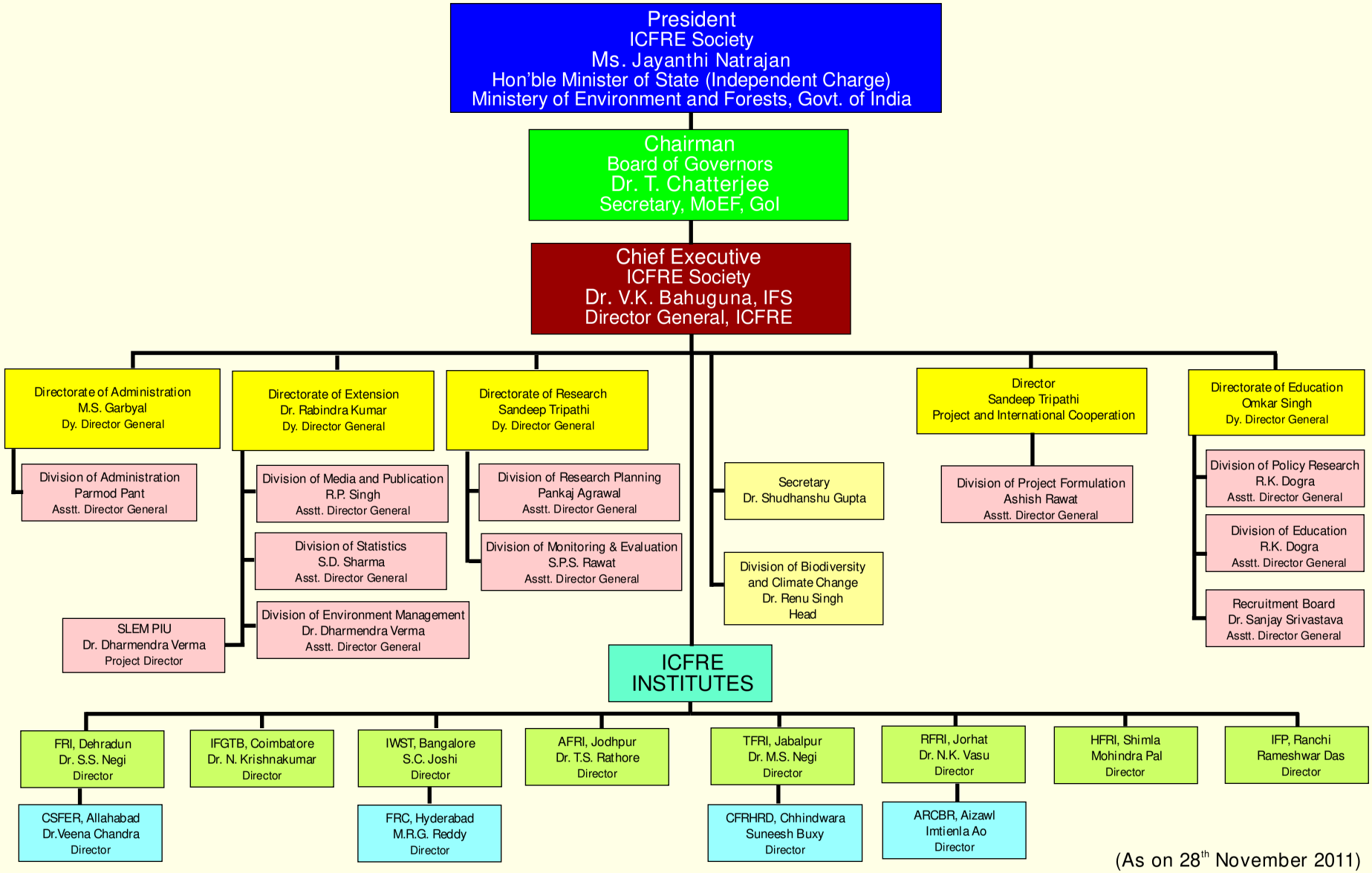
ORGANIZATIONAL STRUCTURE OF ICFRE SOCIETY



(As on 28th November 2011)

Executive Summary

Indian Council of Forestry Research & 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, combating desertification, conservation of bio-diversity and development of resources on the principles of sustainable management.

In the field of Ecosystem Conservation and Management, ICFRE has been awarded the status of Designated Operational Entity (DOE), the first ever in South Asia under the Clean Development Mechanism of the United Nations Framework Convention on Climate Change (UNFCCC) for validation and verification/ certification functions for the sectoral scope of Afforestation and Reforestation.

An Air Pollution Biomonitoring Station for Air Quality Assessment was established in Dehradun. Study on biodiversity of parasitic Chalcidoidea (Hymenoptera) of Uttarakhand was carried out. Carbon Sequestration in soil and vegetation in 254 sites of 12 districts in Rajasthan and Vegetation carbon pool in 19 forest sites under Trees Outside Forest (TOF) was assessed in 6 districts in Rajasthan. An inventory of Soil Organic Carbon of Uttarakhand was also prepared. Eco-restoration works in Uranium Mines, Jadugoda, Jharkhand were carried out.

On the conservation front, ICFRE provided consultancy to Archaeological Survey of India for conservation of trees at Ta Prohm temple at Cambodia and to Bodhgaya temple Management Committee, Bodhgaya for the maintenance of Bodhi vriksha. Case of Achanakmar - Amarkantak Biosphere Reserve was submitted to UNESCO for inclusion in World Network of Biosphere Reserve.

Ethnobotanical Data on 197 plant species were collected under Traditional Knowledge System from Savara, Khond, Jatapu, Kondadora, Nukadora, Bagatha and Porja tribes of Srikakulam, Vizianagaram and Vishakhapatnam districts of Andhra Pradesh.

Phyto-sociological studies conducted in parts of Kalatop Khajjiar Wildlife Sanctuary, Himachal Pradesh revealed the presence of 232 plants species belonging to 76 families and 218 genera which showed the presence of 100 plants species of medicinal importance, 7 of which fall in the category of threatened plants. Bambusa balcooa was identified as potential species for rehabilitation of jhum land with reference to carbon sequestration and livelihood development.

In the field of Forest Productivity, package of practices were developed for the *Dalbergia sissoo* based Agri-Silviculture system under 3 years old sissoo plantation. Two varieties of *Phyllanthus emblica* i.e. NA7 and NA10 were transplanted to establish the multi-tier Silvi-Agri-Spice system at TFRI, Jabalpur. Sustainable clump management practices for economically important bamboo species for enhanced production of quality culms and edible shoots were developed. Results of agroforestry trials revealed that *Cordia myxa* is the best horticulture species and *Prosopis cineraria* is best siliviculture species in Rajasthan. Impact of ban on green felling in deodar, kail, fir and spruce forests of Uttarakhand was also studied. Silvicultural studies of *Hippophae salicifolia* – A wonder and lesser known plant of Uttarakhand were carried out. Initiatives such as establishing field trials with preferred trees and crops along with suitable geometrical arrangements was taken for productivity enhancement in abandoned jhum land through agroforestry management and value addition in Mizoram and Meghalaya. At

RFRI, Jorahat nursery practices for production of quality planting stock of important bamboo species for North-East were developed.

Pursuing research in Genetic Improvement, twenty-one large contiguous deodar forests of Uttarakhand, Himachal Pradesh and Jammu & Kashmir were investigated for Genetic Diversity using Microsatellite (SSR) DNA markers. Artificial hybridization was done in *Eucalyptus pellita* and *E. urophylla* for production of F1 inter species hybrids and seeds collected for raising seedlings. In order to Develop DNA marker technique in *Cedrus deodara* for Timber Forensics, success achieved in isolation of DNA from the dead wood of *C.deodara*. One clone of *Eucalyptus* hybrid (*Eucalyptus camaldulensis* Dehn. X *E. tereticornis* Sm.) and one clone (resistant against wilt disease) of *Dalbergia sissoo* was identified and recommended for release by the Regional Variety Testing Committee.

Under the "Tree improvement programme", two progeny trials of *Melia dubia* and *Melia azadirach* have been established at FRC, Hyderabad and IWST, Bangalore. Early growth performance evaluation of the progenies CPT's collected from Karnataka especially from Kushalnagar, Kodagu showed their superiority. At RFRI, Micropropagation technique was standardized for clonal multiplication of *Aquilaria malaccensis* Roxb. Developed protocol for in vitro propagation of *Jatropha curcus* through somatic embryogenesis and refined protocol for micro-progpagation of *Commiphora wightii* through somatic embryogenesis and axillary shoot proliferation followed by field trial at AFRI. Identified 20 CPT's of *Prosopis cineraria* for the establishment of germplasm bank and tree improvement. Evaluated multilocational clonal trials of *Eucalyptus camaldulensis* and *Dalbergia sissoo* and identified best performing 3 clones in each species, which performed better in all four locations in Gujarat. Eleven populations of *Dalbergia sissoo* were analysed for genetic variation and it was observed that as compared to the populations of Uttarakhand, the populations of Jammu & Kashmir and Himachal Pradesh have more genetic diversity.

A demonstration plot (50 ha.) of *Dendrocalamus hamiltonii* using both tissue cultured and cutting raised plants was maintained during the year by HFRI. The survival percentage of Tissue Culture raised plants was 88% whereas the plants raised through cuttings was up to 95%. The electrophoretic data of the selected clones of *Dalbergia sissoo* were analysed for genetic variation and studies including the stress resistance, insect-pest resistance in the field were also accomplished.

In the field of Forest Management, ICFRE hosted the National Forest Rights Committee, jointly constituted by the Ministry of Environment and Forests and the Ministry of Tribal Affairs which submitted its report *"MANTHAN"* to the Hon'ble Minister of Environment & Forests, Govt. of India in January 2011. Quarantine Clearance to *'Bo Tree'* from Sri Lanka at Gaya Airport was mediated. Deodar and Kail maps of Uttarakhand state were prepared and verified by ground truthing.

The major area of research in Wood Products was successful preparation of handmade paper from noxious weed *Lantana camara*. Drying of bamboo (*D. stocksii* and *D. strictus*) using microwave at different microwave intensity and exposure times was carried out. Ash elemental analysis of four selected bamboo species was carried out. An effort was made to develop eco-friendly wood preservative using naturally available plant by–products of *Cleistanthus collinus* and *Prosopis juliflora*. The plantation grown timber of *Acacia mangium* was observed for its durability in

the graveyard test and it was found that the controlled samples (untreated) were not attacked more than 2% after 3 years of exposure whereas treated samples were all intact without any damage. A non-destructive Ultrasonic method was found to be useful to assess the service life of used structures and as a guide for reuse of the timber structures in use. Timber should be properly seasoned by following proper kiln schedule which was revealed in the shrinkage studies carried out at IWST, Bangalore. In air-seasoning, care must be taken by painting/coating both the ends of timber to avoid defects like twist, cupping, crook and splits etc.

Non Wood Forest Products (NWFP) constitute a very important component of trade in forest products. The studies were carried out for better delignification through mechanical process to improve white rot fungus strains. Technology was developed for 'Reshaping the gums' and transferred to the firms of Chhattisgarh and Madhya Pradesh. A simple and facile process was developed to isolate Hederagenin from seed kernel extract of *Sapindus mukorossii*. Hederagenin is a potential bioactive compound known for its anticancer, anti-inflammatory, antidepressant, antihyperlipidemic, antityrosinase, skin lightening, cure of nephritis and prevention and treatment of bone diseases along with a number of other biological activities.

For sericulture industry, a novel green product named as *"Samriddhi"*- a silk productivity enhancer has been developed from the weeds and tested at Regional Sericulture Research Station, Sahaspur, Dehradun on Silkworm, *Bombyx mori* L. Application of *"Samriddhi"* brings down the silk production cost in terms of feed cost (mulberry leaves), lesser mandays (labour cost), space, infrastructure and time. Natural dyes and their different shades have been developed which are capable of dyeing different type of textiles (silk, wool and cotton). At IWST, Nanoclay was compounded with polypropylene to study the effect of concentration of nanoclay, effect of coupling agent, and type of nanoclay. Specimens as per ASTM standards were prepared and mechanical properties (Tensile, flexural, compression and impact strength) were determined. Sandal oil content was determined by non destructive method by collecting core samples from standing trees from sandal bearing areas of Karnataka. Protocol was developed for cultivation of *Asparagus racemosus* (Shatawar). HFRI, Shimla identified 21 seed sources of *Jatropha curcus* from various parts of Himachal Pradesh with seed oil contents more than 30%, out of which 9 seed sources had oil content more than 35%. IFP, Ranchi has adopted ten villages in Khunti region with the community under UNDP project for establishing broodlac farms where production of lac has failed during last 5 – 6 years. Production of lac has become successful at Bari brood farm after providing (i) Lac cultivation training and demonstration (ii) Local good quality and disease free broodlac (iii) Pest control and (iv) technique demonstration from time to time to them.

On the Forest Protection front, artificial diet for conservation and utilization of praying mantis as biocontrol agents was developed. For Casuarinas, a biopesticide product, *Aegle marmelos* seed oil based biopesticide-"Vilvekam" a growth promoter formulation developed from the oil of *A.marmelos* and Nitrogen fixer *Frankia* sp. were released for the farmers at IFGTB. Biotreatment of industrial wastewaters using fungi was carried out. A new sandal seed borer *Araecerus fasciculatus* was found to cause serious damage to sandal seeds. Control of forest seed pathogenic fungi was achieved by using the leaf and bark extracts of *Prosopis juliflora* and Cleistanthus. Fifteen species of Apanteles have been recorded for the first time from Orissa, which

are promising biological control agents against defoliators of teak and sal forests. Twenty two Braconid larval parasitoids were recovered from key insect pests of forest tree species, with varied degree of field parasitisation, from Chhattisgarh and Maharashtra, which are important biological control agents of key forest insect pests. Diseases of medicinal plants, *Rauvolfia serpentina, Withania somnifera* and *Chlorophytum borivillianum* were identified from Madhya Pradesh and Chhattisgarh. The cause of culm rot and bamboo blight disease in Assam was identified as *Fusarium udum*. The most effective fungicides found *in vitro* are being tried for its management. Artificial inoculations of fungi carried out in Tezpur for inducement of agarwood in healthy agar trees resulted in formation of agarwood within a relatively shorter period. Sixteen species of insects, 2 species of mites, 3 species of parasitic nematodes and 13 species of disease infestation were recorded in *Acacia nilotica* and *Ravenella evansii*. Periodic fires in the Chir pine forests were found affecting the regeneration and stems of even pole size crop and big trees were found to be scorched, which susbsequently resulted in their stunted growth and making these susceptible to insect attacks.

In the field of Training, ICFRE has been entrusted with Mid Career Training (MCT) Project for Indian Forest Service officers for Phase-III, by providing best institutional arrangement and partnership with Institutions like WII, Dehradun, FSI, Dehradun, IIM-Ahmedabad, Colorado State University, USA and Swedish University of Agricultural Sciences (SLU), Sweden. ICFRE has the distinction of organizing second such programme as lead training provider from 31st January to 4th March 2011. As part of the HRD initiatives for capacity building of scientific personnel, 11 training programmes (including 1 training of MCT Phase-III) were organized in 8 Institutions of repute, in which 207 participants (including 60 participants of MCT) were trained .

In order to provide wide national exposure to the scientists, a total of 71 scientists were allowed to participate in national level seminars, workshops, symposia etc. Fourty four cases of foreign visits were approved by the Government of India and funded by various sources to provide a much needed international exposure to the scientific cadre.

A five days training course on 'CDM Validation and Verification' by M/S TÜV SÜD South Asia Pvt. Ltd, New Delhi at ICFRE, Dehradun was organized from 9th to 13th August 2010. One week training programme for Scientists and Technologists on "Climate Change and Carbon Mitigation' from 6th to10th September 2010. One Week Training programme for women scientists and technologists from institutions outside ICFRE on "Climate Change and Carbon Mitigation' from 4th to 8th October 2010 and one week Training Course on "Climate Change and Forests" from 31th January to 4th February 2011) were organized at ICFRE, Dehradun. At IFGTB, Coimbatore, a Training Workshop on "Management of Forest Genetic Resources" for Indian Forest Service officers from 18th to 19th October 2010, An International Training Workshop on "Conservation and Management of Forest Genetic Resources" from 5th to 9th July 2010 were organized. The 2nd National Seminar on Casuarinas was conducted from 3rd and 4th March 2011 and a Consultative Workshop on "Strategies for Formulation of Forest Genetic Resources Management Net work (FGRMN)" from 9th to 10th March 2011 was conducted. A National Seminar on "Tropical Ecosystems: Structure, Function and Services (TESFS -2010)" from 28th and 29th December 2010) was also conducted. At IWST, Training on bamboo macroproliferation and vegetative propagation was provided for officials of Goa Forest

Department (GFD), Andhra Pradesh Forest Development Corporation (APFDC) and Karnataka Forest Department (KFD) during February 2010, September 2010 and January 2011 respectively as a part of Packages of practices for high yield plantations for bamboo.

A field workshop was organized in association with Karnataka State Handicrafts Development Corporation Limited, for the benefit of the handicraft artisans of Multicraft, Metugally, Mysore. It was a lab to land extension programme conducted for extending the newer findings on the methods of production and protection of wooden handicrafts. At TFRI, Jabalpur, ten training programmes including the trainings to the trainers from State Forest Services were conducted during the year.

In the field of Forestry Education, ICFRE is providing Grant-in-Aid for promoting Forestry Education in the Country to various forestry research universities/ institutions under Agricultural universities offering undergraduate and postgraduate courses to strengthen their infrastructure and facilities and for giving impetus to forestry education in the country. Towards this objective, ICFRE released Grant-in-aid to the tune of ¡ 204 lakh to 10 Universities in the financial year 2010-11. Universities were encouraged to get accreditation by ICFRE, as a new initiative of quality control in forestry education for the first time through Accreditation Board of ICFRE. The accreditation process was completed for 9 Universities and certificates issued. The proposals for accreditation of 9 more Universities have been received during the year.

On the Extension front, Tree Growers' Mela (fair), workshops and trainings were conducted for the benefit of farmers covering various themes. A workshop on "Best Practices in Tree Farming and an Exhibition on Plantation Technologies" was organized which was attended by more than 700 farmers and other stakeholders. In order to conduct relevant and responsive research, stakeholder meets were organised at all the institutes with the State Forest Departments. Training programme on seed production and nursery techniques, quality planting stock production, biofertilizers and biomanures, climate change and forestry, reproductive and floral biology of mangroves, and on plantation technologies were organized at the various Van Vigyan Kendras. Trainings were imparted to various the field staff of State Forest Departments on identification, conservation and sustainable utilization of medicinal plants to create awareness on medicinal plants. During the year under report 168 new projects were initiated including 32 externally aided projects whereas 130 projects were completed including 40 externally aided projects.

Summary of projects*

Projects	Completed Projects	Ongoing Projects	New Projects initiated during the Year
Plan	90	157	136
Externally Aided	40	60	32
Total	130	217	168

* Data provided under the various themes in similar tables in the report may vary from this tally due to the multidisciplinary nature of the projects.

CONTENTS

INTRODUCTION

The Indian Council of Forestry Research and Education (ICFRE) is an autonomous body under the Ministry of Environment and Forests, Government of India. The Council is an apex body in the national forestry research system to develop holistic forestry research through planning, promoting, conducting and coordinating research, education and extension on all aspects of forestry. ICFRE ensures scientific management of forest, tree improvement, forest productivity through scientific and biotechnological research, bioremediation of degraded land, efficient utilization of forest produce, value addition, conservation of biodiversity, effective agroforestry models for various agroecological zones, policy research, environmental impact assessment and integrated pest and disease management. The mission of ICFRE is to carry out research of forests, forestry and forest products at national level, and disseminate the results of this research to all concerned parties, including State Forest Departments, forest based industries, traders, farmers and other user groups. ICFRE carries out research under various research programmes eight research institutes and coordinate research in different parts of the country.

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

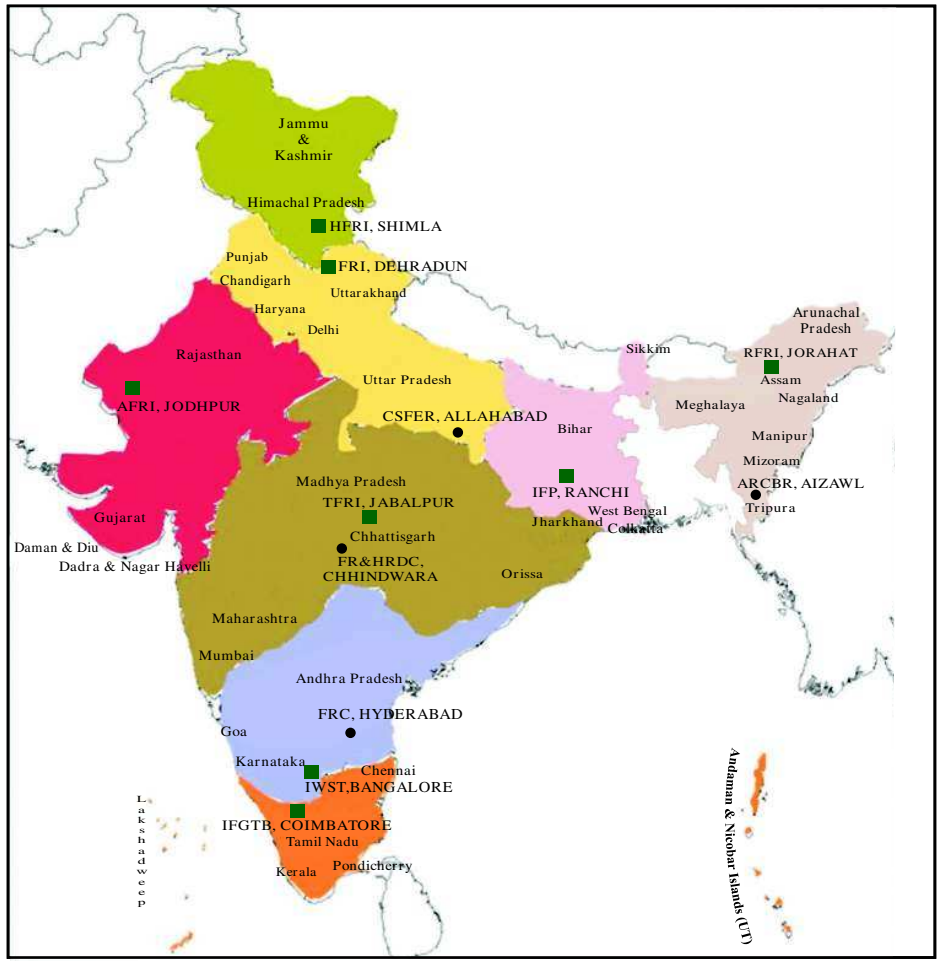
- To undertake, aid, promote and coordinate forestry education, research and their applications.
- To develop and maintain a national library and information centre for forestry and allied sciences.
- To act as a clearing-house for research and general information related to forests and wildlife.
- To develop forestry extension programmes and propagate the same through mass media, audio-visual aids and extension machinery.
- To provide consultancy services in the field of forestry research, education and allied sciences.
- To undertake other 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 is a premier scientific research institute under the aegis of Indian Council of Forestry Research & Education (ICFRE). FRI has established itself on 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 other subcontinent. At present, its research is prioritized on the basis of needs in its working jurisdiction of Uttarakhand, Uttar Pradesh, Haryana, Punjab and National Capital Territory of Delhi. The institute carries forward the high tradition of forestry research carried out by erstwhile Imperial Forest Research Institute. Research on various aspects of forestry like silviculture, ecology, pathology, entomology, chemistry, non-wood forest products, genetics and

Map showing Institutes, Centres and their Jurisdiction



tree breeding and forest soil and land reclamation.The Institute is involved in meticulous research works related to improvement and management of forests and other associated issues. It also undertakes the research in other allied sectors of environment, climate change, soil reclamation, extension etc. based upon the needs and precedences. The Institute also has a field research station at Khirshu, Pauri Garhwal and a centre for social forestry and eco-rehabilitation at Allahabad.

Forest Research Institute, Dehradun has also been conferred the status of "Deemed University" by the Ministry of Human Resource Development, Government of India, New Delhi and at present conducts 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 and Post Graduate diploma in Pulp & Paper Technology. It also has Doctoral programme 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 document collection on forestry and allied sciences in South and South-East Asia. At present Institute enjoys the status of ISO 9001:2000.

Institute of Forest Genetics and Tree Breeding (IFGTB) at Coimbatore is a national institute and focuses activities in the states of Tamil Nadu and Kerala. The institute was formed by upgradation of the earstwhile Forest Research Centre (FRC), Coimbatore working under the Forest Research Institute and Colleges ever since 1959. The institute focuses research on various aspects of forestry like genetics and tree breeding, plant biotechnology, forestry, land use and climate change, seed technology, forest protection, biodiversity and bioprospecting etc. The institute has DNA finger printing laboratory, Genomics laboratory, Phytochemistry laboratory, Genetic transformation laboratory, Tissue culture laboratory, Soil and water testing laboratory, and modern Seed Testing laboratory. The institute also has field units at Walayar and Panampally in Kerala; Karunya Nagar, Bharathiyar University Campus, Veerapandi, Kurumbapatty, Gudalur and Chennai in Tamil Nadu. IFGTB is in the process of establishing more field units across agroclimatic zones in the mandated states. The institute maintains one of the country's oldest herbaria established in 1911. The oldest forest museum in the country, the Gass Forest Museum established in 1906 maintains 4500 exhibits related to forestry and wildlife. The institute also has a botanical garden recognized by the Botanic Gardens Conservation International (BGCI) and the Indian Botanic Gardens Network (IBGN) which was established in 1973 over an area of 3.7 ha. to support *ex-situ* conservation activities.

Institute of Wood Science and Technology (IWST) at Bangalore is a national institute to conduct research on wood sciences and technology focuses activities in the states of Karnataka, Andhra Pradesh and Goa. Taking into consideration the expertise available and contributions made, the Indian Council of Forestry Research and Education (ICFRE) has assigned the institute the status of "Centre for Advanced Studies" in the areas of improved utilisation of wood, mangroves and coastal ecology, and research on sandal. The institute aims to develop strategies for use and production of wood and other forest products in a way that sustains, their supply. A Shore Laboratory at Visakhapatnam and a Forest Research Centre at Hyderabad are parts of the institute with field stations at Gottipura and Nallal.

Tropical Forest Research Institute (TFRI) located at Jabalpur focuses activities in the states of central India, viz., Madhya Pradesh, Chhattisgarh, Maharashtra and Orissa. The institute conducts research on 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. The institute is actively involved in extension activities through its Van Vigyan Kendras. The Centre for Forestry Research and Human Resource Development (CFRHRD), Chhindwara came into existence as a centre to conduct research in the specialized areas like biodiversity conservation, non-wood forest products, forest protection, silviculture and tree improvement.

Rain Forest Research Institute (RFRI) at Jorhat was established in 1988 with an aim to extend knowledge on forestry related issues through research, education and extension and supports forestry research of north-eastern states including Sikkim. The institute focuses on conservation methods to restoration of degraded lands under shifting cultivation, management of community forests, preservation of unique heritage of the region for eco-restoration and multi-facet use of bamboo and cane, without damaging the ecological characters. To maintain economy and productivity to the farmers, RFRI

has been developing viable agroforestry models for North-East region of India. Research on tree improvement programme, field provenance trials, germplasm collection, standardizing macropropagation technique in nursery of important species have also been conducted and significant achievements made. Recently an Advanced Research Centre for Bamboo and Rattan (ARCBR)has been constituted at Aizawl, Mizoram by RFRI, specially for handling research problems on Bamboo and Rattans.

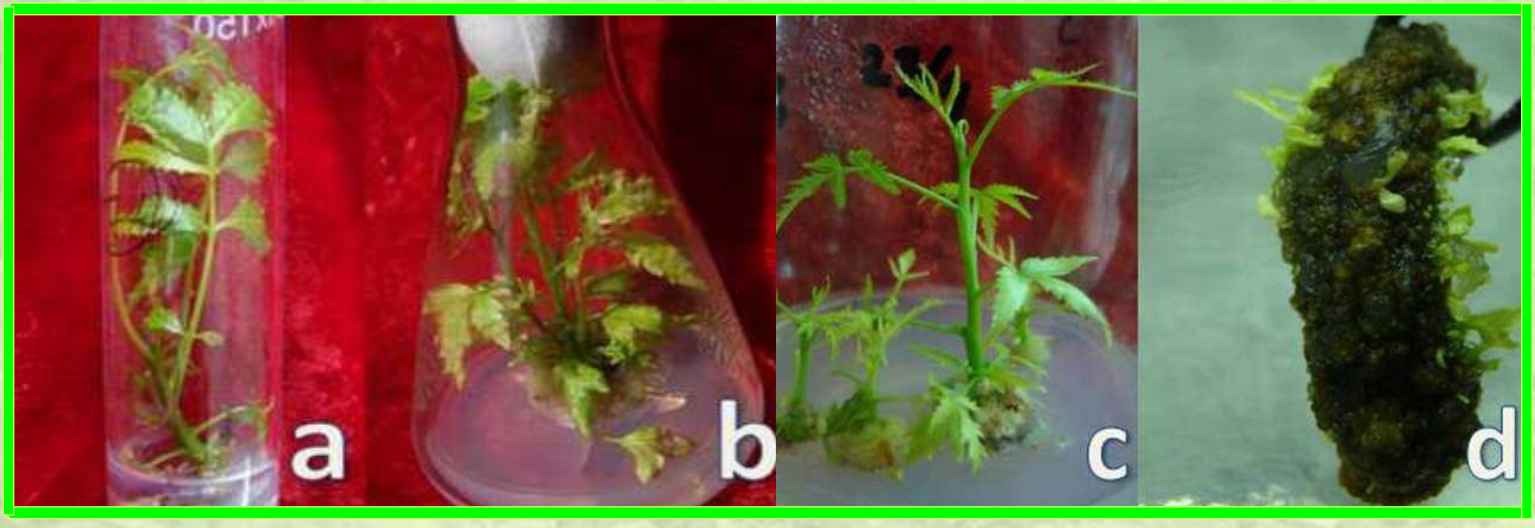
Arid Forest Research Institute (AFRI) at Jodhpur focuses activities in Rajasthan, Gujarat and Dadra & Nagar Havelli. The institute carries out research in forestry and allied fields to enhance land productivity and vegetative cover to conserve biodiversity and to develop technologies for the end-users. The main thrust areas of the institute are soil, water and nutrient management, technologies for afforestation of stress sites, management of plantations, growth and yield modelling, planting stock improvement, biofertilizers and biopesticides, agroforestry, JFM and extension, phytochemistry and non-timber forest products, integrated pest and disease management and forestry education and extension.

Himalayan Forest Research Institute (HFRI) at Shimla was established as High Level Conifer Regeneration Research Centre in May 1977 with an aim to carry out research on the problems associated with natural regeneration of silver fir and spruce. But after becoming part of the Council in 1987 it caters to the needs of J&K and Himachal Pradesh with focused research on eco-rehabilitation of cold deserts, mined areas rehabilitation, insect-pests and disease incidences and management, besides studies on agroforestry practices in hills and regeneration of coniferous and high altitude broadleaved forests. The institute has well developed infrastructure of laboratories, library, herbarium, nurseries and experimental field areas for conducting research and training programmes and has nine Field Research Stations for carrying out site specific/ objective research. The institute has also been declared as the "Advanced Centre for Cold Desert Afforestation and Pasture Management" by the ICFRE for taking up advanced research in eco-restoration of these difficult sites. Research Station located at Tabo and Lahaul-Spiti (HP) caters to the specific research needs of the cold deserts and the institute will soon start its research operations from Field Research Station, Leh (J&K).

Institute of Forest Productivity (IFP) at Ranchi came into existence in 1993 with the objective to formulate, organize, direct, manage and carry out forestry research and education in eastern region of the country i.e. the states of Bihar, Jharkhand and West Bengal. It has well developed infrastructure of laboratories, nurseries and demonstration/experimental field areas for conducting research and training programmes. The institute has Forest Research Centre, Mandar, Ranchi; Environmental Research Station, Sukna, West Bengal and Forest Research & Extension Centre, Patna, Bihar to cater the state research needs and extension activities.




RESEARCH HIGHLIGHTS



RESEARCH HIGHLIGHTS

Introduction

Directorate of Research at ICFRE Headquarters plan, coordinate and monitor the forestry research in all the eight research institute and four centres of the Council and evaluate the progress of various research projects. The Council represents the nation through Biodiversity Conservation and Climate Change Division at international echelon at various platforms in this field.

The Biodiversity and Climate Change (BCC) Division is actively engaged in capacity building programmes by conducting various national and international workshops, and training programmes on climate change, Clean Development Mechanism (CDM) and forestry for forest officers and other stakeholders. The Division is working on forestry and climate change related policy issues leading to international negotiations under United Nations Framework Convention on Climate Change (UNFCCC). The Division is actively involved in providing technical inputs to "Forestry Sub Group on Climate Change" to the Ministry of Environment and Forests (MoEF), Government of India and contributes towards the development of country submissions to the UNFCCC. Biodiversity and Climate Change (BCC) Division, ICFRE has also undertaken several short and long term policy programmes to address the problems of Biodiversity Conservation and Climate Change.

ICFRE Accredited by UNFCCC as First Designated Operational Entity (DOE) from India for Clean Development Mechanism

The CDM Assessment team (CDM-AT) from UNFCCC visited ICFRE Hqs 30th April and 1st May 2010 for on-site assessment of ICFRE for accreditation as Designated Operational Entity (DOE) for Clean Development Mechanism projects.

CDM Assessment Team (CDM-AT)

On the successful assessment and recommendation by CDM –AT, ICFRE became the first Indian Designated Operational Entity (DOE). It has also accredited by the Executive Board of Clean Development Mechanism of the United Nations Framework Convention on Climate Change (UNFCCC), as DOE for validation and verification/certification functions for the sectoral scope, Afforestation and Reforestation in its fifty ninth meeting held at Bonn, Germany from 14th to 18th February 2011.

BCC Division has also compiled and prepared a report of ICFRE on celebration of International Day for Biological Diversity on 22nd May 2010 under the theme "Biodiversity, Development and Poverty Alleviation" given by Convention on Biological Diversity (CBD) and submitted to MoEF for onward transmisson to the CBD Secretariat, Montreal, Canada.

The BCC Division undertook two externally aided projects related to climate change:

i. Research Needs, and the Financial, Technological and Capacity Needs and Constraints to Address Climate Change Concern vis-a-vis Forests and Forest Products in India':

   The project was subcontracted to ICFRE by the Ministry of Environment and Forests, Government of India through Winrock International India. The project was completed and project report submitted to donor agency.

ii. Measurement of Forest Carbon Exchange Using Eddy Covariance and CDM Potential Studies in India:

The project is a partnership study between the Department of Forest Science and Resources (DISAFRI), University of Tuscia (Italy), Indian Institute of Remote Sensing, Indian Council of Forestry Research and Education, and Uttarakhand Forest Department. Under this project, BCC Division of ICFRE is developed curriculum on climate change and CDM aspects for FRI University students and state forest department and FAQ About CDM A/R Project under preparation.

Research Planning Division under the Directorate of Research deals with the planning, formulation and finalization of ICFRE plan funded forestry projects. It coordinates the stakeholders meets, Research Advisory Group (RAG) meetings at each institute and Research Policy Committee (RPC) meeting at National level at ICFRE Hqs. following bottom-up, transparent and participatory approach. It also reviews the ongoing projects under five years rolling plan.

During the year 2010-11, following achievements were made by this division:

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

S.N.	Name of Institute	Details of Stakeholders meet held	
		Venue	Date
1	IWST, Bangalore	Karnataka	28th May 2010
		Goa	4th June 2010
		Andhra Pradesh	19th May 2010
2	RFRI, Jorhat	Assam, Arunachal Pradesh, Meghalaya and Sikkim	31st May 2010
		Mizoram	03rd June 2010
		Tripura	07th June 2010
		Nagaland and Manipur	29th June 2010
3	IFGTB, Coimbatore	Tamil Nadu	28th April 2010
		Kerala	19th May 2010
		Andaman & Nicobar Islands	31st May 2010
4	AFRI, Jodhpur	Gujarat	19th July 2010
		Rajasthan	09th June 2010
5	HFRI, Shimla	Himachal Pradesh	
		Jammu & Kashmir	01th July 2010
6	IFP, Ranchi	Jharkhand	25th May 2010
		Bihar	15th June 2010
		West Bengal	23rd August 2010
7	TFRI, Jabalpur	Madhya Pradesh	05th April 2010
		Chhattisgarh	23rd April 2010
		Maharashtra	13th May 2010
		Orissa	24th May 2010
8	FRI, Dehradun	Uttarakhand	03rd May 2010
		Haryana	18th May 2010
		Chandigarh	15th June 2010
		Uttar Pradesh	21st May 2010
		Delhi	
		Punjab	15th June 2010

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

IFGTB, Coimbatore	12th and 13th October 2010
AFRI, Jodhpur	28th and 29th October 2010
HFRI, Shimla	1st and 2nd November 2010
IFP, Ranchi	8thand 9th November 2010
FRI, Dehradun	11th and 12th November 2010
IWST,Bangalore	18th and 19th November 2010
TFRI, Jabalpur	24thand 25th November 2010
RFRI, Jorhat	25th and 26 th November 2010

Research Advisory Groups were chaired by PCCFs of the concerned states and attended by members from different strata of scientists, forest officials, stakeholders viz. NGOs, industries, progressive farmers and Universities. The proposals were evaluated by two subject experts/referees and accordingly projects were modified for the consideration of RAG and RPC.

Research Policy Committee (RPC) Meeting

Research Policy Committee (RPC) is the apex body at ICFRE that prioritize the ICFRE funded projects of eight research institutes and four research centres of ICFRE recommended by RAG of the institute and ensure balance among international, national, regional and state research requirements and decide investment in high quality forestry research.

ICFRE research has been broadly categorized in to seven thrust areas and thirty two themes. All the new projects were categorized accordingly as given below:

S.N.	Thrust Area	Theme
1	Forest Productivity	1. Improvement of Forest Productivity 2. Social Forestry, Agro/Farm Forestry 3. Vegetative Propagation 4. Nursery Techniques/Seed Technology
2	Ecosystem Research	1. Control of weeds and invasive species, 2. Natural regeneration of imp. species, 3. Fire Management, Planted Forests and forest harvesting practices, Community based approaches, 4. Protection of endangered species, 5. Shifting cultivation, 6. Wetlands and mangrove forests, 7. Soil and water conservation including integrated, Renewal bioenergy, 8. Preservation plots, 9. Indigenous knowledge system, 10. Phytodiversity networ,. 11. Bioremidation and Pollution Control, 12. Ecorestoration of degraded lands, 13. Environment Impact Assessment/development,
3	Genetic Improvement	1. Tissue Culture 2. Conservation of Forest Genetic Resources 3. Tree Improvement
4	Forest Management and Protection	1. Watershed Management 2. Participatory/Joint Forest Management, 3. Control of Pests and Diseases
5	Climate Change	4. CO_2 Sequestration 5. Mitigation and Adoptation and Carbon Pool Assessment
6	Forest Wood Products	1. Wood/Plantation Species Utilization, 2. Timber Statistics, Bamboos.
7	Non Wood Forest Product	3. Biofuel, *in situ/ex situ* conservation of NWFPs 4. Medicinal Plants, 5. Utilization of NWFPs

However, these seven thrust areas are under thought process for further refinement into following four thrust areas having thirty two themes.

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

Directors' Meet: The V Directors' Meet was organized on 26th October 2010, in the Board Room of 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.

Bamboo Technical Support Group (BTSG) – ICFRE:

Bamboo Technical Support Group (BTSG)- Indian Council of Forestry Research and Education (ICFRE), Dehradun constituted by National Bamboo Mission, Ministry of Agriculture, Govt. of India caters to the research and technology based needs of eleven States of the country viz., Jammu & Kashmir, Punjab, Haryana, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Bihar, Madhya Pradesh, Chhattisgarh, Rajasthan and Gujarat to facilitate the implementation of the programmes of National Bamboo Mission. BTSG–ICFRE had come into existence in July 2007. Activities of BTSG include organizing trainings to the farmers and field functionaries; Publication of bamboo literature; Promotional C]campaign through Electronic Media; Organizing seminars, etc.

Five Days' Training Programme for Farmers and Field Functionaries: Principal Chief Conservators of Forests and State Mission Directors of concerned States nominate farmers and field functionaries of their respective states for organizing training programmes by following ICFRE institutes/centre:

- Forest Research Institute (FRI), Dehradun
- Tropical Forest Research Institute (TFRI), Jabalpur
- Arid Forest Research Institute (AFRI), Jodhpur
- Himalayan Forest Research Institute (HFRI), Shimla
- Institute of Forest Productivity (IFP), Ranchi
- Centre of Social Forestry and Eco-Rehabilitation (CSFER), Allahabad

Training Programme for Farmers and Field Functionaries:

During 2010-11, BTSG–ICFRE organized a five Days Training programme for the Farmers and Field Functionaries of Punjab from 07 to11 February 2011. This training programme was organized by FRI, Dehradun.

Promotional Campaign Through Electronic Media:

A full-page coloured advertisement of BTSG–ICFRE, Dehradun depicting the objectives and strategies of National Bamboo Mission has been published on the back jacket (back page) of the Indian Forester during the year.

Bamboo Literature:

Six hundred copies of the hindi book titled "Baans Ropan Evam Upyogita" and 100 copies of hindi poster "Bans Aajeevika Ka Ek Saadhan" published by BTSG-ICFRE, were provided to different concerned ICFRE Institutes and State Bamboo Missions for free distribution among the participants of training programmes under National Bamboo Mission.

Monitoring and Evaluation Division deals with the review and evaluation of all the

ongoing research projects of ICFRE institutes and suggests corrective measures for timely completion & achieving the objectives with perfection and objectives. Also independent evaluation of some research projects of ICFRE Institutes through independent external evaluators/ subject matter specialist/ experts/ agency for improvement in the quality of research and transfer of technology developed to the stakeholders is being done. Project Completion Reports (PCRs) are scrutinized and accepted as per the Format Guide of ICFRE. Seventy Seven such ICFRE funded projects have been received and scrutinized.

Quarterly Progress Reports of individual projects from Directors are scrutinized for conformity with the approved action plan and corrective measures are suggested for timely achieving the objectives.

During 2010-11, 436 ongoing research projects including 86 externally aided were reviewed and evaluated as per schedule.

Institute-wise Ongoing Research Projects Reviewed During 2010-11

S.No.	Name of Institute	Date of Review	No. of Ongoing Projects Reviewed		
			ICFRE funded	EAP	Total
1	AFRI, Jodhpur	25th and 26thAugust 2010	24	10	34
2	FRI, Dehradun and CSF & ER, Allahabad	13th to 17thSeptember 2010	104	23	127
3	HFRI, Shimla	01st to 03rd June 2010	22	6	28
4	IFGTB, Coimbatore	15th to 18th June 2010	62	11	73
5	IFP, Ranchi	15th to 17th July 2010	23	2	25
6	IWST, Bangalore and FRC, Hyderabad	29th to 30th June 2010	48	13	61
7	RFRI, Jorhat	19th to 21st July 2010	41	5	46
8	TFRI, Jabalpur and FHRDC, Chhindwara	09th to 13th August 2010	26	16	42
		Total	350	86	436

Independent External Evaluation (IEE) of 30 projects randomly selected from each institute was carried out through independent external evaluators/ subject matter specialist/ experts/ agencies from out side ICFRE system. Evaluation reports of 26 research project have been received, scrutinized and accepted by the competent authority. Evaluation for other projects is in the process.

Project Formulation Division functions as a facilitator between the ICFRE institutes/ centres and the potential donor agencies; for the formulation of research projects in the identified thrust areas and seeking funding for various national and international donor agencies. It also coordinated the implementation of the research projects by ICFRE institutes/ centres and of status report.

Collaborated project 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) in 2010-11 are 79 with the sanctioned worth of ¡ 1477.06/- lakh. Project proposals on

"Community based sustainable natural resource management for poverty alleviation in the ten states of Uttarakhand, West Bengal, Madhya Pradesh, Chhattisgarh, Jharkhand, Gujarat, Rajasthan, Andhra Pradesh, Maharashtra and Orissa" submitted jointly by ICFRE and Tapobhoomi Trust and "Quantification, value addition of NTFP and improved agricultural productivity to enhance livelihood opportunities in tribal belt of Sirohi District of Rajasthan" have been submiltted for seeking financial support.

The international funding agencies like World Bank through ICAR, International Foundation for Science, Sweden and CSIRO funded the ICFRE Institutes. Eleven externally aided projects worth of ¡ 149.09 lakh have been completed in this year. Six internationally funded projects with the sanctioned worth of ¡ 84.31 lakh are under implementation. Some important International projects namely, project on "New bio-control opportunity for prickly Acacia - Exploration in India", funded by Alan Fletcher Research Station, Australia; "A Value Chain on Industrial Agroforestry in Tamil Nadu" by World Bank through ICAR; "Improving the accessibility and affordability of improved seeds from breeding programmes to benefit large numbers of smallholder tree farms and rural communities in Tamil Nadu and Puducherry" funded by CSIRO, Australia and "New bio-control opportunities for prickly Acacia: Exploration in India" funded by Alan Fletcher Research Station, Australia are under implementation in AFRI, IFGTB and other Institutes of ICFRE.

Several MoUs and agreements for the execution of collaborative projects/ programmes by ICFRE institutes were finalized with renowned institutions, such as IFGTB, Coimbatore with and TNPL undertaken project on "Production and testing of control pollinated *Eucalyptus* hybrids with improved biomass and pulp yield to support industrial forestry in Tamil Nadu", IFGTB, Coimbatore and ITC R&D Centre, Hyderabad project on "Development of an inter specific hybrid *Corymbia* hybrid *Corymbia torelliana* x *Corymbia citriodora*" and IWST, Bangalore and IINRG, Ranchi project on "Termite and borer resistance of shellac-based varnishes".

Bihar Project - Samudai Adharit Samanvit Van Prabandhan Evam Sanrakhshan Yojna (SASVPESY) to Address Livelihood Issues: Samudai Adharit Samanvit Van Prabandhan Evam Sanrakhshan Yojna (SASVPESY) of Bihar State sponsored by Planning Commission, Govt. of India launched during 2006 and being implemented by ICFRE, Dehradun. Actual physical activity started in January 2007 in Vaishali district of Bihar with focus on well being on each and every section of the farming community including landless laborers, small, marginal and big farmers by involving them into nursery raising, uprooting and seedling transporting & planting in farmlands. The project will be completed in two phases. In Phase-I, Vaishali district has been taken up and in the IInd phase remaining districts of North Bihar will be taken up.

The project has main objective of the socio-economic development of the Vaishali district of Bihar through poplar based agroforestry and capacity building of the farmers by providing technology and services, quality planting stock material, training and extension, establishment of Hi-tech Nurseries/Kisan Nursery, agroforestry demonstration trials and technological exposure etc. in the area.

Poplar Kisan Nursery Village Loma, Jandaha, Bihar

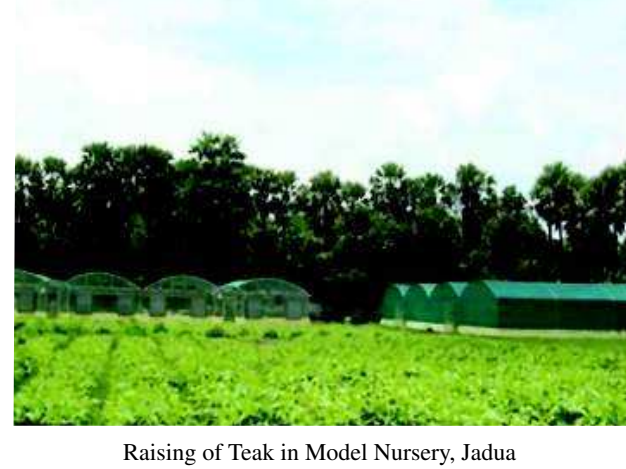
Uprooting of Poplar in Kisan Nursery at Patepur Vaishali

Since January 2007 a total of 74.00 lakh ETPs/seedlings were distributed for nursery raising and for preparation of planting stock and farmers created wood lots on their fields. The major wood yield would start coming gradually from year 2013-14 onwards. The process oriented activities mainly Kisan Nursery and planting operations has generated lot of economic activity among different stakeholders in the form of farmers, landless laborers, water pump set owners, tractor owners, fertilizer and hardware shops and fuel stations. Apart from that approx 100 families/ individuals worked with the project since last 4 years as Extension Workers.

Table Showing the Amount of Mandays Generate Under the Project Activity

S.N.	Nature of work	Executing agency	Duration	Man days creation (in Lac)
1	Engagement of technical and semi skilled staff	ICFRE	2007 to 2011	1.71
2	Uprooting and transporting	ICFRE	2007 to 2011	0.90
3	Provision for nursery planting material	ICFRE	2007 to 2011	0.16
4	Demonstration plot	ICFRE	2007 to 2011	0.08
5	Kisan Nursery	Farmers	2007 to 2011	1.08
6	Planting operations	Farmers	2007 to 2011	2.96
7	Maintenance of plantations	Farmers	2007 to 2011	1.32
			TOTAL	8.21

Besides Poplar, species of teak, mahogani, gamhar, kadamb, semal, jamun, arjun, kathal etc. were raised. Meanwhile, more than 24 lakh quality plants of poplar and around 12 lakh of non poplar species were distributed in all 16 blocks of Vaishali & adjoining areas. Species which are produced in Kisan nurseries are being distributed free of cost to the farmers of Vaishali and adjoining villages in the nearby districts of Muzzaffarpur, Samastipur, Saran and Patna. Training on VAM inoculation was imparted by Scientist from FRI Dehradun.



Raising of Teak in Model Nursery, Jadua

Demonstration centres were established at Jadua and Goraul and these centres provide on the spot technical knowledge to farmers. Capacity building trainings at Jadua training centre and field training at different villages of Vaishali, Rahimpur Vaishali and Rahsa Pachiyari, Bhagwanpur had been organized and under this programme, around 6281 farmers were trained on planting & nursery raising techniques of poplar.

ICFRE Demo Plot at Goraul

Kisan Study Tour for Haldwani

Extension material/field manuals, Pamphlets on Agroforestry, Booklets on poplar, bamboo, Kisan Nursery, Krishi Vaniki ki Pramukh Prajati and documentary film on "Silent Revolution" have been developed in Hindi for beneficiaries. To develop marketing linkages between Forest based industries and the farmers of Vaishali district "Buyer Seller Meet" was organized under the SASVPESY of Bihar State.

The acceptability of farming community to allow tree crop along with agriculture crop was most important breakthrough. Year after year the message of adoption of agroforestry is going deeper and deeper in mind of farmers and spreading like wild fire. Farmers are interested in taking this calculated risk for getting 3-4 fold increased revenue return from the same piece of land. Poplar is replacing semal, the traditional industrial wood raw material of the area aggressively. The initial strategy of "Push" the poplar has gradually turned into "Pull" (demand) driven stage. Approach of farmers towards tree farming has gone a sea change and they are trying to stick to irrigation and pruning and other tending activities in the tree crops. The project activities have already been started bringing in socio-economic changes in the area in a very short period by eliciting community participation, by providing research and technological inputs by ICFRE and is being seen as a future industrial development based on generation of raw material for wood based industries.

Theme based research achievements of the Council follow in the sub-chapters ahead.

2.1 Ecosystem Conservation and Management

Overview

The growing awareness that ecosystems provide supporting, provisioning, regulating and cultural services–such as nutrient cycling, food and fresh water production, flood regulation and recreational space–has focused attention on how these services might change, and so influence human well-being as the organisms within ecosystems respond to mounting environmental pressures. To predict the responses of organisms and the services they provide – requires a detailed understanding of ecological science, where the focus is on understanding how biotic and abiotic interactions shape the structure and function of ecosystems. The purpose of the Ecosystem Conservation and Management research is to understand, interpret and apply ecological science to understand adaptive management of species, communities, and ecosystems in a changing environmental scenario.

The principal objective of ecosystem management is the efficient maintenance and ethical use of natural resources. Ecosystem management acknowledges that the interrelation of socio-cultural, economic and ecological systems is paramount to understanding the circumstances that affect environmental goals and outcomes. It is a multifaceted and holistic approach which requires a significant change in how the natural and human environments are identified. Several approaches to effective ecosystem management engage conservation efforts at both a local or landscape level and involves: adaptive management, natural resource management, strategic management, and command and control management.

The goal of a natural resource manager is to fulfill the demand for a given resource without causing harm to the ecosystem, or jeopardizing the future of the resource. Partnerships between ecosystem managers, natural resource managers and stakeholders should be encouraged in order to promote a more sustainable use of limited natural resources.

Projects under the theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	18	19	25
Externally Aided	11	11	15
Total	29	30	40

2.1.2 Climate Change

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. In view of projected trends of likely impacts of climate change on forest ecosystems, it becomes pertinent to incorporate climate change consideration in planning while managing the forestry sector on long term basis. Besides, there is a dire need to concentrate on eco-regions rather than the boundaries as the unit of analysis and management.

Effect of Climate Change on the Phenology of Himalayan Rhododendrons

Study was conducted at Tungnath- Chopta of Garhwal Himalaya. Four aspects i.e., North, South, East and West and four species of Rhododendron i.e. *R. arboreum, R. barbatum, R. campanulatum* and *R. anthopogon* were selected

for phenological studies. At each site, mini-meteorology was established to collect maximum, minimum temperature, soil temperature, humidity and rainfall. The data is regularly recorded at weekly interval from each site. Analysis of associate species, their density, basal area and regeneration was carried out at each site.

R. arboreum Floral Bud Break

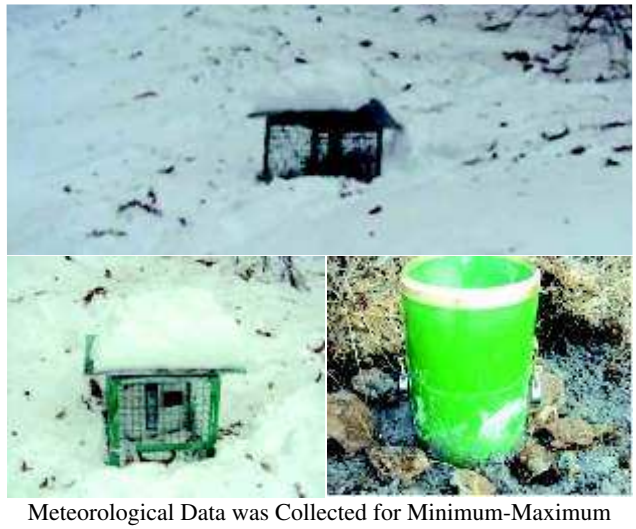
R. arboreum Flowering

R. campanulatum Floral Bud

Floral Bud Break

R. anthopogon Vegetative Bud

R. anthopogon Capsule Break and Seed Dispersal



Meteorological Data was Collected for Minimum-Maximum Temperature, Humidity, Rainfall and Solar Radiation

Assessment on Carbon Pool Potential of Important Tree Species at Different Ages, Sites and Management Regimes

The study was aimed to assess carbon pools in plantations of teak, eucalypts, casuarinas and acacias in different site conditions. The sampling was done by adopting "Average tree technique" (Arts and Mark, 1971). The sampling of plantations also covered different management practices mainly the irrigated as well as rainfed conditions. In all the plantations studied, composite soil samples were collected up to 30 cm for estimation of soil carbon as per IPCC guidelines. The results on dry matter production in the present study revealed that the difference in above ground biomass between trees of smallest and biggest diameter in even-aged plantation was 2 to 3 folds, particularly in the plantations of seedling origin. Such variations in dry matter production of sample trees within the plantations of the same age can be attributed to inherent genetic variation existing in the plantations of seed origin. With reference to average productivity of various biomass componentsin plantations of *Casuarina*, larger difference was noticed for productivity of stem, which was greater in coastal region (9.67 mt ha^{-1} $year^{-1}$) than in inland region (8.41 mt ha^{-1} $year^{-1}$). This variation in stem wood productivity between two regions studied can be mainly attributed to the change in climatic factors, particularly the intensity and distribution of rainfall. It is observed that total annual rainfall is high and distribution of rainfall also well spread in coastal region when compared with inland region. Further, soil also influenced stem wood productivity and it is observed that stem wood productivity was nearly 50 % lesser in clayey soils of vertisol, when compared to that registered in sandy (inceptisol) and red loamy (alfisol) soils. Alfisol and inceptisol provide good soil aeration, induce more nodule formation and more nutrients availability and leads to more stem wood productivity and carbon sequestration potential of plantations of *C. equisetifolia.* Hence, it is concluded that alfisol and inceptisol can be

preferred for greater carbon sequestration. A book titled "Regional yield table and carbon table for plantations of *Casuarina equisetifolia* in farmlands of Tamil Nadu" has been released based on the results of the present studies.

Evaluation of Tree Species of "Tree Cultivation in Private Land" programme for Carbon Sequestration under Elevated CO_2 Levels.

The study was undertaken to understand the response of the important tree species, which are used in the "Tree Cultivation in Private Land (TCPL) programme" of Tamil Nadu State Forest Department, to the elevated CO_2 levels. The study also intended screening and selection of species that show a positive response so that they can be planted on a large scale to increase the productivity as well as to improve the carbon sequestration potential of the plantations. The study brought out that the response of different tree species to different concentration of CO_2 and under different temperature conditions was highly varying which emphasized the need to assess all important tropical tree species individually and not to generalize the response of tree species to elevated CO_2. *Tectona grandis, Casuarina junghuhniana, Pongamia pinnata, Casuarina equisetifolia, Azadirachta indica,* and *Melia dubia* were the species which positively responded even at 900 ppm of CO_2 elevation and these species may be considered for greater carbon sequestration under elevated CO_2 and temperature levels. It was also concluded that equivalent to or even greater than inter-specific variation, there exists huge intra-specific variation, particularly in *Casuarina equisetifolia* and *C. junghuhniana*, which could be exploited for future breeding programme in developing climate ready genotypes having greater potential to sequester more CO_2. Among the species evaluated, *Tectona grandis, Gmelina arborea, Melia dubia* and *Pongamia pinnata* were observed to accumulate greater dry matter under elevated CO_2 and hence could be recommended as a "Carbon sink" species for afforestation programme for future levels of elevated CO_2.

Vegetation Carbon Pool Assessment for Andhra Pradesh North Region

Vegetation carbon pool assessment was taken up in 21 forest sites and 30 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.

National Vegetation Carbon Pool Assessment for Six Districts of Andhra Pradesh

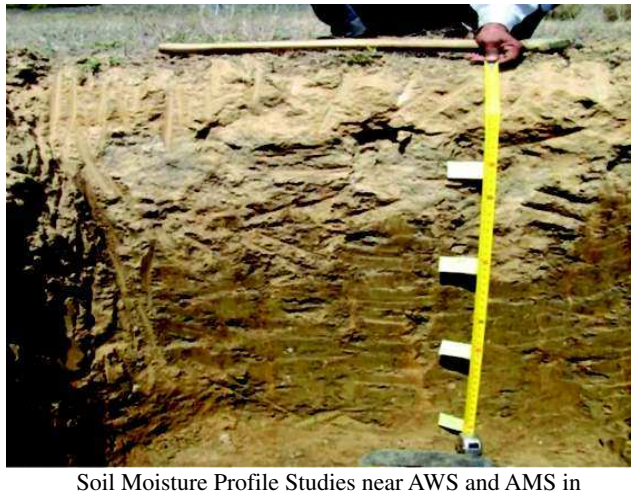
A total of 36 plots at pre-assigned geographic coordinates were studied by laying out four quadrats of 0.1 ha each. The data on above ground biomass and locality information were collected. Total forest biomass was estimated in six districts of Andhra Pradesh viz., Medak, Mahabubnagar, Guntur, Nalgonda,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

Utilization of Automatic Weather Station/ Agro-Meteorological Station Data for Agriculture, Forestry and Hydrological Applications in Madhya Pradesh

Sites were selected near Automatic Weather Station (AWS) and Agro-meteorological Station (AMS) in Kanha National Park (KNP), Bandhavgarh National Park (BNP) and Madhav National Park (MNP) in Madhya Pradesh. Grass biomass studies were conducted in the selected sites. Maximum grass production was found in September (post rainy season) and December (winter season), which gradually decreased in the month of March. Soil moisture profile at an

interval of 30 cms and till the depth 150 cms was quantified by volumetric method. AMS has been installed at Ronda in Kanha National Park, which is a plain area with clayey loam soil. In all the four seasons, soil moisture increased with depth because of vertical seepage and accumulation of water to lower horizons. The soil of the Supkhar area was sandy loam to loam. Soil moisture increased from surface till 60-90 cms or 90-120 cms, then slightly decreased due to the presence of few gravels. Maximum soil moisture was recorded in September, followed by December and March. Regression equation for quantifying above ground biomass against GBH was developed for *Shorea robusta*. Specific leaf area of major tree species of three national parks was calculated.

Grass Biomass Studies near AWS and AMS in National Parks



Soil Moisture Profile Studies near AWS and AMS in National Parks

Impact of Climate Change on Litter Microbial Dynamics in Dipterocarp Forest

The project was aimed to investigate the effect of climatic parameters on the decomposer microfungal populations in Dipterocarps forests and to develop a prediction module for the impact of climatic change on litter microbial dynamics by identifying potential bio-indicator species of microorganisms of climate change. It was observed from the findings that all decomposer microfungi did not occur in all the climatic conditions categorized to three seasons experienced by the study sites. The pattern of occurrence of each fungal species in a particular range of rainfall and temperature were recorded. It was seen that a certain group was representing a certain pattern of climatic parameters. Some species were seen in all the seasons of the year and some restricted their occurrence to a single season only. Such findings gave a basic idea of the considerable influence of climatic parameters on decomposer mycoflora. Decomposition of plant detritus in undisturbed forest ecosystems accounts for the nutrient return up to a great extent. Any alteration in microbial population which is one of the chief parameters influencing litter decomposition, the overall productivity of the forest ecosystem may be disturbed and may pose a threat if adverse depletion in decomposition may occur. The findings of the project described the role of these decomposer floras as potential climate

Collection of Sample from Litter Trap

change indicators as their occurrence represents a particular climatic condition. The findings of the project are intended to be used as baseline data for the next rolled over project entitled "CO_2 emission and microbial immobilization in Dipterocarp forest soils: effect of abiotic and biotic factors with special reference to climate change" in which the data will be simulated and more biotic and abiotic factors will be incorporated to exploit the role of these microbes as climate change indicators.

Carbon Sink and Fertility Status Relation of Soil under Different Land Use System of Some States of North-East India

Soil were characterized under selected plantation forest and other vegetations viz., Tea, Coffee, Rubber and Jhum land, Cardamom plantation areas of Assam, Meghalaya, Tripura and Nagaland states and assessed soil carbon sink under selected forest and other land use systems. Organic carbon content in soils under Cardamom plant of Sikkim state was found high and varied from 2.25 to 4.72%. Soils under Cardamom plantation of Sikkim were acidic and the pH value varied from 3.9 to 5.8 and belongs to "Sand" textural class. They were also light in weight due to high amount of organic carbon. It was found that phosphorus content in Cardamom plantation was low. Available phosphorus content of Tea plantation soil of upper Assam was low. Available phosphorus and potassium content of Coffee, Rubber and Jhum land soil belonging to Diphu and adjoining areas of Assam was low to medium. Soil Organic Carbon (SOC) was found high under Jhum land whereas it was low under Rubber plantation areas and wide variation of SOC was under Coffee plantation. All the soils were slightly acidic to neutral under Rubber, Coffee and Jhum land.

Available potassium content of Haflong and adjoining areas NC Hill of Assam was found medium for Coffee and low to high for Jhum. Phosphorus content was found low but SOC was found high. Soils were acidic, loose and porous. Available potassium content in soil under Rubber belong to Bongaigaon, Kokrajhar, Goalpara and Kamrup districts of Assam was found medium in most of the samples and in few samples low and high. Low phosphorus content and high SOC was found. Soils were found acidic.

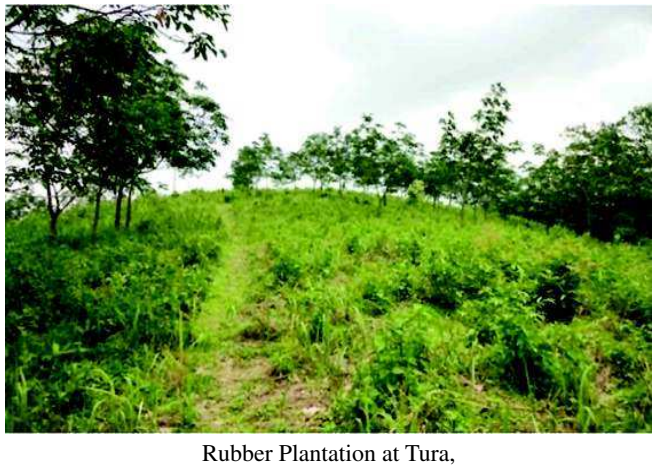
Available potassium content of soil collected from Mokokchung found medium ranged and acidic in nature. Soil organic carbon was found high. Available phosphorous content was found low. Soils were found light having sandy clay loam to sandy loam texture. Soil organic carbon was found low under the rubber plantation area in the state of Tripura and high in Meghalaya. Available phosphorous content was low having mainly sandy clay loam texture.

Recent Jhum Land at Diphu

Coffee Plant at Fruiting Stage at Diphu

Tea Leaf Collection at Tura, Meghalaya

Paddy, Maize Cultivation in Jhum Land Tura, Meghalaya



Rubber Plantation at Tura, Meghalaya

Coffee Plantation under Betel Nut at Meghalaya

Vegetation Carbon Pool Assessment in Some Districts in Northern Rajasthan

Project was started with objectives to estimate carbon in growing vegetation and assess carbon dynamics in the forests as well as Trees Outside Forest (TOF) in Sri Ganganagar, Hanumangarh, Churu, Jhunjhunu, Sikar and Jaipur districts. A total number of 19 forest sites (76 plots) and 33 plots under Trees Outside Forest (TOF) were surveyed in these districts and trees and shrubs measured in cluster sample of four plots at each site in the forests blocks. There were 21 trees and 11 shrub species identified in the study area. The highest number of species was in Jaipur, followed by Hanumangarh forest division. Hanumangarh division showed "Desert thorn forest" of *P. cineraria* and *Z. nummularia,* but now invaded by *Prosopis juliflora*, which dominated in about 25% area. Forest cover in Churu division is dominated by *Acacia senegal* in trees and *Mytenus emarginata/Z. nummularia* in shrubs, whereas, Jhunjhunu is dominated by *P. juliflora*. Forest covers in Sikar division was dominated by *Anogeissus pendula* in about 75% area followed by *Boswellia serrata* in 25% area. In Jaipur, about 18% forests were dominated by *A. penduala*, 36% by *B. serrata*, 18% by *P. juliflora*, 18% by *A. senegal* and 10% by *A. catechu* tree species. Among the shrubs, the dominant species in Jaipur was *M. emarginata*.

Previously *Anogeissus pendula* Forest in Jhunjhunu

Now Dominated by *P. juliflora* Forest in Jhunjhunu

Most of the dry hilly region in North-Eastern Rajasthan is occupied by *A. pendula,* but is now infested by *P. juliflora*.

Studies on Carbon Sequestration in Different Forest Types of Rajasthan

Project was started with objectives (i) to estimate carbon stock in forest soils, (ii) to estimate carbon stock in forest litters and (iii) 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.

Twelve districts covering 238 forest blocks and 254 plots were surveyed in 2010-11, growth of trees and shrubs were measured and shrub/herbage biomass recorded. Litter, plant and soil samples were collected from the plots and analyzed for the carbon. Dune scrub areas of Jaisalmer were dominated partly by *Calligonum polygonoides* that help in control of sand drift. Alwar, Dholpur and Bharatpur were dominated by *P. juliflora*, whereas, Bhilawara was dominated by *Acacia leucophloea* as the tree species. *Anogeissus pendula* still dominated in Tonk and some parts of Bharatpur division. Ajmer division was dominated by *A. senegal*, whereas, Baran division was dominated by *Gymnosporia* spp. and *B. monopserma*. During survey in Bharatpur, a belt of *Mitragyna parviflora* was also observed, but forest is now infested by *P. juliflora*.

In 27 districts covering 588 blocks, *P. juliflora* recorded in the forest blocks of all districts except, Pratapgarh. Diameter at breast height, height and crown diameter varied from 12.26 to 48.82 cm, 1.51 to 7.83 m and 2.63 to 9.00 m, respectively, whereas, average basal area ranged from 111.3 to 2252.8 cm^2 per ha with wide spread root system. *P. juliflora* density and frequency of its occurrence (F) varied from 0.8 ha^{-1} and 2.78% in Sikar to 17.81 ha^{-1} (Pali) and 68.97% (Ajmer district), respectively. About 35.4% of forest

blocks are infested with *P. juliflora*, which is likely to increase in future.

Root Systems of *Zizyphus nummularia* (up) and *Prosopis juliflora* (down) Excavated for Biomass Showing Both Feeders as well as Anchoring Roots

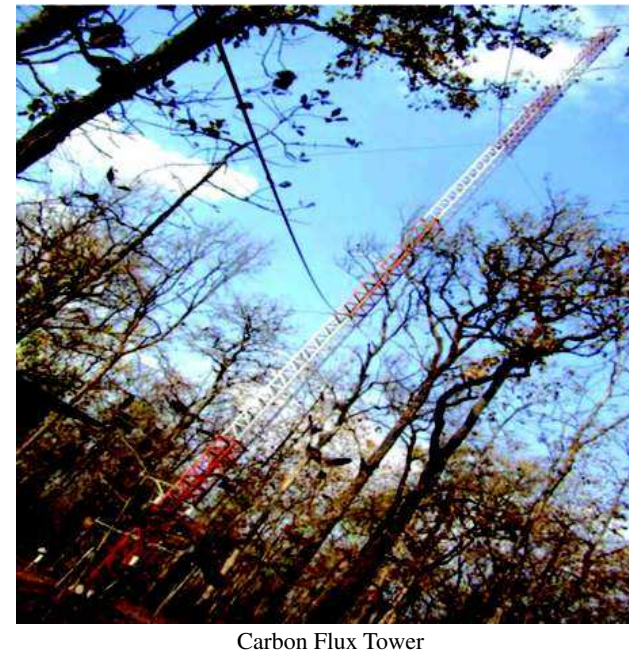
Development of Air Pollution Biomonitoring Station for Air Quality Assessment in Dehradun

Two biomonitoring stations, one at Shatabdi Van Vigyan Kendra, FRI City Campus, Dehradun and the other in the Selakui industrial area, Dehradun were set up to biomonitor the air quality of these sites by adopting active biomonitoring technique.

Plant sensitivity index to air pollution and air pollution index were also developed for evaluating the air quality status of the industrial area. Several active biomonitoring studies were performed to evaluate the air quality of both the biomonitoring stations i.e., Shatabadi Van Vigyan Kendra, FRI City Campus, Dehradun and Selakui Industrial area, Dehradun.

Vegetation Carbon Pool Assessment Project in India:

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 were installed in five major forest types of the country. Betul (teak forest) in Madhya Pradesh was one of them. The objectives of the project were to measure the vegetation and soil parameters to support modeling and to collect the data related to silviculture, inventory, management and utilization, to estimate the net ecosystem exchange of carbon.



Carbon Flux Tower

Enumeration of Trees at Site

Litter Collection

Energy and Mass Exchange in Vegetative System: Canopy Atmosphere Exchange Modelling Using Micrometeorological and Scintillometer

In-situ measurements of micro-meteorological and biophysical parameters were taken over selected pine plantation (forest ecosystem). Modelling of canopy atmospheric exchange processes and primary productivity using land surface process models was done and validation of satellite derived parameters carried out using *in situ* measurements.

2.1.3 Eco-restoration

Eco-restoration Studies in Uranium Mines

On the basis of findings by team of scientists from FRI, Dehradun and NABTD, Mumbai, in order to avoid translocation of radioactivity in the atmosphere as well as biosphere through food chain, it was recommended that:

Since tailing pond is in the vicinity of forest, propagules of deep rooted woody species may invade the area, regular vegetation monitoring on the tailing pond needs to be undertaken. Invasion of deep rooted species like *Acacia nilotica, Butea monosperma* and *Vitex negundo* etc. has to be checked through manual removal of seedlings/saplings.

Saccharum spontaneum may be allowed to grow only on the periphery of tailing pond in the form of greenbelt.

The species with minimum concentration of radio nuclides were identified as *Colebrookea oppositifolia, Dodonaea viscosa, Furcraea foetida, Imperata cylindrica, Jatropha gossypifolia, Pogostemon benghalense* and *Saccharum spontaneum*. They are non-edible, with shallow root system, evergreen with less height and more crown cover. These seven species show minimum concentration (or below detective limit) of the uptake of radionuclide by plants.

Eco-restoration and Conservation Initiatives at Danda Shrinagraja in Garhwal Himalayas

The study reveals that the people residing nearby Danda Shrinagraja are either laboures or marginal farmers having limited source of income. The produces from their agriculture and livestock used on domestic level without any commercial use. They depend on nearby forests for fuel and fodder. Open grazing is common in

the area. People collect the grass from community land and forest and keep it on lopped tress after drying it. This dried grass is used during winter. About 60% people including 40% women are literate. Every child in the villages is school going but a proper transportation is lacking. Drinking water is obtained from public tap. The common trees on farmland boundaries are *Bauhinia purpurea* (semla), *Toona cilita* (toon), *Grewia optiva* (bhimal), *Ougeinia oojeinensis* (sadhan) and *Terminalia tomentosa* (sain/asna) etc. Besides, there are some fruit trees on the farmland. These are: jackfruit, guava and citrus etc. Among agriculture crops the main crops grown are maize, wheat, madua, ramdana, urad, tor, soyabean, paddy, etc. But since few years, there is a drastic fall in the yield of these crops due to drought in the area. Regarding yield and economy based on agriculture, there is no marketing of agriculture produces as they are mostly used domestically. Plantation of *Terminalia chebula* (harad), *Terminalia balarica* (beheda), *Grevelliea robusta* (silver oak), *Bauhinia variegata* (kachnar) and *Cupressus torulosa* and some others was done. Out of these species, silver oak was found first in its performance while Harad was found second, other species showed poor performance at that site. Akhrot planted in winter of that year showed a better performance. Protection of area through social fencing and moisture retention activities also brought a remarkable change in the vegetation density. People got encouraged for adoption of forestry practices in the area through awareness programmes.

Exploitation and Utilization of Beneficial Microflora from the Sholas for the Restoration of Degraded Shola Forests in the Nilgiri Hills, Tamil Nadu

Rhizosphere soil samples collected from the root zone of different shola species in Kotagiri, Glenmorgan, Governor Shola, Kariamandu and Pykara areas in the Nilgiri Hills, Tamil Nadu were analyzed and recorded the status of AM fungal spore population and PGPR population density. Three types of AM fungi Acaulospora, Gigaspora and Glomus were recorded. Ninty four isolates of PGPRs (PSB 42 isolates, *Azotobacter* 26 isolates and *Azospirillum* sp. 26 isolates) were isolated and identified and pure cultures of these strains are maintained in the Institute's germplasm for further studies. Screening of efficient PGPR isolates was done by IAA production and phosphate solubilization and the best isolates were selected for nursery experiments. All the soil samples collected from different shola sites were analyzed and estimated for the physico-chemical properties such as pH, E.C., macro-nutrients. Nursery experiment was conducted at SFD nurseries at Coonoor and Ootacamund. Seedlings of selected shola species were inoculated with different bio-inoculants isolated from various shola soils. Study revealed that beneficial microbes (bio-fertilizers) inoculated seedlings had better seedling health and growth parameters over uninoculated (control) seedlings.

Fruits of ten shola species namely, *Michelia nilagirica, Mappia foetida, Viburnum erbuscens, Photonia notoniana, Michelia champaca, Berberis tinctoria, Syzigium cuminii, Syzigium arnottianum, Dysoxylon malabaricum* 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 fruits weight, fruit moisture content, seed moisture content, 100 seeds weight, germination %, shoot length, root length, collar diameter and seedling vigour were recorded. 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.

Preparation of the Management Plan of Asola Bhatti Wildlife Sanctuary, New Delhi

The required tasks as per the guidelines of WII for Preparation of Management Plan of protected area have been carried out. Vegetation survey including regeneration status, the assessment of the abandoned mining pits and soil sampling and analysis of the samples were carried out by FRI, Dehradun. Sample plots have been laid out and observations have been collected for assessment of inventory. For making out boundary map of the area and mapping of forest density, forest cover, forest type, the remote sensing and GIS techniques are adopted with active involvement of Forest and Ecology Division of IIRS. Field observations for this purpose have been recorded.

2.1.4 Bioremediation

Study of Bio-accumulation of Heavy Metals and its Impact on Different Plant Species

Different plant species for experimentation were sown and a waited for 3 months till the treatment given for the establishment of seedlings. The species were placed in the natural condition of central nursery of Forest Research Institute, Dehradun. Total six species (*Lagerstroemia* sp., *Holoptelea intergrifolia, Alstonia scholaris, Grevilia robusta, Dalbergia sissoo* and *Terminalia arjuna*) were watered daily (for one year). After 3 months, plant species had been ready for treatment with different doses of heavy metals. Different doses of heavy metals applied to plant soil at nursery level after different intervals. Heavy metal (Cu, Co, Cr, Pb, As) treatments with four different concentrations of 10mg/l, 20mg/l, 30mg/l and 40mg/l are applied to plant soil after different intervals till date.

Utilization of Fungi for Bio-treatment of Industrial Wastewaters

Experiments with different fungi mentioned below were conducted at different industries to test the growth and bio-remediation capacity of different fungi:- *Flavodon flavus, Oxyporus ravidus, Schizophyllum commune, Trametes versicolor, T. cingulata* and *Pycnoporus sanguineus*.

Three fungi namely *Schizophyllum commune*, *Aspergilus niger* and *Merulius tremolosus* showed growth in pulp and paper effluent. Only two species of fungi i.e. *Aspergillus niger* and *Trametes versicolor* showed growth in tannery effluent and also removed colour from the effluent.

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

Initial data collection for all the four dumping sites was done which include municipal solid waste generation rate (per capita per day), manual segregation of waste to know the percentage of each categories of waste (household waste, yard/garden waste, commercial/market waste), percentage of municipal solid waste that goes to Solid Waste Dumping Sites (SWDS). Procurement of secondary data from all respective municipal authorities regarding dumping site status. Calculation of Degradable Organic Carbon (DOC) was done at all the four selected municipal dumping sites, i.e.- Nanurkheda (Dehradun), Vikas Nagar, Doiwala and Rishikesh for summer, rainy and winter season to know the seasonal variation in percentage of DOC as well as the nature of the municipal solid waste. Estimation of methane emission from all the dumping sites is in the final stage.

2.1.5 Ecology and Environment

Role of Temple Forests in Rejuvenating Microclimate of Some Villages of Uttarakhand

To see the role of temple forest in rejuvenating the microclimate of Nagdev temple forest area, the temple forest was compared with a control site, which was nearby Nagdev temple area having relatively more disturbed forest.

Vegetation of both the sites was studied following standard nested quadrat method for trees, shrubs and herbs. All phyto-sociological parameters of tree, shrub and herb species common at both the sites also showed differences in these parameters at both the sites. Surface soil of both the study sites were also analysed for physicochemical attributes of their replicate samples and compared. Average values of soil samples for their different attributes have also shown clear variations in their ranges at both the sites.

Weather parameters viz. maximum, minimum temperatures, wind velocity, rainfall, sunshine hours etc. have been collected from both the study sites, compiled for monthly and annual values and compared. Daily climatic variables showed significant differences in some of the parameters. There are marked variations in the range of daily observations of all the micro-climatic parameters of both the sites. List of plant species present in Nagdev area (out side the study sites, not covered in quadrats studied) have been given along with plant species of Garhwal Forest Division.

Ecological Impact of Urbanization on Floristic Diversity in Natural and manmade Forests of Doon Valley

Increase in trees diversity, undergrowth biomass relative humidity and decrease in undergrowth species diversity and temperature was observed in the forest ecosystem as per increasing distance from urban/village habitations.

Habitations located nearby forest ecosystems show dependency on forest resources by mean of collection of fodder and fuel.

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

Monitored flowering, fruiting and seed maturity in *Rhododendron arboreum.* Permanent plots were marked for monitoring of seed germination and establishment of seedlings of *R.arboreum* and *M. esculanta* in the field. Seeds of *R. arboreum* were collected and tested for viability test in laboratory. Cyclic behavior of flowering was observed in *R. arboreum*. Seedlings establishment of *R. arboreum* and *M. esculanta* were recorded higher under open canopy as compared to the close canopy.

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

Field survey was done for selection of *Shorea robusta* (sal) and *Pinus roxburghii* (chir pine) forests. Employment of project staff and purchase of equipments were done. Survey of *Shorea robusta* (sal) forests at Thano, Lachhiwala, Timli, Chharba and Narendra Nagar was done and preliminary field data collected for the sites. For chir forests at Almus, Tyuni, Purola, Mori surveyed. Sample plots of different sizes were laid out at all these sites. Height measurement of all trees was done in all sample plots/ sites. Diameter classes of both the species at different sites have been worked out. Selection of mean trees from different diameter classes for felling at each sample plot has been done and felling of some trees of both the species has been done. Their biomass estimation is in progress.

Ecological Study of Wetland Forest Ecosystem of Doon Valley (Uttarakhand)

Asan Barage

The preliminary study revealed that the 57 plant species belonging to 27 families were recorded in the study area. Out of this, 10 tree species, 21 shrub species, 26 herb species have been recorded.

Jhilmil Area

The preliminary study revealed that the 76 plant species belonging to 30 families were recorded in the study area. Out of this, 20 tree species, 26 shrub species, 30 herb species have been recorded.

Impact of Forest Plantations on Ground Flora Diversity and Soil Characteristics Including the Prescription of Management Practices

The study, "Impact of forest plantations on ground flora diversity and soil characteristics" focuses on biodiversity dynamics as applicable to forest plantations since plantations could lend themselves to experimental investigations to a great extent. *Tectona grandis*, *Eucalyptus grandis* and *Acacia mearnsii* plantations were selected for studying the ground flora diversity, soil properties, soil microbes and soil fauna. *T. grandis* plantations were selected at Nilambur (Kerala) and Sadivayal (Tamil Nadu), *Eucalyptus grandis* and *Acacia mearnsii* plantations were selected at Nilgiris (Tamil Nadu) and Munnar (Kerala). Plant species enumerated in and around the selected plantations for quantitative assessment of ground flora diversity in different age group of Teak plantations in different plantations by laying out quadrates. Herbarium specimens were collected for species which could not be identified in the field.

Soil samples were collected from all the above plantations for studying soil properties and microflora. Soil samples collected from Nilambur and Sadivayal plantations were analyzed for soil microflora (VAM and bacteria). Soil samples collected from Sadivayal were analyzed for the soil properties.

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

Survey was conducted at Thellavagu nallah and data on flora and fauna were collected in every quarter. *Pongamia pinnata* was found to be the most dominant species in the diverted old Thellavagu nallah, whereas *Morinda tinctoria* is the most dominant species found in the diverted new Thellavagu nallah. Shannon Weiner tree species diversity index was found reasonably good in old and new nallahs with H= 1.293 and H= 2.55 respectively.

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

Four quadrats were laid i.e. three in the podu cultivated areas of Srikakulam, Bhadrachalam and Kakinada Forest Divisions and one on a control plot. Data on species occurrence were noted during two seasons and soil samples gathered for physico-chemical analysis. Soil samples are being analyzed at Forest Research Centre and ANGRU Rajendra Nagar, Hyderabad.

Seed Infestation by Insects Among the Emergent Rainforest Canopies at Makutta, Western Ghats

Laid out one-hectare sample plot and worked out species-abundance data on emergent canopies. Interception traps were set up in the one hectare sample plot. Insect emergences and extent of seed predation have been recorded. Field and lab germination studies have been carried out. Seed germination studies of important upper canopy species have been completed. On the whole, extremely variable seed predation rates were discovered across species–a few being highly vulnerable, and a few nearly excluded. High dominance and low diversity was discovered among the insect herbivores. Certain interesting patterns like that in *Dipterocarpus indicus,* where considerable temporal variation in predation pattern was discovered. Infestation pattern by the tephritid fly on seeds of *Dysoxylum malabaricum* revealed complex interactions between the tree, seed disperser and seed predator.

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 micro-climates, 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 years plantations, changing of soil properties and the similarities between plant species in each of those teak plantations and plant species in natural forest of teak.

Team at Work with Forest Officials

Teak Plantation

Preliminary survey of Barnawapara project has been completed for selection of sites and collection of maps etc. and site details have been recorded. Quadrats have been laid out in 12 compartment of teak plantation of various age groups. Enumeration of vegetation has been carried out in 21, 26, 30 and 36 years old plantation of teak. Thirty six trees, 6 shrubs and 13 herbs species have been recorded other than teak. Sixty two soil samples have been collected and analysis of soil samples is in progress.

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

Interactions between forest canopy cover and understorey vegetation for phyto-diversity conservation was studied and the effect of changing canopy structure and density on regeneration and growth of ground flora including native and alien species, edaphic and micro-climatic parameters was observed. Fifteen study sites were selected in Raigad, Ratnagiri and Sindhudurg districts (5 in each district) of Western Ghats of Maharashtra. Change in ground flora, soil characteristics and micro-climatic parameters like temperature and humidity were observed with change in canopy density. Number of species in ground flora increased with decrease in canopy density. 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. Natural regeneration of the species was also studied in the selected sites.

Counter Balancing the Detrimental Effect of Sponge Iron Factory-emitted Particulate Matters (SIFPM) with the Protective Effect of Vesicular Arbuscular Mycorrhiza (VAM) on the Growth of Weedlings 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* and *Butea monosperma* on a critical comparison with control data collected from least polluted areas. Physico-chemical estimations in terms of biochemical estimations (Chlorophyll, Sugar, Ascorbic Acid and Phenol) of leaf and soil samples are on process.

Experiments have been made with two sets at the nursery of TFRI; 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 analyses of which alongwith growth data should 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 after, 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.

Initial growth data of height (cm), number of leaves, and number of branches and collar circumference (1.5 inches above ground level) of all the 1200 plants were recorded during December 2010 to January 2011. Suspended Particulate Matter (SPM) was added in 600 of plants while 300 were maintained as control and 300 more kept to which only VAM to be added. VAM mixed with the potting media of specific number (400) of experimental plants.

- Categories and variables
  i. Control (Soil + FYM) 300 plants (?? baseline data)
  ii. Soil + FYM + SPM 300 plants (degrading agent¡)
  iii. Soil + FYM + VAM 300 plants (enhancing agent¡ª)
  iv. Soil + FYM + SPM (Pollutant¡) + VAM (Enhancer¡ª) 300 plants (result data)

VAM Culture

Treated Plantlets

Conservation, Management and Utilization of Selected Rattans of Assam

Surveys were carried out in Gibbon WLS, Kaziranga National Park, Dibrusaikhowa, Jeypore RF, Shillong. Soil sample were collected from rattan growing areas. Studies on phenology and growth parameters is being carried out.

Ecological Assessment of Medicinal Plants in Nambor Reserve Forest and their Socio-economic Impact on Fringe Villagers

Phyto-sociological study in Nambor reserved forest under Golaghat and Karbi Anglong district was done to identify the status of medicinal plants species in disturbed and undisturbed forest. In total 12 plots of 1 hectare were selected for the study randomly. The ecological data of 142 plant species have been collected, out of which medicinal uses and values of 85 plant species were identified based on ethnobotanic case studies. It has been observed that species like *Croton joufra, Smilax zeylanica, Rhus japonica,* and *Garcinia xanthoschymus* are threatened in the reserve. Socio-economic survey of 131 households was conducted in the fringe villages to collect information on medicinal uses of plants in their surrounding forest through a questionnaire. Emphasis was also given to focus the perception of these people about the conservation of medicinal plants. Information from different tribes was collected on the local uses of plants in different aspects apart from medicinal use. Market survey was also conducted and information of 57 medicinal plants pertaining to rate, availability and source of medicinal plants in five local markets situated in the fringe areas of the reserve i.e., Koilamati, Bukajan, Silonijan, Borpathar and Tengani was collected.

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 16 Sample plots have been laid out in the sanctuary covering four ranges.
- The sample plots have been marked semi-permanently for further evaluation of the gap dynamics. Species association patterns are being analyzed. So far 66 plant species are identified and authenticated.

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

Field surveys were conducted in Salna (Naogaon District, Assam), Gibbon WLS (Assam), RFRI Garden (Jorhat), Amguri (Sivasagar District, Assam), Dimapur, New Bisupui (Nagaland), Nongpoh, Darugiri (East Garo hill)- Meghalaya. Pollination Ecology, Embryology, Pollen biology and plant breeding are in progress.

Mapping and Quantitative Assessment of Geographic Distribution and Population Status of Plant Resources of Eastern Himalayan Region (Upper Assam unit)

Survey and sampling of 131 belt transects belonging to different sampling Grids (6.5 kms X 6.5 kms of size approximately in Assam: Jorhat, Dibrugarh, Golaghat, Lakhimpur

and Sibasagar districts) was completed. Collection of plant specimen (for preparation of herbarium), photography of all available plants in and around each belt transects were done accordingly. Information regarding girth, height, phenology was also collected as per prescribed format. The GPS location of starting point, midpoint and end point of all belt transects were noted. Information regarding tree, shrub and herb species of sampled area was documented. Herbaria of about 309 specimens were prepared following appropriate procedure. Upgradation of GIS database were done accordingly.

2.1.6 Biodiversity

Studies on Biodiversity of Parasitic Chalcidoidea (Hymenoptera) of Uttarakhand

Survey of eight districts of Uttarakhand (Dehradun, Haridwar, Tehri, Pauri, Nanital, Uttarkashi, Rudra Prayag and Chamoli) was carried out for collection of parasitic Chalcidoidea. Collection was done with the help of sweep nets and yellow pan traps. Hundreds of samples of insects were collected. Chalcidoids were sorted out in the laboratory under stereozoom microscope. Further sorting of collected specimens was done into 18 Chalcid families. Encyrtid parasitoids were identified upto genus level. From the preliminary observations, it was found that family Eulophidae was most abundant and species rich family followed by Encyrtidae, Mymaridae, Eupelmidae, Pteromalidae, Aphilinidae and Trichogrammatidae. Hundreds of hosts of these parasitoids were also collected from various localities and reared in the laboratory. Emerged parasitoids were preserved in alcohol/ card mounted. Several new species have been identified and work on their description is in progress. One new species of family Tanaostimatidae, *Cynipencyrtus indicus* Singh has been described. Genus Cynipencyrtus is recorded for the first time from India.

Recorded *Proleurocerus litoralis* Hayat and Kazmi (Encyrtidae) parsitizing egg masses of *Eurybrachys tomentosa* (Fulgoridae) from Doon Valley, Uttarakhand, which was also a new host record for the species. Earlier this species was known from females only, therefore, its males was also described. A new species of *Eutrichosomella indica* (Chalcidoidea: Aphelinidae) was described. Two new species of *Psyllaephagus* parasitizing and *Phacopteron lentiginosum* (Hemiptera: Psyllidae) forming leaf galls on *Garuga pinnata* were also described.

Taxonomic Studies on Parasitoids Belonging to Subfamily *Microgastrinae* (Hymenoptera: Braconidae) of Uttarakhand and Haryana

Survey and collection of Microgastrinae parasitoids was carried out from Uttarahkand (Doon Valley : Rajaji National Park, Mohand and Asarori Forest, Muni ki Reti, Rishikesh Forest Division, Barkot, Timili, Kalsi, Langha, Karwapani, Jhajara, Phanduwala, Lachchiwala Forest, Riawala, Chiriapur-Haridwar forest division and FRI Campus. Upper Himalaya (Forest areas of Tehri, Badshahi Thaul, Chamba, Kaddukhal and Dhanaulti) Haldwani (Ram Nagar Kaddukhal and Dhanaulti); and Haryana (Pinjor nursery, Chiken Kothi, Nolta and Jalon Forest range, Ambala Forest Division. Kalyeswer, Chhichharauli-Yammuna Nagar Forest Division). Comparison of field collected Microgastrinae parasitoids was carried out with available material in National Forest Insect Collection (NFIC) and identification was done up to species level.

Updating of Microgastrinae parasites of NFIC was done. Microgastrinae of NFIC includes 44 species in 8 genera and 4 tribes. These four tribes are Apantelini, Cotesiini, Microgastrini and Microplitini. Genera-wise number of species are: 19 species in *Apanteles*, 4 species in *Dolichogenidea*, 8 species in *Cotesia*, 1 species in *Diolcogaster*, 3 species in *Proapanteles*, 1 species in *Protomicroplitis*, 3 species in *Microgaster* and

5 species in *Microplitis*. Study was carried out on external morphology and taxonomic characters of Microgastrinae parasitoids reared in laboratory: *Apanteles galleria*: Wilkinson; *Apanteles plutellae,* Kurdjumov; *Microplitis mediator* (Haliday); *Cotesia eletrae* (Veiereck) and *Cotesia koebelei* (Riley). Key is prepared of all the described species of Microgastrinae parasitoids which were collected from Upper Himalaya, Doon Valley and Haryana.

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

Survey was carried out for collection of parasitoids belonging to subfamily Braconinae from different sites of Uttarakhand. Sorting of the specimens belonging to Braconinae from the collection has also been carried out. Identification of one species of each genus *Bracon* and *Atanycolus* has been done. Identification of Braconin parasitoids up to species level is in progress.

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

About two thousand card mounted specimens were sorted out from the general collection. Alcohol preserved specimen were also card mounted. Following genera and species were identified and work on further identification is continued: *Pleurotroppopsis* spp. (2 species), *Aprostocetus cauperdatus, Tetrasticus* spp., *Neotrichoporoides* spp., *Parahorismenus* spp., *Pediobius* spp. and *Elasmus* spp.

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

Literature survey and collection was carried out from various sources including internet. About one thousand specimens were sorted out from the general collection. They were all mounted on cards. Following species were identified (*Copidosoma varicornis, Lakshaphagus* sp., *Neastymachus* sp. nov., *Psyllaephagus* sp. nov. (2 species). Permanent slides were prepared.

Orthopteran diversity of the Nilgiri Biosphere Reserve (NBR)

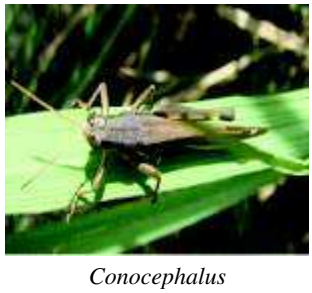
Study sites of seven habitats namely Scrub jungle (Masinagudi), Deciduous forest (Mudumalai), Shola forest (Kothagiri), Grassland (Kodanadu), Teak Plantation (Kargudi), Evergreen forest and Swamp forest (Gudalur) have been identified in NBR. Preliminarily six sites representing three habitat types viz., grassland, scrub jungle and deciduous forest (two sites/habitat types) with reference to disturbances which are anthropogenic interference such as grazing corridors and controlled fire have been identified. A total of 19 species of Orthoptera namely, *Xenocatantops humilis, Morphacris sulcata, Orthacris maindronii, Oxya nitidula, Heiroglyphus banian, Cyrtacanthacris tartarica, Acrida exaltata, Aularches scabiosa, Eyepreponemus alacris, Ailopus thalassinus, Phlaeoba infumata, Tyloterpedus varicornis, Gastrimarcus affricanaus, Hetracris pulcher, Conocephalus maculatus, Euconocephalus incertus, Himertula* spp. *Hexacentrus major* and *Gryllodes sigillatus* belonging to three different families were recorded. The family Acrididae shared the largest representation of 14 species followed by four species of Tettigoniidae and Gryllidae by one species. The species *X. humilis, C. maculatus* and *P. infumata* common in all habitat with the host range of some species has been studied.

Some of the Orthopteran species/Habitats recorded in NBR

Swamp Forest

Shola Forest

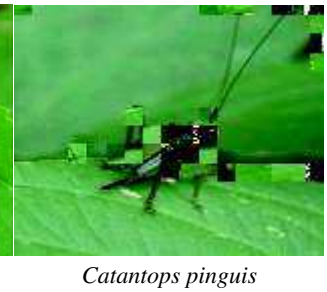
Deciduous Forest



Conocephalus maculates

Phlaeoba pictus

Gesonula punctifrons



Catantops pinguis

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

Preliminary identification of site/transects for the sampling work was carried out during the first year at the study area, Makutta, based on the observation and existence of fungal fruiting bodies. A total number of 5th transects were identified. Line transect method was followed for the actual sampling work to be carried out in the study area. Regular visit to transects for documenting the macrofungi were carried out during all the quarters. Documentation based on the prevalence of fungi during monsoon, pre and post monsoon is carried out through photographs, collections and characterization of the macrofungi. A total of 150 macrofungi were identified. Substrates of the fungi were also recorded like; fallen logs, twigs and snags. A manual is being developed for field identification of macrofungi for the study area.

Achanakmar-Amarkantak Biosphere Reserve

A complete UNESCO nomination document of Achanakmar-Amarkantak Biosphere Reserve was prepared and submitted for designation on the World Network of Biosphere Reserves. Collected literature on biosphere reserves of tropical moist/dry deciduous forest types and information on flora and fauna was updated. Meteorological data from core and buffer zones of Achanakmar-Amarkantak Biosphere Reserve were collected. Status of economically important threatened flora was recorded in buffer zone. One day workshop on identification of butterflies and birds of Achanakmar-Amarkantak Biosphere Reserve and sustainable harvesting of NTFP's was conducted in October 2010. Biannual series of information of Biosphere Reserve (BRIS) was published. Out of 12 species of butterflies and 24 species of moths collected from the buffer and transition zones of Biosphere Reserve, butterfly *Ypthima avanta* and 20 species

of moths is new addition to the insect faunal composition of Achanakmar-Amarkantak Biosphere Reserve.

Exploration and Conservation of Genetic Resources of Selected Rare and Endemic Plants of North-East India

Surveys were carried out in Karbi-anglong, Golaghat and Jorhat district, Assam and Mon and Mukokchung district, Nagaland to explore the distribution of *Livistona jenkinsiana* and *Gnetum gnemon*. *L. jenkinsiana* found sporadically at higher altitudes of Meghalaya. Different uses of *L. jenkinsiana* and *G. gnemon* were recorded with consultation of rural people. Rural people conserve and give care for the growth of the species, since people use the leaves for roofing and preparation of indigenous "Japi". Seeds of *L. jenkinsiana* were collected from the study site along with stump cuttings of *G. gnemon,* leaves of which are used as leafy vegetable among different communities, were also collected from Nambor Wildlife Sanctuary and raised for nursery trials in the experimental garden at RFRI for germination and survival. Survey was carried out in foothills of Mon district and Mukakchun district of Nagaland, Cheerapunjee, Mawsinram, Dawki and Nongpou of Meghalaya for inventorization and studying the distribution pattern of *Vanda coerulea* where the species are naturally grown. *Renanthera imschootiana* recorded being restricted in Ukrul district of Manipur. Study on the natural occurrence of the species, data on traditional uses of the species, their ritual and ornamental importance in the society were collected by discussion with rural people. Survival percentage was recorded. Growth data of plantlets viz., leaf number, seedling height, leaf size, internode length, number and length of aerial root were taken initially and after three month of interval. Two numbers of new shoot initiation of *Vanda coerulea* were recorded in Sphagnum (moss) based media.

A Study on the Biodiversity of the Plant Resources of the Patch Vegetations Around Rural Homestead in Jorhat District, Assam and its role in Socio-economy of the Villagers

The study was conducted with an aim to make an inventory of plant resources of the patch vegetation and its different uses by the villagers in Jorhat District, Assam. Distribution and ecology of different species were studied in 30 study sites throughout the district. As per the distribution of plants in different areas along the riversides were dominated by *Lagerstroemia-Barringtonia-Premna* and *Bombax-Trewa- Bischofia* community. On the other hand, *Artocarpus-Castanopsis-Mesua* was found towards the foothill areas of Nagaland and the foremost species in secondary patches in western part of the district was *Schima wallichii*.

Socio-economic and ecological study was also done in the selected sites. About 230 plant species used by the villagers in day to day life were recorded. The different usages of the plant resources of the patch vegetations was categorized as timber, firewood, food, medicine, fodder, feeder plant for silk worm and some other minor uses. Timber yielding plants recorded in the study areas are *Artocarpus chama, Albizzia procera, Castanopsis armata, C. tribuloides, Cinnamum glaucescens, Dysoxylum procerum, Michelia montana,* and *Schima wallichii, Stereospermum colais* etc. Some species like *Machilus bombycina, Litsea monopetala, Heteropanax fragrans* are recorded as feeder plants for silk worm. The medicinal plants recorded from the sites were *Paederia foetida , Centella asiatica, Argyreia speciosa , Spilanthes acmella, Smilex zeylanica*, *Cromolina odorata, Clerodendron coleobrookeanum*, *Eugenia balsamea* etc.

The edible fruit plants available in the patches are *Antidesma bunius, Baccaurea sapida, Dillinia indica, Garcinia morella* , *G. xanthochymus*

and *Syzygium cumini,* etc. Other economic plants that have been used by the villagers in different non timber usages are *Calamus tenuis, Canarium bengalense, Clinogyne dichotoma, Aquilaria agallocha,Litsea cubeba* and *Livistonia jenkinsiana.*

Two awareness programmes-one titled "Patch vegetation, phytodiversity and livelihood" security at Jhangimukh, Jorhat and "Phytodiversity of patch vegetation, its value and conservation" were also organized.

Exploration of Diversity and Utilization Potential of *Sphagnum* Species of Forestry Importance in North-East India

Surveyed different Forest and commercial nurseries and localities to explore *Sphagnum* species in North-eastern region including Arunachal Pradesh, Tripura, Mizoram, Meghalaya, Sikkim and Nagaland. Meetings with SFDs, Scientists of NBRI, Lucknow; GBPHID, Sikkim; BSI, Shillong, Dehradun and Sikkim circle; NCOR, Sikkim; SFRI, Itanagar and Universities. Collected geographical information of Sphagnum rich localities. Collected specimens from different localities of East Khasi hills and West Khasi hills and prepared herbarium. The species variability among four species of *Sphagnum* were studied . Physical property (pH) of total four *Sphagnum* species were analyzed. *Bamboosa balcooa* and *B. nutans* selected for macroproliferation with *Sphagnum* species, *Cinnamomum zeylanicum, Elaeocarpus, Gmelina arborea* and *Aqularia* were selected for air layering experiments, while some orchid species selected for potting media experiments and got positive results .

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

Fruit body samples of *Ganoderma* spp. were collected from different forest areas of Kamrup, Morigaon, Nagaon, Karbi Anglong, Sonitpur, Jorhat, Dibrugarh, Tinsukia, Cachar, Hailakandi and Karimganj districts of Assam. Morphological characters of the collected species were done for enabling their identification. Isolation of the fungus was done from the collected fruit body samples of different *Ganoderma* spp. Standard method was followed for preparation of pure culture of different samples using Potato Dextrose Agar (PDA) as growing media. These cultured samples were maintained in the laboratory by conducting regular sub culturing at 15 days interval and preserved under refrigerated condition. Microscopic characters were studied under compound microscope and observations recorded regularly. Biochemical studies: Estimation of total soluble sugar, moisture content of different samples of *Ganoderma* spp. is on. Market survey for *Ganoderma* and its product: Study on availability of *Ganoderma* products in market of Assam is going on with the help of different distributors of commercial Ganoderma products present in Assam.

Biodiversity Impact Assessment of Strategic Flaghill-Dokala Road, Pangolakha Wildlife Sanctuary, Sikkim, India

Field surveys were carried out in Pangolakha Wildlife Sanctuary along the Indo-China/Bhutan Trijunction along the alignment proposed for construction of a 33 km road passing through alpine, sub-alpine and Type 14/C2-East Himalayan sub-alpine birch/fir forests (Champion and Seth,1968) between 3,500-4,000m was awarded to RFRI, Jorhat.

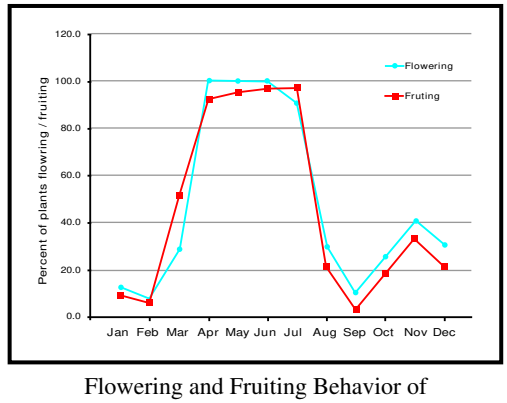
Type 14/C2-East Himalayan Sub-alpine Birch/Fir Forest on the Proposed Strategic Flaghill-Dokela Road, alignment along the Indo China Border in Sikkim

Assessment of Guggal Germplasm for Studying Population Density, Diversity, Female-male Plant's ratio for *in situ* and *ex situ* Conservation in Rajasthan

Project has three components viz., 1. survey work (to study population density and sex ratio), 2. conservation and 3. propagation. Sixteen districts viz; Ajmer, Barmer, Bhilwara, Churu, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Karoli, Nagaur, Pali, Rajsamand, Sawai Madhopur, Sikar, Sirohi and Udaipur were surveyed. Data on number of plants and associated species were recorded in sample plots (size 0.1 ha) with GPS locations. Spatial variation in the *Commiphora wightii* was clearly evident within the area. A positive association was recorded with species like; *Euphorbia caducifolia, Acacia senegal, Boswellia serrata, Anogeissus pendula, Capparis decidua* and *Zizyphus nummularia*. It was found that in hilly areas, on rocky tracks, *C. wightii* usually grows on the foot of hills. It grows well in sandy desert areas (Barmer and Jaisalmer). Plants in high density were found in Sawai Madhopur, Jhunjhunu, Barmer, Jalore, Sikar, Karoli districts, while in Nagaur, Pali, Jaisalmer Sirohi districts low density of guggal plants were observed. In ravines of Chambal river at Mandrayal range in Karoli district, it is widely distributed and density of guggal was 47 plants per hectare. High density of guggal plants were recorded in four places viz. Kot (Udaipurwati) forest block of Jhunjhunu, Tajpur (Sawai Madhopur), Kiradu (Barmer) and Chekla (Jalore). After survey of 16 districts, guggal was found in 61 forest blocks of 15 districts. In Churu, no guggal population was recorded. Male plants were not seen during survey.

Conservation: Germplasm was collected for *ex situ* conservation from identified 80 Candidate Plus Plants (CPPs). About 948 cuttings of CPPs with detail records were raised in vegetative propagation area.

Propagation: Guggal population at Kaylana (Jodhpur) was selected for annual studies of flowering and fruiting behaviour in Rajasthan where *Commiphora wightii* is growing in natural habitat. Observations on flowering and fruiting were recorded in each month from 66 guggal plants growing in this area. Annual pattern of flowering and fruiting is given in graph. In Jodhpur, guggal plants produced fruits twice a year i.e. from April to July (main fruiting season) and from October to December (delayed fruiting season). No fruiting was observed in Barmer and Jaisalmer districts during surveyed in the month of November and December. Immature fruits were observed in Ajmer, Jodhpur and Pali districts during survey in the month of August, October and November, respectively. These immature fruits were collected (from Barli and Arna sites of Jodhpur district) for *in vitro* germination. Mature fruits were not available at any of sites surveyed during this period (from August to December 2010).



Flowering and Fruiting Behavior of Guggal Plants at Kaylana (Jodhpur)

From Kaylana (Jodhpur) field, mature fruits were collected in March. Two types of seeds, viz., black and white were observed in mature fruits. The seeds were then air dried and kept in separate labelled air tight plastic containers at room temperature. Both black and white seeds were sown. Only the black coloured seeds were viable, while white seeds were non-viable. Germination percentage of black seeds was found to be 40% and germinated within 5-16 days after sowing.

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 to select *Prosopis juliflora* rich sites in Jodhpur, Pali and Churu District. Associated floral and faunal diversity was recorded of the selected sites. *P. juliflora* density was worked out in orans, gochars, reserved forest, saline lands, wastelands, water bodies and agriculture fields. The most common trees found associated with *P. juliflora* were *Anogeissus* species, *Prosopis cineraria*, *Tamarindus indica*, *Acacia nilotica*, *Capparis decidua*, *Salvadora* spp., *Azadirachta indica, Acacia tortilis, Acacia leucopholea, Acacia senegal, Zizyphus* spp. and *Agele marmelos.* Other floral diversity included *Calotropis procera*, *Tephrosia purpurea*, *Cassia auriculata*, *Aristida royleana*, *Aerva tomentosa*, *Leptadenia pyrotechnica*, *Euphorbia cauducifolia, Cenchrus ciliaris, Cyperus rotundus, Cynodon dactylon,* and *Chloris* spp. In *P. juliflora,* inflorescence varied from 5.1 cm to 11.1 cm. Size of pods varied from 7.6 cm to 20.1cm. Highest size of inflorescenece and pods were recorded in *P. juliflora* growing near water bodies.

Five groups of soil arthropods and entomofaunal invertebrates and four groups of vertebrates were associated with *P. juliflora*. Fauna associated with inflorescence and pods were observed and identified as 2 species of Hymenoptera: *Apis dorsata* and *Apis florea*; 2 species of Diptera and 2 species of Lepidoptera from Jodhpur district. Sap sucker *Oxyrachis tarandus* were observed feeding and breeding on the stem and branches and feeding on the green pods in association with black ants. They were predated upon by 3 natural biological predators identified as 1 species of reptile and 2 species of insectivorous birds. Two species of seed bruchids; *Bruchus chinensis* and *Caryedon serratus* were recorded from dried pods. One species of rodent was observed feeding on the semi-dried pods of *Prosopis juliflora*.

It was found that seeds are utilized as fodder, harvested tree used as fuelwood, bio-fencing, fencing, charcoal manufacturing and making parts of agricultural tools. Dried twigs of *P. juliflora* were also used to protect young planted saplings under various programmes. Dried twigs used for nest building by avian species. *Acacia auriculiformis* was not observed during the study period.

Fauna associated with exotic *Leucaena leucocephala* was identified and documented as *Apis dorsata*, *Apis florae* and *Polistes* spp. (Hymenoptera). The pods and seeds are eaten by *Psittacula krameri* especially the females. No insect was observed feeding on the pods or seeds of *Leucaena leucocephala*. It was found that *Acacia tortilis* pods were eaten by hanuman langurs *Semnopithecus entellus*.

Ecological Assessment of Floristic Diversity in Kalatop Khajjiar Wildlife Sanctuary of District Chamba, Himachal Pradesh

Phyto-sociological studies in the already selected sites were conducted by laying out the quadrats of different sizes randomly and seperately for trees, shrubs and herbs in different altitudinal zones. In this process, total number of plant species in Talai-I beat, recorded were 149 belonging to 55 families and 133 genera with dominance of *Quercus leucotrichophora*, *Picea smithiana, Berberis lycium, Cotoneaster microphyllus, Sarcococca saligna*, *Vibernum erubescens, Rumex hastatus, Valeriana jatamansii* and *Bupleurum falcatu w*hereas, in Khajrot beat, the total number went upto 105, belonging to 60 families and 95 genera with the dominance of *Picea smithiana, Sarcococca saligna* and *Valeriana jatamansii.* The total number of plant species recorded in Khajjiar beat were 101, belonging to 54 families and 95 genera with the dominance of *Persea duthiei,*

Coniferous Forest in the Sanctuary

Dactylorhiza hatagirea

Malaxis muscifera

Picea smithiana, Sarcococca saligna, Vibernum erubescens, Polygonum capitata and *Bergenia ciliata.* However, in Kangarrakh beat of the sanctuary area, number of plant species went upto the total of 127 belonging to 65 families and 119 genera with the dominance of *Pinus wallichiana, Pinus roxburghii, Berberis lyceum, Anaphalis triplinervis, Nasturtium officinale* and *Commelina paludosa.* The recordings of plant speices in Ala beat, reflected a total of 93 species belonging to 44 families and 87 genera with the dominance of *Picea smithiana, Sarcococca saligna, Vibernum erubescens*, *Valeriana jatamansii* and *Arisaema intermedium.* Similar recordings when made in Dainkund beat revealed a toal of 102 plant species belonging to 54 families and 95 genera. The dominant species recorded were *Cedrus deodara*, *Picea smithiana, Sorbaria tomentosa*, *Vibernum erubescens*, *Valeriana jatamansii* and *Erigeron multiradiatus* whereas, in Lakadmandi beat the total number of plant species recorded was 81, found belonging to 52 families and 76 genera. The dominant species were *Quercus leucotrichophora, Cedrus deodara, Sarcococca* and *Valeriana jatamansii.* Talai-II beat of the sanctuary area revealed 109 plant species belonging to 58 families and 102 genera with the dominance of *Cedrus deodara*, *Berberis lycium, Sarcococca, Bergenia ciliata, Valeriana jatamansii* and *Pilea scripta.* In Kalatop beat, total number of species recorded were 142 belonging to 71 families and 127 genera with the dominance of *Cedrus deodara, Berberis lycium, Sarcococca saligna, Bergenia ciliata, Pilea scripta* and *Valeriana jatamansii.*

In totality, the total number of plant species in the sanctuary area was 232 belonging to 76 families and 218 genera.

The field recordings also showed the presence of 100 plants species of medicinal importance from Kalatop-Khajjiar wildlife sanctuary, 7 species viz., *Cinnamonum tamala, Dioscorea deltoidea, Paris polyphylla, Podophyllum hexandrum, Polygonatum verticillatum, Taxus wallichiana, Zanthoxylum armatum* fall in the category of threatened plants. Also conducted the ethnobotanical study in 14 villages surrounding the sanctuary area and documented 45 plant species being used by the local populace for their day to day requirement.

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

The Noctuidae or owlet moths are a family of robustly-built moths that includes more than 35,000 known species out of possibly 100,000 totals, in more than 4,200 genera. They constitute the largest family in the Lepidoptera. Their distribution is worldwide with about 1,450 species found in Europe. Most have drab forewings,

Diversity of Moth Recorded During Night Hours on Illuminated Shrubs in Kinnaur

although some have brightly coloured hindwings. There are usually few differences between the sexes. The Noctuidae are also remarkable for containing an extraordinary number of species whose caterpillars are able to feed on certain poisonous plants without harm. These foodplants - namely Solanaceae (e.g., Nicotiana) and Fabaceae (e.g., Sophora) - contain chemicals that would kill most insects trying to feed on them.

During the period, the field survey was conducted in additional sites including the areas located in Kinnaur. Damage done to the host (only selected coniferous and associated vegetation) by these species was also recorded. Individuals of 17 sub-families out of 35 Noctuid sub-families have been collected with maximum individuals of the sub-family Hadeninae. A total of 2740 and 1360 specimens of Lepidoptera moths were collected from different conifer sites during 2009 and 2010 respectively. Out of these 663 and 737 specimens collected during 2009 and 2010 respectively belong to the Noctuid moths. Out of this collection, 117 species have been identified. 69 species of moths were dissected so as to study wing venation and genitalia for taxonomic updates. 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.

Phyto-diversity Assessment of Khasi Sub-Tropical Wet Hill Forest in Meghalaya

Literature survey was done intensively to keep an update of the research work in similar themes at RFRI, Jorhat; FRI, Dehradun and BSI, Shillong, as well as online sources. Phyto-sociological studies in Riat-Khwan Reserve Forest, Meghalaya were carried out by laying down 40 Quadrates for trees. Data collected pertaining to the anthropogenic activities around the periphery of the study area was recorded. Herbarium specimens were collected and 93 plant specimens were processed for identification at BSI, Shillong.

Assessment of Phyto-diversity Dynamics for Conservation in Jeypore Reserve Forest

Data for Phyto-sociological studies were collected from 7/10 sites for vegetation analysis and natural regeneration. One hundred species of plants have been identified so far. Density, frequency and basal area of plants have been calculated for two locations. A demonstration plot of one hectare was established in field. A training programme on the awareness of biodiversity and its conservation was also conducted in study area for eco-development committee members, rural people and staff of state forest department. Analysis of physico-chemical properties of soil is in progress.

2.1.7 Invasion

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

Regeneration of dominant tree species after removal of Lantana was studied under Sal and mixed vegetation communities in Rajaji National Park. Vegetation structure and composition as influenced by removal of Lantana was assessed under Sal and mixed vegetation communities and planted forest of Eucalyptus in Rajaji National Park. Soil moisture and soil temperature was monitored in Lantana removal and Lantana invaded sites under Sal and mixed vegetation communities. Appreciable changes in the dominance of some native understorey vegetation such as *Adhatoda vasica,*

Murraya koenigii and *Ehretia laevis* have been recorded as a result of removal of *Lantana* from the park area. Appreciable change in the dominance of grass i.e. *Chloris dolichostachya* has been recorded in planted forest ecosystem as a result of removal of *Lantana*.

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 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.

Hyptis suaveolens in Mixed Forest

Lantana camara in Teak Forest

Cassia tora

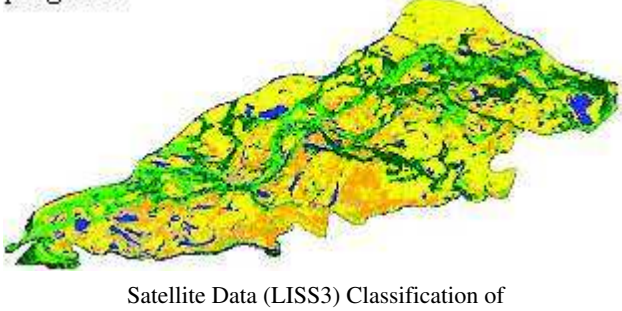
Hyptis suaveolens Infestation

- Preliminary survey of four districts (Jabalpur, Mandla, Katni and Seoni) has been completed for selection of site and collection of maps etc.
- Site details of the study sites have been recorded.
- 144 quadrats (1x1 m) for herbs and grass have been laid out in all sites and vegetation parameters recorded.
- Fourty eight quadrats (5x5 m) laid out for the study of shrubs and saplings along with invasive species.
- Fourty eight quadrate 20m x 20m for the enumeration of the species have been laid out in all districts.
- Total 39 FIS recorded.
- Phenological observations have also been recorded.

Investigations on Ecology of *Mimosa* invasion in Kaziranga National Park, Assam

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. Higher resolution satellite images (LISS 4, PAN) was procured from National Remote Sensing Centre, Hyderabad. Preparation of High resolution vegetation map of Baguri range is completed and Kohora range is in progress. GPS location (both polygons and points) of *Mimosa* patches were examined in the image thoroughly. Phyto-sociological study was carried out in

3 different *Mimosa* infested sites. Recorded phyto-sociological and regeneration data of all plant species found in tall grassland. Data on diameter and height of all the tree species were taken and all the individuals of shrubs/tall grass in each quadrate were counted. Computing and further analysis of data is in progress. Data recording on phenological events of *Mimosa* was also completed and phenograms were prepared. Seeds from healthy *Mimosa* plants identified in invaded areas were collected from Western, Central, Eastern and Buraphar 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 laid out. The seed burial effect, biomass analysis at different environment gradient and seed soaking in water at different intervals experiments under progress.



Satellite Data (LISS3) Classification of Kaziranga National Park, Assam, India

2.1.8 Forest Botany

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

The objective of this project is 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 micro-photographs 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'.

Fluorescent Studies of Indian Woods

Fluorescence is a new aid to analytical work and is finding increasing application in the characterization of a variety of products. Fluorescence is greatly intensified when viewed in ultra-violet light. Bodies, which exhibit little or no fluorescence when viewed in sunlight, begin to show brilliant and often characteristic fluorescence under ultra-violet light. So far, the application of this method for the study of wood has been scanty. The study on wood fluorescence got impetus after the same was mentioned under the feature list given by International Association of Wood Anatomists (1989) and mentioned as one of the important feature for wood anatomical studies. Thus, this study on the Fluorescence behaviour of Indian woods had been undertaken. Under this project, data was collected for 750 species (5000 wood samples) and reported.

Taxonomic and Anatomical Studies of Exotic *Pinus* Species

The genus *Pinus* consists of 110 species (Richardson, 1998) mainly distinguishable based on needles, cone structure etc. In India, 5 species are reported to be occurring in the temperate regions (Chauhan et al., 1996). Preliminary survey of the available literature indicate that species level identification of many of the exotic *Pinus* species has not been possible through their microstructure, and groups have been formed consisting of several species. Thus, it has become imperative to carry out study on the morphology and anatomy of exotic Pines for the purpose of their efficient utilization. This required morphological studies for identification of exotic *Pinus* species in field, literature survey to enlist areas in India having plantations of these exotic *Pinus*, their collection from their plantation areas and subsequent anatomical studies. Thus, the objective of the project was to carry out taxonomic and anatomical studies of exotic *Pinus* species. Herbarium and wood samples were collected from Champavat Forest Division,

Pithoragarh (Anusandhan Nursery & Suipatan, Lohaghat; Punethi Van Panchayat and Sukkhidhang, Champavat), Kalika Research Centre Ranikhet (Pinatum), Chakrata and Kalsi Forest Division and FRI. Following species were studied for their microstructure (71 wood samples) as per feature list given by International Association of Wood Anatomists (124 features) (IAWA, 2004)- *P. densiflora, P. elliotii, P. greggii, P. montezumae, P. oocarpa, P. patula, P. pseudostrobus, P. rigida, P. taeda, P. eldarica, P. halepensis, P. leiophylla, P. kesiya, P. oocarpa, P. patula, P. caribaea, P. echinata, P.merkusii, P. arizonica, P. durangensis, P. engelmannii, P. pringlei, P. brutia, P. corsica, P.edulis, P. monophylla, P. insularis, P. jeffreyi, P. torreyana, P. taiwanensis, P. nigra, P. formosana, P. jezoensis, P. koymai, P. mayri, P. polita, P. densiflora, P.armandii, P. koraiensis, P. laricio, P. lambertiana, P. montana, P. resinosa, P. ponderosa, P. sylvestris, P. strobus* and *P. monticola.*

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 are being looked upon as alternate source for many end uses like tool handles, furniture, agriculture implements etc. Also, stems of many shrubs are 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 are 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. 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 *Melastoma malabathricum, Oxypora paniculata, Osbeckia crinita, Azima tetracantha, Salvadora persica, Rhodomyrtus tomentosa, Psidium guajava, Myricaria squamata, Woodfordia fruticosa, Rosa lechenauitiana, 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 growth parameters namely tree height and Diameter at Breast Height (DBH) were measured for each individual before the collection of wood samples. Study material was collected from 100 progenies of *Populus deltoids* 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. Data for fibre length, diameter, wall thickness, vessel element length and diameter and specific gravity for 30 progenies were completed.

Digitization of FRI (Dehradun) Herbarium

- One thousand six hundred seventy four species details prepared; 1381 entered into the database.
- Eleven thousand nine hundred twenty specimen details prepared; 7861 specimen details have been incorporated into the database.
- Sixteen thousand nine hundred fourty one specimen photos have been taken and 13056 photos have been edited.

2.1.9 Tribals 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 antidysentery), *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.

Utilization Pattern of Plants in Ethno-medicinal uses Prevalent in Tribal Pockets of Satpura plateau in Madhya Pradesh

The traditional healers prevalent in the area of present study were in the district of Jabalpur, Mandla, Katni and Chhindwara who belong to Baiga, Gond, Bhariya, Kol tribes located in the Satpura eco-region of MP. These folk healers have inherited the art of healing, curing the patient by using medicinal and aromatic plants found in forest ecosystem around their tribal localities. These healers know the properties of large number of plants found in forest ecosystem which needs to be documented and scientifically examined for cure of ailment. Gradually, such plants are uprooted from forest in wild forms and due to heavy exploitation, many of these species are in the stage of being extinct category due to commercial utilization. Accordingly, such information on traditional knowledge has been documented on priority basis along with the commercial utilization of medicinal plants by traditional healers and several pharmaceutical companies involved in trade of this region.

Field survey was conducted to identify rich tribal pockets in Mandla, Jabalpur, Katni and Chhindwara districts of MP for documentation of traditional knowledge from traditional herbal healers. In all the 507 plants of medicinal value, which are being utilized by 134 traditional herbal healers of tribal pockets of above four districts for cure of various diseases prevailing among tribal/ local people were documented.

Existing utilization pattern along with formulation and duration of treatment etc. of medicinal plant being utilized by traditional herbal healers against various common diseases were also documented. Survey of Mandla, Jabalpur, Katni, Satna, Chhindwara, Bhopal and Sagar districts of MP were carried out to document the channels involved in marketing of herbal plants. Sixty eight traders involved in trading of herbal plants/parts were contacted to collect the information on trading. The price structure of sale of raw herbal medicinal plant parts was collected from local traders. Market day of tribal villages of Mandla, Jabalpur, Katni and Chhindwara districts, where, trading of raw and finished products take place was also visited and the information on trade was recorded.

Andrographis paniculata

Leea macrophylla

Details of Medicinal Plants, Traditional Herbal Healers and Traders Documented

District	Medicinal plants documented	Traditional herbal healers	Traders
Mandla	133	31	11
Jabalpur	128	38	10
Katni	119	35	10
Chhindwara	127	30	21
Sagar	-	-	02
Bhopal	-	-	07
Satna	-	-	07
TOTAL	507	134	68

Awareness was created through local contacts to the tribal people, traditional herbal healers and villagers of the study area regarding utilization of medicinal plants, importance and sustainable uses of herbal medicinal plants and their conservation during the field visits.

Ethno-Medico-Botanical Studies of Khasi, Garo and Karbi tribes

Nine villages namely, Morokdola, Sonaigaon, Aparikola (Kamrup District, Assam) and Pillingkata, Maikhuli, Umpher, Amphenggre, Matchkre, Umlangpur (Ri-Bhoi District, Meghalaya) were surveyed and information on the use of medicinal plants by Khasi, Garo and Karbi tribes were collected. In some villages meetings were also organized in the community hall for covering the maximum villagers. An enormous wealth of indigenous knowledge accumulated over long past and passed down from generation to generation with oral tradition. However, due to lack of documentation and present day communication facilities and availability of doctor or pharmacy nearby, use of medicinal plants for various ailments has been gradually decreased. Study revealed that common medicinal plants which are found nearby houses/ kitchen garden/road side etc. are still in use by the villagers for the treatment of various ailments. These are *Leucas aspera, Clerodendron viscosum, Ageratum conyzoides, Centella asiatica, Cuscuta reflexa, Lantana camara* and *Mimosa pudica*, etc. Some villagers who are interested in traditional knowledge collected plants of medicinal use and planted in their kitchen garden/ compound or as pot plants and use them when required. For example *Clerodendrum colebrookianum, Bryophyllum pinnatum, Oroxylum indicum, Aloe vera, Malastoma malabathrikum P aederia foetida, Houttuynia cordata, Terminalia chebula, Cinnamomum tamala* and *Rauvolfia serpentina* etc. Khasi tribe use *Abroma augusta* for curing urinary problem and *Thysonaela maxima* for keeping eye cold and clean. Different plant species used as medicine for various ailments were recorded.

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 Sahibgang district 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 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* collected and preserved as voucher specimens.
- Nearly 90 herbal practitioners belonging to Bathudi, Birgia, Birhor, Chero, Karmali, Kharwar, Kissan, Parhaiya, Sourya Pahariya and Sabar tribal communities were interviewed, so far, regarding the use of medicinal herbs for curing their ailments.

2.2 Forest Productivity

Overview

The productivity of our forests is one of the lowest in the world standing at 0.7 m^3 /ha/year as compared to the global average of 2.1 m^3 /ha/year. The forest plantations in India, constitute 17% of global population but their productivity is as low as 1.0 m^3 /ha/year. At the same time, output of the, plantations under farm forestry and agroforestry is also not as high as to match the productivity figures of other countries–major reason for it being the non-availability of quality planting material. 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 particular forests.

Increase in the population and over-exploitation especially of the forest resources for meeting the requirements of the growing populace, the demand for fuelwood, fodder etc., can no longer be met with from the existing resources. Accordingly, practice of agroforestry in its true sense needs 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.

Even the survival of manmade plantations is quite poor, key factor for this is related issues impinging directly upon the quality of the planting stock selected during establishment of plantations those are normally driven by the targets. For achieving plantation targets, the quality of planting stock is invariably compromised ignoring the fact that the success behind any of the plantation programme is the quality of nursery stock. Though, there are some morphological parameters fixed in case of important tree species for selecting the stock for out planting, yet are not adhered to for want of the number of plants required for achieving the targets. In fact, culling is rarely practiced in the forest nurseries in the country which, otherwise, is the most important component for getting higher survival percent and better establishment of plantations for enhanced productivity. Therefore, the outcome of the trails carried out in the nursery for standardization of parameters in the nursery stage can help in fixing the minimum standards of seedling quality.

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.

The effective planning and implementation of afforestation programmes depend on the availability, at all times of sufficient quantities of seeds with right physiological and genetical characteristics. In the first place, 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 is stored until required without losing its germinative capacity and viability. Gujarat state Forest Department has selected plus seed stands, established several seed production areas, seedling seed orchards, CSOs under planting stock improvement programme.

Seed though take up only a minor proportion of the overall cost of plantation, establishment and their management yet their insufficient supply is often seen as a major bottleneck for carrying out various improvements in the production of planting stocks.

Keeping all these aspects in view, the ICFRE is making all out efforts through some research projects so as to suggest specific strategy to the stakeholders.

Seed database is being created on economically important forestry species of Jharkhand for the use of forest seed certification agency. Seed germination studies were conducted on seeds collected from Rajasthan and of *D.sissoo* and *A. catechu* collected from various seed sources of Gujarat.

The germination data of the trials laid out to find the optimum time of seed collection in *Juniperus polycarpus* revealed that second fortnight of November is the best time for seed collection. However, in case of *Fraxinus xanthoxyloides,* optimum time of seed collection is the second fortnight of October.

The moisture content of berries of the *Juniperus polycarpus* is 26.69%, whereas, in case of seed it comes out to be 9.20%. In case of *Fraxinus xanthoxyloides* the moisture content of the samara is 8.28% and that of seed it is 8.22%.

The seeds of *Juniperus polycarpus* stratified in cowdung and placed in open pits for 60 days duration during winter recorded maximum 70% germination, whereas, control (untreated) seeds recorded 40% germination. However, in case of *Fraxinus xanthoxyloides,* the best treatment for overcoming seed dormancy was gibberellic acid (1500ppm).

Air tight moisture-proof polysac containers under low temperature (<5^{0}C) in refrigerated condition were found to be the best storage container and storage environment for storing seeds of *Juniperus polycarpus* for maintaining seed longevity. The seed stored under such condition retained more than 70% viability after one year of storage and 55% viability after two and half years of storage, whereas, other storage containers/storage environment showed decreasing trend in seed viability. Similarly, best storage container and storage environment for storing seeds of *Fraxinus xanthoxyloides* for maintaining seed longevity was also air tight moisture-proof polysac containers, under low temperature (<5^{0}C) in refrigerated condition. The seeds stored under such condition retains > 80% viability after one year of storage and >70% viability after two and half years of storage period whereas, other storage containers/storage environment showed decreasing trend in seed viability.

Physical and physiological parameters including seed purity, seed morphology (length, width, aspect ratio, colour etc.), germination and storage behavior of 20 species were studied to create seed database on economically important forestry species of Jharkhand aiming at functioning of forestry seed certification agency.

Information on natural populations and plantations of kadamb and semul in Jharkhand, Bihar and West Bengal was collected and 70 Candidate Plus Trees were identified. Clonal propagation procedures for both the species have also been evolved.

Soil carbon and nitrogen sequestration potential of mined/overburden soils in Jharkhand is being enhanced through management practices. Soil samples were collected and analysed for understanding their nutrient status and the medicinal plants viz. *Asparagus racemosus*, *Decalepis hamiltonii, Hemidesmus* and *indicus* were planted in Tamil Nadu. These plants were also planted as intercrop along with the tree species. Soils of Western Rajasthan districts found deficient in nitrogen and phosphorus. Overall

46% soils were sandy loam, 29% - loamy sand, 20% - sandy, 3% - sandy clay loam and 0.5% - clay loam.

The soil samples were collected from the coal mine overburden and analysed. Pot trial experiment with four tree species in the overburden soil, reclaimed by vermicompost and green manuring, are being undertaken. Performance of species with respect to germination and growth is being recorded at Ranchi.

Casuarina equisetifolia, Casuarina junghuhniana and *Eucalyptus camaldulensis* have been planted at four locations namely Cuddalore, Jeyamkondam, Sembanoor and Sendurai in Tamil Nadu.

Two study sites as an OSR experimental area of Tropical Forest Research Institute, Jabalpur, and as an OFR in farmer's field, Neemkheda village, Jabalpur district were selected to establish the multitier cropping system by raising Aonla intercropped with Arhar and Adrak.

The project, to develop agroforestry models with *Wrightia tinctoria* R.Br. and *Gmelina arborea* Roxb. as tree species is being implemented.

Quality and yield improvement in agroforestry based food product under integrated nutrient management for bio-fortification was analyzed on the basis of pH value and organic carbon content in agricultural soil to establish correlation with Iodine.

The assessment of litter production by important agroforestry species indicated that *Grewia optiva, Morus alba, Celtis australis, Bauhinia variegata, Toona ciliata* and *Albizia chinensis* contributed significant amount of litter-fall annually through various litter fractions.

Integrated strategy is being developed for evaluation of indigenous fast growing multipurpose trees of eastern India for plantation forestry.

Two species of bamboos viz. *Bambusa nutans* and *Dendrocalamus strictus* were selected to establish the bamboo based agroforestry system at experimental area of Tropical Forest Research Institute, 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.

The experiments are being conducted to develop packages of practices for high yield plantations for bamboo. The data on survival rate and growth performance in terms of number of tillers and average height is being collected in the field trials. Training on Bamboo macro-proliferation and vegetative propagation was provided to officials of Goa Forest Department (GFD), Andhra Pradesh Forest Development Corporation (APFDC) and Karnataka Forest Department (KFD) during February, September 2010 and January 2011 respectively as a part of objective i.e. validation of packages of practices for high yield plantations for bamboo.

The studies are being carried out to extend shoot production period and enhance edible shoot production of selected bamboo species through cultural practices.

BPS of *B. nutans*, *D. asper* and *D. strictus* are being raised through Tissue Culture and clonal culm propagation at Ranchi, Lalgutwa and Forest Rangers College, Mandar. The plantation has also been raised in half an hectare of land.

The nature and degree of degradation and the limiting factors for tree growth in the degraded soils of Chhotanagpur plateau areas of Jharkhand sites were investigated. The species suitable for the area were screened and the strategy for reclamation of these soils were developed.

Application of rain water harvesting, afforestation and protection helped restoration of degraded hills by enhancing soil water, nutrients, number of herbacious species and biomass. In addition, there was increase in carbon stock and water, fodder and fuel wood availability.

Low cost enriched vermicompost has been developed for commercial production. A permanent low cost vermicomposting unit has been established at FRC, Mandar where vermicompost enriched with neem cakes, karanj cakes, phosho-bacteria, cow urine, and poultry manure is being produced.

Initiatives such as establishing field trials with preferred trees and crops along with suitable geometrical arrangements have been taken for productivity enhancement in abandoned jhum land through agroforestry management and value addition in Mizoram and Meghalaya.

Bambusa balcooa was identified as potential bamboo species for rehabilitation of jhum land with reference to carbon sequestration and livelihood development.

Productivity related parameters have been assessed under different land use practices including Jhum in three different watersheds of Arunachal Pradesh.

Five forest blocks studied for identification of indicator species revealed that *Tectona grandis, Lanea coromadelica, Anogeissus pendula, Wrightia tinctoria* and *T. grandis* are the dominant species at the sites in Banswara, Rajsamand, Pali, Palanpur and Sabarkantha districts, respectively.

Ficus bengalensis is the most common species of ficus retained by farmers in cropping systems and mostly grown for fodder for livestock and for small timber. Around 200 individual farmers and 16 villages were surveyed in 7 talukas in Mandya district to capture the ecological, economic and socio-cultural evaluation of a traditional Ficus based agroforestry system in Mandya district, Karnataka.

Sixty thousand seedlings of RET species (*Gmelina arborea, Pterocarpus santalinus* and *Santalum album*) were raised for distribution to farmers and stakeholders.

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, Ablomoscus moscatus, Rauvolfia serpentina, Emblica officinalis* and *Mxvimusops elengi,* out of 12 target species.

On the basis of survey, conducted in Kanhan region of Western Coal Fields Limited, Shivpuri area and Junnardeo and Pench area of Western Coal Fields Limited, for selection of coal mine overburden site for laying out experiment, the Shivpuri open cast mine-1 was selected for laying out the experiment.

Experimental plantations of deodar and ban oak are being maintained intensively in the field and the relevant data recorded regularly by Himalayan Research Institute, Shimla. The plantation success through wildling is still a critical issue since, the results are not encouraging and the fact is being investigated. Less snowfall and rains followed by severe drought subsequently during the years 2008-2009 and 2009-2010 might have added to the large scale mortality in the field conditions of the tall plants.

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 during 2008 and 2009 followed by continuous drought like conditions during summer, which resulted in large scale mortality in experimental plantations of deodar and ban oak – indicating moisture as the triggering factor for mortality.

Preliminary growth data indicated that the *Gmelina arborea* is performing well on all the study sites and have 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.

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 in M.P.

Projects under the Theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	18	40	25
Externally Aided	9	9	9
Total	**27**	**49**	**34**

2.2.2 Silviculture

Impact of Ban on Green Felling in Deodar, Kail, Fir and Spruce Forests of Uttarakhand

The Govt. of Uttar Pradesh (then Uttarakhand was part of UP) imposed ban on green felling, above 1000 m altitude in the Himalayas, in early eighties. Before 1980, the coniferous forests of the Himalayas were felled under prescribed silvicultural techniques of working plans. These forests are being managed by the forest department on salvage felling to meet the timber rights of the villagers. To observe the impact of ban on green felling in *Cedrus deodara, Pinus wallichiana, Picea smithiana* and *Abies pindrow* forests, twelve sites were selected in Uttarakhand in the coupes which were prescribed for felling but felling was not carried out and in those coupes where felling was actually done. Nanda Devi (Old Badrinath division), Uttarkashi and Chakrata forest divisions were selected for data collection based on the presence of species and records of compartment's histories, with the help of Uttarakhand forest department. Data were collected on phyto-diversity, growth of trees, regeneration status, socio-economic conditions of the people near forests and soil organic carbon, soil moisture and soil nutrients from felled and un-felled coupes.

It was observed that plant diversity of shrubs and herbs was high in un-felled coupes in comparison to felled coupes although tree diversity was observed more in felled coupes owing to presence of advance regeneration crops due to opening of canopy during felling. In felled coupes, monoculture species was observed but in un-felled coupes, some broadleaved species like oaks, maples, bhojpatra and burance etc. were also associated with coniferous species probably due to favourable micro-climatic conditions.

The growing stock and productivity of all the four conifer species did not differ significantly in felled and un-felled coupes. The normal regeneration trend was found in all age groups in felled coupes. A very sparse regeneration was found in un-felled coupes. The regeneration was affected due to slow decomposition rate of soil litters in un-felled coupes. The values of soil organic carbon and soil organic matter were found high in un-felled coupes. It may be due to slow decomposition rate of soil organic matters in un-felled coupes. Soil moisture did not show significant differences between felled and un-felled coupes.

The villagers, whose employment was based on felling operations, have migrated from the fringed areas in search of other employment. A few settled households were in favour of green felling but majority of fringed villagers were not in favour of felling owing to the fact that coniferous forests are protecting their houses and agricultural fields from natural disasters.

Study on Impact of Ban on Green Felling in Deodar, Kail, Fir and Spruce Forests of Uttarakhand and Himachal Pradesh. (A collaborative project of HFRI Shimla with FRI Dehradun)

Basic information pertaining to study sites from the offices of respective Divisional Officers was collected and the forests in Chamba, Shimla and Kullu districts were identified for the detailed investigations. Preliminary survey has been

Deodar Stand in Padra Riyas Forest of Naggar Range, Kullu Valley

undertaken in Chamba, Chopal and Kullu Forest Divisions of the identified districts and the basic information/ details of the forests was collected from compartment history files from the respective ranges. Accordingly, sites for carrying out the studies were selected in Naggar Range of Kullu Forest Division, Upper Chamba Range in Chamba Forest Division and Chopal Range of Chopal Forest Division.

During the year under report, Padra Riyas Forest area having Silver, Fir and Spruce forests and Nashala block supporting bluepine and deodar forest were investigated for detailed studies. However, on the information of the Chairperson of RAG, that the Forest Department (FD) is already working on a project with Indian Institute of Forest Management (IIFM), Bhopal, Madhya Pradesh, with the similar objectives, the institute has terminated the project.

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

One site, adjacent to Field Research Station of this institute located at Shillaru, District Shimla, was selected for establishing pilot scale experiment by using deodar wildlings. In addition, areas for extracting wildling for experimental purposes were surveyed and identified. The experimental plantations of Deodar was carried out, using tall wildlings of the species, during August 2008 and February 2009 and the same was repeated during August 2009 and August 2010. Wildlings were planted on the basis of height and root collar diameter classes. Experiments were also carried out as per Root Exposure Time and Root Desiccation Protecting Substances while extracting and planting wildling directly in the field.

Nursery studies were initiated during March, 2009 as per the availability of deodar plants in nursery beds. Deodar seeds were also sown in nursery during December 2009 and maintained properly for further research in the nursery. Nursery bed raised seedlings after attaining height of more than two feet were transplanted to gunny bags or plastic buckets for further growth, development and stabilization in the nursery conditions. Experiments are also being conducted on pruning, root exposure time during transplanting and root desiccation protecting substances similarly as being done in case of direct planting of wildlings.

Experimental plantations are being maintained intensively in the field and the relevant data are recorded regularly. The plantation success through wildling is still a critical issue since, the results are not encouraging and the cause is being investigated. Less snowfall and rains followed by severe drought subsequently during the years 2008-2009 and 2009-2010 might have added to the large scale mortality in the field conditions. However, the experiments have been repeated during August 2010 and the wildlings exhibited initial success. The findings, however, can be confirmed only after one summer.

Raising tall plants in the nursery in big containers such as gunny bags, plastic containers etc are in progress. Initiated works on tall planting

experiments in gunny bags with Gel Grow treatment in the nursery. For the benefit of end users particularly field functionaries of the Himachal Pradesh State Forest Department (HPSFD) a Training-cum- Interaction programme on "Production of Tall Plants in Nursery: Issues and Concerns" was conducted on 15th February 2011 at Forest Training Institute, Chail, district Solan, Himachal Pradesh.

Raising of Deodar Tall Plants in Nursery

Training on Production of Tall Plants in Nursery

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 (5,000) and ban oak (20,000) at Model nursery Shimla and Shilly nursery Solan respectively. Visited 35 nurseries of State Forest Department of Himachal Pradesh and collected information from field functionaries regarding nursery raising and quality parameters adopted in deodar and ban oak nursery stock. Sites were selected for carrying out experimental plantations in Shimla and Solan Forest Divisions. Experimental plantations carried out as per morphological parameters of these species during August 2008 & 2009 at six sites, three for each species. In order to develop interim minimum standards of quality of deodar and ban oak nursery stock, extensive survey in various deodar and ban oak nurseries of State Forest Department (H.P.) was carried out. The survey was done through structured interview and a questionnaire was developed for that purpose. It was found that only one physical parameter was adopted in the nurseries of State Forest Department (SFD) for measuring the quality of deodar and ban oak nursery stock i.e. height (shoot length) of the nursery stock. According to that the stock is considered fit for planting or marked as quality stock if the height is 9 inch or more. The root collar diameter, type of production system (polybag or bare root), age, site conditions of plantation area etc. are important for selecting quality stock for planting but not being considered presently. On the basis of field discussions, interim minimum standards for nursery stock of deodar and ban oak have been proposed for further discussions and finalization.

For achieving second objective of the project, out planting has been carried out during 2008 and 2009 rains based on morphological grading of nursery stock of ban oak and deodar. The experimental sites which are located in Shimla and Solan districts of Himachal Pradesh (HP) received very less snow fall/rains during 2008 and 2009 followed by continuous drought like conditions during summer which resulted in large scale mortality in experimental plantations of deodar and ban oak. Therefore, during the rainy season of 2010, the out planting experiments based on morphological grading of deodar and

Out Planting of Deodar and Ban Oak in Gunny Bags

ban oak nursery stock in gunny bags were repeated following Randomized Block Design (RBD) with 10 plants per replication. Initiated the studies for judging quality of deodar and ban oak nursery stock based on Root Growth Potential (RGP), were conducted during the year 2010.

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

Sites were selected for experimentation at Deoban, Chakrata Forest Division. Litter, humus and soil samples have been collected on monthly basis and soil samples have been analyzed for Total Nitrogen, Available N and Organic Carbon. Leachates of soil and humus were prepared. Seed of fir and spruce, collected from Chakrata, were sown in Deoban forest nursery for further experiments.

Enhancement of Seed Longevity of *Diploknema butyracea*

Seeds of *Diploknema butyracea* were collected from four locations in Pithoragarh FD (Uttarakhand). The seed parameters, initial germination, viability, vigour, studies on desiccation sensitivity of seeds were studied. For storage studies, seeds were desiccated to four moisture levels i.e. 30%, 25%, 20 % and 15 % and desiccated seeds were stored at four temperature viz. ambient room temperature, 15°C, 10°C and 5°C. Seed longevity could be enhanced to 30 days. 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. Morphological and biochemical studies during fruit/seed development was also done.

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

Seeds of *Bauhinia variegata , B. purpurea* and *B. retusa* were collected from 15 sources in Dehradun, Tehri, Uttarkashi, Muzaffarnagar, Saharanpur and Kanpur. Variability in seed morphological parameters such as total sample weight, seed length, seed width, seed thickness, seed colour, 100 seed weight, purity %, moisture content, number of seeds in a single fruit, number of seeds in 100g seeds were recorded. The seeds were subjected to moisture content and germination tests. Seeds from all the sources had high initial viability (85-90%). Seeds of all the sources stored well and maintained high viability (75 -85%) after one year in storage. Status of fungi associated with seeds of *B. variegata* and *B. purpurea* collected from FRI was studied. Out of seven sources of *B. retusa*, seeds of Kaichidham and Kandikhal had highest infection (21 colonies) followed by Retighat and Rambar source (20 colonies).

Enhancement of Seed Germination in *Anogeissus latifolia* Through Various Seed Technological Inputs

Seed Maturity indices of *Anogeissus latifolia* have been quantified and seed handling protocol developed. Germination and storage protocol has also been developed but needs to be confirmed with sound seed. More than 90% emptiness was observed in the seeds of species. Sucking of sap by insect from fruits during developing stage seems to be one of the causes of the emptiness for which studies are continuing and also planned for identification and control of the insect in collaboration with Entomology Division of FRI.

Seed Physiology of the Tropical Forest Species with Special Reference to their Maturity and Storage

Out of 12 target species germination percentage was found improved after pretreatments of seeds of *Schleichera trijuga, Terminalia arjuna, Sapindus laurifolia, Terminalia chebula, Ablomoscus moscatus, Rauvolfia serpentina, Emblica officinalis* and *Mimusops elengi,* . Other species did not needed any seed pretreatment. Studies on desiccation tolerance and seed storage behaviour had been done on *Schleichera trijuga, Terminalia arjuna, Hardwickia binnata, Moringa oleifera, Holoptelea integrifolia, Sapindus laurifolia, Terminalia chebula Ablomoscus moscatus, Rauvolfia serpentina, Emblica officinalis, Bassia latifolia* and *Mimusops elengi. Mimusops elengi* was found as intermediate and *Bassia latifolia* as recalcitrant. Other species were observed orthodox type and can be programmed for long term storage. Seeds of *Terminalia arjuna, Hardwickia binnata, Moringa oleifera, Holoptelea integrifolia, Sapindus laurifolia, Terminalia chebula, Rauvolfia serpentina, Emblica officinalis, Bassia latifolia* and *Mimusops elengi* were adjusted to three to five moisture contents and stored at four different temperatures for evaluation of storage potential for estimation of viability at regular intervals. Viability constants were estimated for four orthodox species: *Hardwickia binnata, Moringa oleifera, Holoptelea integrifolia,* and *Sapindus laurifolia*. Best storage conditions were determined for other species.

Studies on seed maturation for determination of seed collection time had been done and maturity indicators were determined on *Schleichera trijuga, Hardwickia binnata, Moringa oleifera, Holoptelea integrifolia, Sapindus laurifolia, Ablomoscus moscatus, Bassia latifolia* and *Mimusops elengi.* Seeds of *Rauvolfia serpentine* and *Emblica officinalis* should be collected after full maturity and seeds of these species need after-ripening for better germination. Biochemical characterization of three categories of seed. Total fatty oil and carbohydrate composition was compared between different categories of seeds. It was concluded that there was no significant difference among the three categories of seeds. As all these three species are oil-rich seed (fatty oil composition: *Schleichera trijuga*- 45%, *Bassia latifolia*- 51%, *Mimusops elengi*- 31 %.) As only one out of 12 species was identified as recalcitrant and another as intermediate, no conclusion could be made in this aspect.

Germination Ecophysiology of Two Important Tropical Forest Tree Species: *Schleichera oleosa* and *Pterocarpus marsupium*

A study on germination phenology and physical dormancy was done on *Schleichera oleosa* seeds. Immature and mature Seeds of *Pterocarpus marsupium* were collected from Jabalpur and Mandla District. Effect of seed maturation on germinability was done on *Pterocarpus marsupium.*

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

Studies on the effect of different levels of seed collection on natural regeneration of Sal (*Shorea robusta*) was conducted in three agroclimatic zones i.e. Bilaspur, Raipur and Bastar in Chhattisgarh. Sample plots were laid out in Marwahi, Dhamtari and Bastar Forest Division as per statistical design.

Phyto-sociological studies including regeneration survey of newly recruited seedlings of seed and of coppice origin were recorded. Flowered trees were enumerated. Hoeing, cleaning and fire treatments were applied to see its effect on regeneration of sal.

Sal seeds were collected and their weighing / counting were done. The seeds were

broadcasted under the sal trees as per the experimental design. After rains, again regeneration survey of newly grown seedlings of seed and coppice origin were done to see the impact of different treatments.

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

Seeds of 11 species were collected during the year 2010-11, amongst them five species (from 61 seed sources viz. 9 stands of *Acacia catechu*, 04 CPTs of *Dalbergia sissoo*, 32 source of *Tectona grandis*, 09 source of *Anogeissus pendula* and 07 source of *A. latifolia*) were tested for germination. 100 seed weight of *A. catechu* varied from 4.50±0.13g in seed-lot of Khakharia, Rajpipla seed stand to 5.66±0.19g in Mandav, Godhara seed stand. Seed germination varied from 64±3.74% in Mandav, Godhara seed stand, to 84±1.83% in Keliya Godhara seed stand.

100 pod weights of *D. sissoo* varied from 2.11±0.08g in seed lot collected from Fulwadi, Rajpipla CSO tree no. 5 to 2.51±0.04g in Tree no. 10 of the same CSO. Percent seed germination, varied from 35% in tree no. 2 to 41% in tree 10 of same CSO.

Amongst all the CSO of teak, the length varied from 8.20 mm in Manch, Rajpipla to 11.17 mm in Fulwadi Rajpipla and the width varied from 8.94 mm in Manch, Rajpipla to 11.38 mm in Manch, Rajpipla. The un-weathered stones ranged between 35.33 g in Fulwadi, Rajpipla and 51.38 g in Manch, Rajpipla. While from weathered stones the length, width and 100 stone weights ranged from 8.31 mm in Fulwadi Rajpipla to 9.75 mm in Fulwadi, Rajpipla, 7.77 mm in Fulwadi, Rajpipla to 9.94 mm in Manch, Rajpipla and 26.80 g in Fulwadi, Rajpipla to 39.24 g in Manch, Rajpipla, respectively. Locule/stone and seeds/stone varied from 3.56 in Manch, Rajpipla to 3.96 in Manch, Rajpipla to 1.08 in Manch, Rajpipla.

Seeds of *A. pendula* were collected from 09 sources from Ranakpur region of Rajasthan. Seed from all the sources were subjected to seed testing parameters. Number of seeds per gram ranged from 154.50±05.20 in Parasram mahadev to 254.75±18.06 in near Ranakpur temple. Germination percentage and vigour index ranged from 0.80% and 1.446 (near Ranakpur temple) to 3.48% and 7.274 (Ranakpur/Highway), respectively.

In *A. latifolia* number of seeds per gram ranged from 146.50±16.54 in Ranakpur to 241.50±05.00 in Jeatran, Rajsamand. Minimum value of germination percent and vigour index observed were 0.175% and 0.293, respectively in Jeatran. Whereas, maximum value of germination percent and vigour index were noticed 0.917% and 1.333, respectively in Jeatran.

Standardization of Methodology for Seed Collection, Seed Handling, Storage and Breaking Seed Dormancy in *Juniperus polycarpos* C. Koch and *Fraxinus xanthoxyloides* (Wall. ex G. Don) DC.

The germination data of the trials laid out to find the optimum time of seed collection in *Juniperus polycarpus* revealed that second fortnight of November was the best time for seed collection and the seed collected during this period recorded maximum of 40.00% germination as compared to other collection dates which recorded less germination percent. Similarly, germination data of the trials laid out to find the optimum time of seed collection in *Fraxinus xanthoxyloides* revealed that second fortnight of October was the best time for seed collection and the seed collected during this period recorded maximum 26.66% germination as compared to other collection dates which recorded less germination percent. The moisture content of berries and seeds of *J. polycarpus* and samaras and seeds of *F. xanthoxyloides* under different

collection dates were taken after complete drying in the laboratory. The moisture content of berries of the *J. polycarpus* is 26.69% and the seed is 9.20% respectively. The moisture content of the samara of *F. xanthoxyloides* is 8.28% and the seed is 8.22% respectively. The best treatment for overcoming seed dormancy in *J. polycarpus* seeds is cold moist stratification in cowdung. The seeds of *J. polycarpus* stratified in cowdung and placed in open pits for 60 days duration during winter recorded maximum 70% germination where as control (untreated) seeds recorded 40% germination. The best treatment for overcoming seed dormancy in *F. xanthoxyloides* is gibberellic acid1500ppm. The seeds of *F. xanthoxyloides* treated with different concentration of gibberellic acid ranging from 500ppm to 3000ppm recorded maximum 74% germination in seeds treated with gibberellic acid 1500ppm where as control (untreated) seeds recorded only 19% germination within a month's period.

The air tight moisture-proof polysac containers under low temperature (<5^{0}C) in refrigerated condition produced best storage container and storage environment for storing seeds of *J. polycarpus* for maintaining seed longevity. The seeds stored under such condition retains more than 70% viability after one year of storage and 55% viability after two and half years of storage whereas other storage containers/storage environment showed decreasing trend in seed viability. Similarly, best storage container and storage environment for storing seeds of *F. xanthoxyloides* for maintaining seed longevity is also air tight moisture-proof polysac containers under low temperature (<5^{0}C) in refrigerated condition. The seeds stored under such condition retains > 80% viability after one year of storage and >70% viability after two and half years of storage period whereas other storage containers/storage environment showed decreasing trend in seed viability.

Creation of Seed Database on Economically Important Forestry Species of Jharkhand Aiming at Functioning of Forestry Seed Certification Agency.

The study envisaged generation of base line information on physical and physiological characteristics of 20 important forestry species of Jharkhand. Identification of 16 important seed sources in 12 districts, recording of seed characteristics of 20 species on physical and physiological parameters including seed purity, seed morphology (length, width, aspect ratio, colour etc.), germination behaviour and storage behaviour in different types of containers and storage temperatures was carried out. A technical bulletin for dissemination of findings is in process of publication.

The study was important in the context that the seeds being employed in the ongoing plantation programmes were generally of poor quality having low germination percentage, poor emergence, poor survival and poor adaptability to site and susceptibility to disease despite continual advocating on use of high quality seeds from identified superior seed sources. That result in wastage of efforts, time and other inputs involved in the forestry endeavour. The most probable reason for use of inferior seeds resulting in such failures was due to lack of regional forestry seed database pertaining to variation in germination and other attributes due to seed sources. The Institute of Forest Productivity, Ranchi has built up the required infrastructural facilities to act as seed testing and certification agency under the project which will be beneficial for forestry operation in the region. The following are the achievements under the project :

Identification of 16 important seed sources in 12 districts, recording of seed characteristics of 20 species on physical and physiological parameters including seed purity, seed morphology (length, width, aspect ratio, colour etc.), germination

behavior, storage behaviour studied through recording viability under storage in different types of containers and storage temperatures. A technical bulletin for dissemination of findings is alsoin process of publication.

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

Seeds of *B. wallichiana* were collected from Matkangra block (Chakrata FD) at different stages of maturity and also Mandal forest in Kedarnath WLS. Almost 55-60% of the seeds were found empty. Fresh seeds yielded 15-20% germination and that too was very slow. Seeds were subjected to stratification, Gibberellic acid, KNO_3 and Cytokinin pretreatments for enhancing the germination. Seeds responded best to 45 days stratification yielding 63% germination, while it was 85% in GA_3 (0.02% for 24 hours) soaked seeds.

Cuttings of *B. wallichiana* collected from Chakrata FD were treated with various combinations of rooting hormones (IBA & NAA) and kept for rooting in the mist chamber. Air layering experiments were done on trees in Chakrata.

Establishing Germplasm Garden of Some Rare and Endangered Plants

Locations of five species viz. *Catamixis baccharoides, Ulmus wallichiana, Rauvolfia serpentine, Berberis aristata* and *Mahonia jaunsarensis* were identified and collection of propagation material (seeds/ cuttings/wildlings) was done from Chakrata, Haridwar 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. Germplasm of *Ulmus wallichiana* has been collected from Chakrata and Kashmir and plants have been produced successfully through cuttings.

Characterization of Eucalyptus clones for Physiological and Nutritional Parameters

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. B and total chlorophyll, total leaf area were worked out. Observations on physiological parameters and growth parameters are being recorded in four locations. Biomass sampling has been completed in four locations and biomass components like leaf, twig, branch, stem, etc. were collected for nutrient analysis. Soil samples were collected from two depths (0-15 and 15-30 cm) on monthly basis for recording the moisture status with reference to productivity of clones.

Nursery project on Rare Endangered and Threatened Species - *Gmelina arborea, Pterocarpus santalinus* and *Santalum album*

Sixty thousand seedlings of *Gmelina arborea, Pterocarpus santalinus* and *Santalum album* have been raised for distribution to farmers and other stakeholders. Nursery infrastructure like shade house and irrigation system have been developed.

Silviculture Studies of *Hippophae salicifolia* –A Wonder Lesser Known Plant of Uttarakhand

Three districts of Uttarakhand where natural populations of *Hippophae salicifolia* are found were surveyed i.e Uttarkashi, Chamoli and Pithoragarh. The geographic range of seed sources in Uttarakhand varied from 30° 03′ to 31° 34′ N latitude, 74° 30′ to 80° 13′ E longitude and the altitudinal range varied from 1949 to 3212 m above msl. The study suggested Chamoli district to be superior to the other two provenances. Hanumanchatti in Chamoli district could be recommended as a seed source for large scale plant production of the species for afforestation programme and for further breeding work as Hanumanchatti is superior to rest of the eleven

seed source with respect to various growth parameters studied.

Temperature of 25±1°C was considered optimum temperature for seed germination of *H. salicifolia* under laboratory conditions. The results revealed that 15°C, 20°C and 25°C temperature have positive influence on seed germination but 30°C temperature showed negative influence on seed germination. The maximum germination percentage was observed under red light followed by yellow light and minimum germination was observed in green light.

IBA 1000 ppm is most suitable hormones for initiation of rooting in the cuttings of *H.salicifolia*. IBA treated cuttings showed better results than IAA. In *H. salicifolia* phytohormones does not play much role but effect of season is important. Late March and April is the best season to plants its cuttings without any hormones. Vegetative propagated plants are better for field planting as comparison to seeds. Plants from seeds are very delicate and need protection till 2½ yrs of age and only those plants which are branchy/woody can be outplated. Like conifers *H. salicifolia* also need to be kept in nursery for longer duration. Weeding in polybags/root trainer is harmful for young seedlings of *H.salicifolia*.

Sustainable management of medicinal plants in JFM areas in different agro-climatic zones of Madhya Pradesh

Studies on sustainable management of medicinal plants in JFM areas in two agro-climatic zone of Madhya Pradesh was conducted. Sample plots, for the study of sustainable harvesting of *Andorgraphis paniculata* (Kalmegh), were laid out in Satnur, Naunichhapar, Delakhadi and Umaranala Forest area, Chhindwara Forest Division. Sample plots for the study of sustainable harvesting of *Buchanania lanzan* (Chironjii) were laid out in Sitadongri, Delakhadi, Khumbhadeo, Batkakhapa and Ojhaldhana Forest Area, Chhindwara Forest Division. Sample plots were also laid out as per statistical design in Umariya Forest Area, Katni Forest Division for the study of sustainable harvesting of *Asparagus recemosus* (Satawar) and *Chlorphytum borivillium* (Safed Musli).

Data on sustainable harvesting collected from the field was statistically analysed and interpreted. On the basis of three year's observation, it was concluded that regeneration of *A. paniculata* is sustainable at all harvesting level (20-80%) and thus, 80% entire plant of *A. paniculata* can be harvested for maximum productivity and without loss in regeneration. Regeneration of *B. lanzan is* sustainable at all harvesting level (60-90%) and thus, upto 90% fruits of *B. lanzan* can be harvested for maximum productivity and without loss in regeneration. Regeneration of *A. racemosus* and *C. borivillium* is sustainable at 20-60% harvesting level and thus, for maximum productivity and without loss in regeneration, 60% *A. racemosus* and *C. borivillium* plants with roots can be harvested.

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

Sites were selected in Morga, Kotadol, Litipara and Lohattar in Chhattisgarh. Experiments on foliar spray of chemical fertilizers were conducted in Morga to observe the effect of different doses of fertilizers, either individually or

Foliar Spray of Chemical Fertilizers on Tendu Leaves in Morga (Chhattisgarh

in combination, on increment in size of Tendu leaves using RBD statistical design. Surface and sub-surface soil samples were collected from the selected site and analysed in laboratory for their physico-chemical characteristics.

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

The information on natural populations and plantations of kadamb and semul was collected. Seventy Candidate Plus Trees were identified in Jharkhand, Bihar and West Bengal and relative analyses of CPTs was carried out on physiological parameters. The experiments were designed for evolving clonal propagation procedures and the Hedge garden/VMG of *Anthocephalus chinensis* and *Bombax ceiba* has been established.

Edible Shoot Production of Selected Bamboo Species and Extension of Shoot Production period Through Cultural Practice

Thirty five villages and 25 markets were 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. The 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 were conducted.

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.

2.2.3 Social Forestry, Agroforestry/ Farm Forestry

Effect of *Populus deltoides* on Medicinal Plants

The findings of the project indicates that Chitrak (*Plumbago zeylanica*) and Satavar (*Asparagus recemosus*) are suitable species of medicinal plants under poplar based agroforestry systems in Shiwalik foot hills of Uttarakhand. The farming of these medicinal plants can be started in three years old plantation and minimum two crops may be taken in a rotation of 6 years of *P. deltoides*. Poplar – Chitrak and Poplar – Satavar agroforestry models are economically viable and may be beneficial to farmers provided availability of market. The study has a vital utility for different category of stakeholders like farmers, plywood industries, pharmaceutical and State Forest Departments. The study also reveals that a proper guidance to farmers to adopt Poplar – Medicinal plants based agroforestry practices through different extension tools can also be helpful to raise the medicinal plants on their farmlands under agroforestry practices.

Tree- Crop Interaction: Effect of *Melia* spp. on Crops

Keeping in view of this a project on *Melia composita* was started under which experimental plots were established at Handesra in district Mohali and Hukran in district of Hoshiarpur. Focus was kept on interaction of *Melia composita* with agriculture crops like maize and wheat. Three plots having the spacing of 4X5m, 5X5m, 4X6m respectively were established at both places. Overall observations showed that the *Melia composita* attains about 14m height with a girth of about 65cm. Under proper canopy management the plants also give good amount of fuelwood in its rotation of 8 years. Yield of two crops i.e. wheat and maize was also recorded unto 4 years plantations of *Melia composita* under different spacing and it was found that there was no remarkable difference in the yield of both crops in comparison of open area crops. Property of the soil was also studied during the experimentation in all plots and it was found that there was no adverse effect on the fertility of the soil in *Melia composita* plantation. The fertility of the soil was found improved in plantation.

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

In the present scenario, agroforestry is aviable option for increasing tree cover in Eastern U. P. The unorganized and poor availability of wood based markets as well as timber industries depressed farmers for promoting agroforestry. But the market linkages are very poor in the Eastern U.P. as farmers and traders are not well aware about raw material as well as the trading sources of timber and Bamboos. Thus, with a view to strengthening market linkages between growers and traders, this study has been proposed in the region of Eastern U.P. Consultation of literature under the project regarding baseline data, identification of species , selection of districts, identification of market places , village list in respective districts .Under the study, important species of the area for agroforestry had been identified. The selected species are shisham, sagaun sam, neem, jamun, kathal, bamboo, mahua, popular, babool and *Eucalyptus*. The study area has been identified in consultation with UPSFD in six districts covering all the three agro-climatic zones lying under Eastern U.P. The selected districts are Allahabad, Raebareli, Barabanki , Bahraich , Gorakhpur and Sonbhadra. The questionnaire for collecting growers and traders information had also been prepared for market places, farmers, village information, industries, contractors, furniture/wood markets. The data collection has been done in two districts-Raebareilly and Allahabad for farmer/grower information having marketable timber under agro forestry. One representative village had also been selected from each block for collection of general information of villages, demand supply gap status of selected species and constraints in marketing of timber species. Likewise market details had also been collected from saw mills, industries and other market places. The data compilation is under progress for preparation of database of traders/growers.

Development of Site Specific Medicinal Plant based Agroforestry Models for Existing Plantations in Eastern Uttar Pradesh and Establishment of Demonstration Model

Surveyed the area for site selection for on-farm agroforestry participatory research and questionaire has been prepared for identification of suitable farmers for the participatory research. Site has been selected for experimental trials of medicinal plants in Allahabad district with the tree crops of mango, aonla, mahua, bamboo and *Eucalyptus* sp. Procured the propagules of sarpgandha, pachauli and satawar and kalmegh from CIMAP Lucknow and nursery for Propagation of medicinal plants and experiments laid out.

Establishment of Bamboo Model Plantations in Different Agro-climatic Zones of Tamil Nadu

Established bamboo plantations in 100 ha in different agroclimatic zones of Tamil Nadu using quality planting stock to demonstrate the growth performance of introduced species (*Bambusa balcooa, B. tulda, B. nutans, B. vulgaris and Dendrocalamus stocksii)* and native species (*Dendrocalamus strictus* and *Bambusa bamboos*) and also to demonstrate the growth performance of micro-propagated, macro-propagated and seedling raised planting materials. The species recommended for different zones in order of preference based on number of culms are:

Western zone: *Dendrocalamus strictus, Bambusa vulgaris, Bambusa tulda, Bambusa nutans, Bambusa bambos, Bambusa balcooa* and *Dendrocalamus stocksii.*

North-eastern zone: *Bambusa vulgaris, Bambusa tulda, Bambusa nutans, Dendrocalamus strictus, Dendrocalamus stocksii, Bambusa bambos* and *Bambusa balcooa.*

North-western zone: *Bambusa vulgaris, Dendrocalamus strictus, Bambusa nutans,*

Bambusa tulda, Bambusa bamboos and *Bambusa balcooa*.

Cauvery delta zone: *Bambusa vulgaris, Bambusa tulda, Dendrocalamus strictus, Dendrocalamus stocksii Bambusa bamboos, Bambusa nutans* and *Bambusa balcooa.*

Southern zone: *Bambusa vulgaris, Dendrocalamus strictus, Bambusa nutans, Bambusa bamboos, Dendrocalamus stocksii, Bambusa tulda* and *Bambusa balcooa*.

Among the different selected phenotypes studied for the 7 different species, BB5 and BB6 of *Bambusa balcooa,* BA1, BA12 and BA8 of *Bambusa bambos,* BN6 of *Bambusa nutans,* BT1 of *Bambusa tulda,* BV2 and BV6 of *Bambusa vulgaris,* DSI2 of *Dendrocalamus stocksii* and DS4 of *Dendrocalamus strictus* were found to be most adopted phenotypes which can be grown across different regions of Tamil Nadu.

The planting of seedlings, branch cuttings and rhizomes should be done prior to North-East Monsoon season preferably before October. Watering of plants should be done frequently to enable them grow vigorously before the rainy season. Bamboo needs water but cannot stand water-logging. Watering is needed in the dry season to keep the moisture balance inside the bamboo which is essential for survival of newly planted Bamboo and rhizome expansion. The clay soils and soils with low moisture retention capacity should be avoided. The bamboo should be grown in fields where irrigation is available since all the species other than the native ones have original distribution in wet conditions.The silica content in *Bambusa vulgaris* is low as compared to other species, hence paper and pulp industries particularly TNPL is promoting the same under contract farming. There is an assured market for the species in the present situation in Tamil Nadu. Hence farmers are encouraged to grow the species, provided they enter into contract with the paper mill.

Spacing for bamboo should be increased from 5X5m to either 7X5 or 7X6m since there is early congestion in plantations of 3 years age. Further, wide spacing will be useful for intercropping as well as future working of the clumps.Bamboo can be grown with agroforestry models and species like Tapioca, Turmeric, Groundnut, Banana and vegetables atleast in the initial years upto two years. Pruning of branches need to be done in the third year to decongest the clump which will also ensure clump hygiene. Branch nodal cuttings are the effective way for mass propagation of bamboos. From one branch a minimum of five to seven cuttings can be made. From each culm three to four branches can be obtained. The knowledge gained from the project has been used in the training programmes organised for Horticulture officers of Tamil Nadu, Farmers of Tamil Nadu and officials of NABARD, Tamil Nadu Forest Department and Puducherry Forest Department. A brochure on cultivable bamboos in Tamil Nadu was published for the benefit of farming communities.

Improving Productivity of Bamboo Cultivation in Farmlands of Tamil Nadu

Traditional bamboo planting is restricted to raising of few clumps of *Bambusa bamboos* along the bunds of agriculture fields as is prevalent in the Cauvery Delta region of Tamil Nadu. Under the project funded by the National Bamboo Mission, Department of Agriculture and Cooperation (Horticulture Division), Ministry of Agriculture, Government of India, block plantations of non-thorny bamboos viz., *B. balcooa, B. vulgaris, B. tulda, B. nutans* and *Oxytenanthera parvifolia* have been raised in farmers fields. Farmers were invited, through newspaper advertisements, to offer their land for raising non thorny bamboo block plantations from three agro-climatic zones of Tamil Nadu viz., Southern zone, Cauvery Delta zone and North-Western zone. Farmlands offered were inspected

and based on availability of irrigation and protection facilities, sites were shortlisted. In each location, 1.5 acre (0.6 ha.) of block plantation of each species has been laid out, in 2 replications, which is subjected to different levels of fertilizer treatment including control. In each location, 7.5 acre (3 ha) of field trials covering 5 species is laid out. In each agro-climatic zone, 3 such trials have been laid out totaling 9 trials spread over 27 ha. of on-farm trials. Data on survival are being recorded periodically.

In order to establish a bamboo germplasm and multiplication garden, 10 ha. area has been prepared within the IFGTB Field Station at Kuruchi, Coimbatore. Eighty one accessions of 34 bamboo species to be assembled in bamboo germplasm bank have been collected from across the country. Fourty accessions of 5 species have been assembled and are being maintained in the Model Nursery, Coimbatore.

Development of Elite Planting Material and Model Plantation

. For raising 50 ha of model plantations of Neem and Pungam, 15,000 Neem seedlings were raised in the Institute's nursery at Coimbatore while 12,500 Pungam seedlings were procured from a private agency. Utilizing the seedlings, 2 ha. each of Neem and Pungam plantations has been established at the recently established field station at Salem in the form of block plantations and line planting. Similarly Neem (5 ha) and Pungam (1ha) plantations were raised within BSF Campus, Kittampalayam, Coimbatore by adopting line planting model. Tamil Nadu Magnesite Limited (TANMAG), Salem has granted in principle approval for raising Neem and Pungam trees within their campus over 40 ha area in forthcoming monsoon season.

A Value Chain on Industrial Agroforestry in Tamil Nadu

The best Clones / Seedlots of *Eucalyptus* and *Casuariana* identified as superior by IFGTB are transferred to the Industry under a Material Transfer Agreement. This material in turn is supplied by the Industry to the farmer, with whom it has Buy-back management. It is a tri-partite arrangement between a Forestry Research Institute, Wood-based Industry and tree farmers. Two districts of Tamil Nadu are covered under this project (Agroforestry) by contract forming. The experimental sites or farmers field are selected in consultation with the Industry. About 30 ha plantation were completed in the farmers field under tri-partite system.

Casuarina: Two hybrid clonal trials were established in Coimbatore (Bharathiar university campus), Cuddalore and five clonal trials were established in the following five places Coimbatore, Erode, Karur, Namakkal and cuddalore.

Eucalyptus: One clonal-cum-progeny trial established for selection of clones/ families in high sodic soil at Athipalayam and 15 farmers field trials are established in Karur District like Athipalayam puthur, Uppilipalayam, Kanagapiliyur and 2 fields near NH 7 Dindugal main road. One hybrid trial established at Coimbatore.

The tri-partite arrangement is effective in transferring the results of research to the farmer's field. Genetically improved material is made available for planting by tree farmers and there is an assured market value for the produce due to the Buy-Back arrangement.

Development of Agroforestry Systems with Economically Important Medicinal Plants under Industrial Tree Species of Casuarina and Eucalyptus

Agroforestry is gaining importance as land use practice in different parts of the country. In farmlands, farmers intercrop tree species with many agricultural crops like cotton, soyabean maize, ground nut and many other food plants. While agroforestry models have been developed for these agricultural crops by many researchers,

no adequate research has been done to develop agroforestry system with medicinal plants. In the context of growing interest among the farmers for cultivating tree species in farmlands, particularly Casuarina and Eucalyptus and existing potential market for medicinal plants, the present study has been carried out to develop suitable agroforestry systems with medicinal plants. Under this study, industrially important medicinal plants such as *Asparagus racemosus*, *Cassia senna*, *Decalepis hamiltonii*, *Gloriosa superba*, *Hemidesmus indicus*, *Plectranthus barbatus*, *Withania obtusifolia* and *W. somnifera* have been selected. 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.

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

Identified the required land of 15 ha farm land in three zones (North-eastern, Cauvery delta and Southern zones of Tamil Nadu) and established agroforestry trials with fast growing tree species of *Melia dubia*, *Gmelina arborea*, *Neolamarkia cadamba* and *Sweitenia macrophylla* over 5 ha each in three zones. Intercropping activities were carried out and the biomass and yield of the intercrops have 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) per ha basis. Allelopathy study was also 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 was conducted on "Capacity building on agroforestry plantation establishment and management" to farmers' of Pudukottai district.

Gmelina arborea and Sugarcane in Southern Zone of Tamil Nadu

Melia dubia with Turmeric Field in Cauvery Delta Zone of Tamil Nadu

Neolamarckia cadamba, *Gmelina arborea* and *Melia dubia* under Farmer's Field in North-eastern Zone of Tamil Nadu (Villupuram District)

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

The experimental site was prepared for plantation at Chelmeda, Ramayampet Mandal, Medak District of Andhra Pradesh. Soil samples were collected from the study site and analyzed for physico-chemical properties. Seedlings of *Gmelina arborea* and *Wrightia tinctoria* was raised in FRC nursery and then planted out along with Red gram and Sorghum as inter crops. The inter crops were harvested upon maturation and yield data recorded. Growth data of *Wrightia tinctoria* and *Gmelina arborea* was recorded six months after plantation.

Ecological, Economic and Socio-cultural Evaluation of a Traditional Ficus Based Agroforestry System in Mandya District, Karnataka

Around 200 individual farmer surveys and 16 village level surveys have been completed covering 7 taluks in Mandya District. *Ficus benghalensis* is the most common species of ficus retained by farmers in cropping systems and mostly grown for fodder for livestock and for small timber. Ficus species are highly preferred by farmers in dry lands, but with irrigation, preference shifts to fast growing trees like eucalyptus and horticultural species like coconut which are financially more profitable. Logit analysis of factors influencing ficus adoption of ficus trees in farming systems revealed that adoption of ficus trees is positively related to livestock income and total land area and negatively related to percentage of irrigated area. Studies on litter fall pattern and nutrient input through litter reveled that total annual litter fall of *F. benghalensis* was around 2.5 ton/ha, out of which 60% was contributed by leaf litter alone. Peak litter fall months were found to be October–November. It was found that at an average density of 16 trees /ha, *Ficus* trees meet 77 % of N, 20 % of P and 68 % K requirement of dryland crops/ha/year. Litter decomposition studies showed that ficus leaf litter in subsurface treatment decomposed to half of its original mass in 169 days (half –life period) while when left at the soil surface took 200 days for decomposition of half of the mass.

Multilocational Introduction cum Demonstration trial and Field Evaluation of Six Important Bamboo species viz; *Bambusa balcooa. B. nutans, Dendrocalamus asper, D. hamiltonii, D. stocksii* and *Guadua angustifolia* in Andhra Pradesh, Karnataka and Goa

During May-June 2007 selection of sites in Andhra Pradesh and Goa were finalized in consultation of SFDs, whereas, the finalization of site for Karnataka was completed in June 2008. Production and establishment cultures of *Bambusa nutans, Dendrocalamus asper, D. stocksii* and *Guadua angustifolia* were carried out at IWST, Bangalore during 2006-2009. *Bambusa balcooa* and *Dendrocalamus hamiltonii* micro-propagated plants were procured from Grow More Biotech, Hosur, Tamil Nadu and IHBT, Palampur, Himachal Pradesh, respectively during 2007-2008. *Bambusa nutans* for Andhra Pradesh and Goa were also procured from TFRI, Jabalpur during June 2007. Field preparation and plantation was carried out during July- August 2007 in Andhra Pradesh (20ha at Chintalapudi, and Buggapadu) and Goa (5ha, Agalote). Field preparation and plantation was carried out during July-August, 2008 in Karnataka (20ha Navtoor, Shimoga). Achieved complete target of 45ha of demonstration trials (20ha in A.P., 20ha in Karnataka and 5ha in Goa) in 2008. Mortality replacement at all the three states was completed in September 2009. Regular data recording was carried out of the field trials to evaluate survival rate and growth performance in terms of number of tillers and average height. Training on bamboo macro-proliferation and vegetative propagation

was provided to the officials of Goa Forest Department (GFD), Andhra Pradesh Forest Development Corporation (APFDC) and Karnataka Forest Department (KFD) during February, September 2010 and January 2011 respectively as a part of objective i.e. validation of Packages of practices for high yield plantations for bamboo.

Sustainable Development of New Bamboo Agroforestry Techniques for Increased Income Generation in the Central Indian States

Two species of bamboos viz. *Bambusa nutans* and *Dendrocalamus strictus* were selected to establish the bamboo based agroforestry system at experimental area of TFRI 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. So far training through PRA technique was conducted for the farmers of Chhindwara and Gwalior district of Madhya Pradesh and Deopur and Raipur of Chhattisgarh during the 2008 and 2009 to train them about the benefits of bamboo based agroforestry system and its management. Distributed the seedlings of *B.nutans* as demanded by them. Standardized the Bamboo-Wheat and Bamboo-Urad silvi-agri system by repeating the system in two cropping season i.e. Kharif and Rabi.

Demonstration and Training on the Benefits of Bamboo Based silvi-agri systems being Imparted to Progressive Farmers of Majhuali Block of Jabalpur District on 23rd December 2010 at OSR, TFRI, Jabalpur.

Director of TFRI Addressing to the Farmers About the Benefit of Agroforestry

Post Harvest view of Bamboo –Wheat silvi-agri System Established as an OSR at the Agroforestry Experimental plot, TFRI, Jabalpur

PI of the Project is Giving Knowledge of the Sissoo-mays silvi-agri System During the Technical Session of Training

Prepared nutrient balance sheet through physico-chemical analysis of the soil samples collected before and after the each removal of the crop from the system. The data show the increasing status of nitrogen as compared to initial stage of land. Data of yield and growth parameters were recorded and statistically analysed to draw the effect of bamboo on grain yield under the intercropping. Data indicates the maximum grain yield of wheat under the *B.nutans* and minimum in *D.strictus*.

Evaluation of Productivity of Maize in *Dalbergia sissoo* (Shisham) and *Zea mays* (Maize) Agroforestry System

Dalbergia sissoo based agri-silviculture system was standardized by intercropping of Hybrid variety of *Zea mays* crops during kharif season under the age of 3 year old *Sissoo* plantation at the experimental area of TFRI. The data were collected on the various parameters (growth, yield, biomass and nutrient status) of tree crop under the system. Results, indicated that the maximum productivity of maize crop was in 5mx 5m spacing of sissoo, followed by 4m x 4m when intercropped with sissoo tree. Similarly the growth of *D.sissoo* plants showed gradual increase in height and girth, due to the fact that every cultural operation given to the associated crop provided benefit to the trees under the agroforestry system. Compilation, tabulation and analysis of data is under progress for the writing of report.

Organized one day training cum demonstration programme on *Dalbergia sissoo* and *zea mays* silvi-agri system for the farmers of four villages Padariya, Khamariya, Saliwada and Neemkheda of Jabalpur district.

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 10mx8m and 10mx6m intercropped with *Cajanus cajan* (Arhar) in Factorial RBD. Collected and analysed soil samples for the determination of soil properties (soil pH, EC and Organic matter content before the initiation of the system. Data on growth of aonla plants were recorded and tabulated.

Development of Lac based Silvi-Agri-Lac Systems

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.

Standardization of Cultivation Protocol for *Asparagus racemosus* (Satawar)

Maximum germination was observed in the month of June (70%) and the depth 2.5-3.0 cm gave better results. The observation showed that T2- fortnightly irrigation is the best treatment in terms of fresh root weight, plant height, length, diameter and number of tubers as compared to other treatments. The doses of FYM, Vermi-compost @12.5t/ha (i.e. 250 gm/plant), and VAM @5t/ha (i.e.10 gms/plant) were proved as optimum dose in terms of highest number of roots and fresh root yield. Spacing of 60 x 60 cm resulted in minimum damage during harvest of tubers and also improved the growth of tubers.

The best harvesting age of satawar to get maximum yield was 18-24 months. Chemical analysis of tubers had been done for satavarin IV from MPMFP Processing & Research Centre, BHOPAL and for saponin content from Venkatesh Food Industries, NISO 9001 HACCP certified company, Chhindwara. Satavarin IV content 0.73% and Saponin content of 49.0% was found maximum in FYM treated plots.

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

Three types of land uses systems were observed-settled, jhum and home gardens. In Jhum cultivation seasonal crop like tomato, cabbage, chilly etc. are in practices. In home garden the practice is pumpkin etc. Aquaculture is practiced traditionally. Activity calendar was prepared with the help of PRA tools and direct interaction with people etc. The activity performed in Singchung village, Tenga and Keopa village of Singchung block. Sakchi Kho watershed of West Kaming district was selected for second year. Collected all geographical details. Four type of land use system exist in Sacho-Kho watershed i.e: Jhum, settled, aquaculture and home gardens. With the help of PRA , RRA and questionnaire activity calendar was prepared. Soil analysis done using GPS point in Quantum GIS. Annual Report of Sakchi Koh is under progress, while data gathered from Tenga watershed are completed.

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

Study sites were selected for participating farmers in the on-farm research. The willing farmers were interacted for their problems and prospects. A questionnaire was also tested to record their socio-economic status based on seasonal market product. Participatory appraisal for their crop preferences and planning for field trials. The sites were prepared and lay out of the trials designed.

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

Soil samples and Plant samples (lady finger, bitter gourd , cucumber etc.) from Satra, Demo Village, Cachar, Sonitpur, Golaghat, Kokarajar, Nalbari Kamrup & Nagaon district were collected. Physical & chemical properties (pH, moisture content organic carbon, phosphorus etc) and iodine content of 37 soil samples have been analyzed. Field trial for iodine bio-fortification in bamboo based agroforestry crops (lady finger and cucumber) were established in Satra, Jorhat. Samples were collected and their iodine content under various treatments was analyzed. On the basis of preliminary data, it has been interpreted that correlation between iodine content and organic carbon is positive where as correlation between iodine content and pH is negative.

Development of Economically Viable and Integrated Agroforestry Models for Arid Region

An agroforestry model was established in August 2006 and maintained at farmer's field at village Harsh, Bilara and District - Jodhpur. *Sesbania aculeata* (Dhaincha) was grown in the field for green manuring. Survival, growth and crop production data were recorded, compiled and analyzed. Performance of *Cordia mixa* was found the best as horticultural species and *Prosopis cineraria* as silvicultural species. *Colophospermum mopane* plants attained maximum height (213 cm), followed by *P. cineraria* (203 cm), *A. excelsa* (200 cm) and *Cordia mixa* (183 cm) whereas *Z. mauritiana* attained minimum height (117 cm).

Collar diameter was maximum in *A. excelsa* (8.13 cm), followed by *Cordia myxa* (7.00 cm), *Colophospermum mopane* (5.60 cm) and *P. cineraria* (5.32 cm). The plant growth and survival was higher in agroforestry plots as compared to the control (without crop). Wheat crop production was recorded 14.03 quintal /ha during the year. Wheat crop production was found

reduced significantly in *C. mopane* and *Cordia myxa* tree combination plots in fifth year.

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

Procurement/collection of seeds of *Gmelina arborea* from five locations was accomplished through Institute of Forest Productivity, Ranchi and was later sown in the Field Research Stations of the institute locted at Johron (Paonta Sahib) and Bir Palasi (Nalagarh), falling in the District. Sirmour and Solan respectively. These two stations are located in low hill zone of the state and accordingly, have been used for the production of planting stock of the species. After field survey, four sites in lower hill zone at Puruwala and Kot in Himachal Pradesh (HP) and Nudh and Basanterbella in Jammu and Kashmir (J&K) measuring 5.0 ha have been identified and experimental trials with three replications and following Randomized Block Designs (RBD) were established. Preliminary growth data indicate that the *G. arborea* is performing well on all the study sites and have attained an average height of about 250 cms within three years of its establishment. Though very early to predict, yet, keeping in view the permormance of the species with special reference to the growth data and its short rotation period as well, it can be a potential species for carrying out future plantations in the lower hills of both these mandated states.

Evaluation of Soil Fertility Status and Nutrient Return from the Important Indigenous Agroforestry Tree Species in Himachal Pradesh with Special Reference to Hamirpur District

Quantitative parameters of agri-silvicultural system have been recorded for developing correlations and recommendations. The results indicate that the six important agroforestry species (frequency > 56%) selected for taking up the present study were also integral part of the naturally occurring agri-silvicultural agroforestry systems in the region. Collected soil samples have been analyzed. Nitrogen has been observed higher in the upper soil horizons which tend to decrease towards lower horizons of soil in most of the agroforestry species under the study. The preliminary results of soil analysis indicate a positive role of agroforestry species in maintaining the fertility status of the soil.

Nutrient contents in the litter of six important agroforestry species i.e., *Grewia optiva, Mours alba, Celtis australis, Bauhinia variegata, Toona ciliata* and *Albizia chinensis* had been undertaken. Litter samples collected from the experimental area were further segregated into various litter parts. These are oven dried in hot air oven at 80±2°C till the constant weight reached and are then ground in Wiley Mill for further chemical analysis. Results of litter production by important agroforestry species indicate that *Grewia optiva, Mours alba, Celtis australis, Bauhinia variegata, Toona ciliata* and *Albizia chinensis* all together contributes significant amount of litter-fall annually through various litter fractions. Results on nutrients contents in litter of agroforestry species indicated that leaves of these six important species have higher concentrations of either of the five nutrients (Nitrogen, Phosphorous, Potassium, Calcium and Magnesium) studied. Study showed that significant amount of nutrients had been returned to the ground/ soil by these agroforestry species.

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

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

soils and physico-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.

2.2.4 Forest Soils & Land Reclamation

Bioremediation of Bauxite Residue Through Bio-inoculants

A team of scientists visited HINDALCo for surveying the Red Mud Production. Red Mud is produced during the Bayer Process. HINDALCo dumps Red Mud, after drying process called dry stacking of Red Mud in nearby area closed to the forest. Red Mud Samples were collected and analyzed. Effect of bioinoculant in the bioremediation of Red Mud is being studied.

Phyto-remediation 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 facing the threat of waterlogging. About 4981.43 sq km area in Uttar Pradesh is suffering from water logging resulting in reduced productivity. The present study is aimed to phyto-remediate the waterlogged area through plantation of biodrainage species. Water logged site of eastern U.P. has been surveyed and nursery of selected species has been established.

Soil Organic Carbon Inventory of Uttarakhand

Total SOC pool in the soils in Uttarakhand under Quercus forests was 36.95 million ton, Miscellaneous forests 36.22 million ton, Chir forests 24.10 million ton, Sal forests 18.30 million ton, unproductive barren lands 15.01 million ton, silver fir & spruce forests 13.03 million ton, deodar forests 2.22 million tons, kail forests 1.26 million tons, *Eucalyptus* forests 0.91 million ton, teak forests 0.82 million tone, shisham forests 0.50 million ton, khair forests 0.24 million ton and the least was cypress forests 0.20 million ton. Total SOC pool under forests owned by forest department (24,41,480.41 ha area) was 149.73 million ton in Uttarakhand. 65.43 million ton SOC pool was under the forests of Garhwal zone (which is 43.69 % of total SOC pool in UK forests), 47.13 million ton was in the soils under Park and Sanctuaries (which is 31.48% of total SOC pool in UK forests) and the least was in Kumaun zone i.e. 37.17 m t (which is 24.83% of total SOC pool in UK forests). Maximum SOC pool was in the soils under forests in Bhagirthi circle (26.36 m t and 17.60 % of total SOC pool of UK forests) followed by North Kumaun circle (17.17 m t and 11.47 % of total SOC pool of UK forests), Western Circle (16.32 mt and 10.90 % of total SOC pool of UK forests) and the least was in South Kumaun circle (3.69 m t and 2.46 % of total SOC pool of UK forests). SOC pool in the soils under Apple orchards was 80.80 t ha^{-1}, Mango 50.69 t ha^{-1}, Citrus 47.55 t ha^{-1}, Litchi 44.92 t ha^{-1} and Guava 40.21 t ha^{-1}. Total SOC pool in the soils under Horticulture (1,93,787 ha area) was 10.75 million tons in Uttarakhand. SOC pool in the soils of grass land below 2750 m altitude was 86.57 t ha^{-1} while in the soils above 2750 m altitude, it was 143.76 t ha^{-1}.

Total SOC pool in the soils under grassland in Uttarakhand was 26.77 million ton. SOC pool in the soils under block plantation was maximum in cypress 66.32 t ha 1, followed by *Eucalyptus* 46.39 t ha^{-1}, Chir 43.30 t ha^{-1}, teak 42.93 t ha^{-1}, shisham 37.67 t ha^{-1} and the least was under poplar 31.41 t ha^{-1}. SOC pool in the soils supporting sugarcane–poplar model was maximum 33.48 t ha^{-1} while under wheat – poplar model it was 24.81 t ha^{-1}.

Relative Effect of Geology, Vegetation & Climate on Soil Formation of Uttarakhand

Uttarakhand forests of North-Western Himalaya are a confluence of all the rock formations resulting in different soil and vegetation types on different climatic zones. Mineralogical studies have special importance in forestry where tree growth lasts over a long period and depends to a large extent on the minerals as a source of nutrients in the soil. The underlying parent material plays a vital role in determining the success or otherwise of the plantations especially over a number of rotations in a given year on different climatic conditions The plant nutrients are chiefly derived from the weathering of minerals. The reserve and availability of nutrients depends largely on the mineralogical composition of soils and their parent material. The importance of geology in forest is of great significance in evaluating the soil fertility status and in managing the soils for greater production. Keeping in view the importance of soil mineralogy its study was carried out in Uttarakhand.

Extensive survey of natural forests in Uttarakhand was carried out. Suitable sites were selected on the basis of different forest vegetation, geology, altitude and climate in Dehradun, Tehri Garhwal, Pauri Garhwal, Uttarkashi, Chamoli, Rudraprayag and Nainital districts of Uttarakhand. In each site three subsites were selected and soil samples collected from different genetic horizons viz. 0-15 cm, 15-30 cm, 30-60 cm, 60-90 cm and 90-120cm with the help of soil auger. Further one soil profile at each site was excavated to study morphological features of soil. These samples are being analyzed for different physical and chemical attributes. The rock samples were collected from different sampling points having similar or different vegetation and geological formations. Suitable numbers of 10 x 10 m. quadrates were laid down in each sampling points and the trees within the quadrates enumerated for dbh, height and crown area. Different physico–chemical attributes of soil and rock samples collected so far are being analysed.

Soil Organic Carbon Store Under Different Land Uses in Haryana

Soil organic carbon is very important component of global carbon cycle. It is very sensitive to anthropogenic activities so it may readily depleted by anthropogenic disturbances such as land use changes and cultivation. Land is being used for different purposes viz. for forestry, agriculture, agroforestry, pastures, horticulture, plantations, habitat etc. Land use and soil management practices can significantly influence soil organic carbon dynamics. Accurate quantification of soil carbon is necessary for detection and prediction of changes over a period of time. Most of the data in literature is in the form of per cent soil organic carbon. Whenever it is converted in soil organic carbon pool / store, some assumptions have to be used especially for calculation of weight of the soil. No systematic study had been conducted in Haryana to estimate SOC pool neither in forests nor in any other land uses. Therefore, this project was undertaken to estimate SOC pool in different land uses in Haryana. Information generated from this project on SOC store in different land uses will serve as benchmark information for the future investigations and provide authentic information on this very important aspect of climate change.

Soil organic carbon is being estimating under four land uses viz. forests, block plantations, agroforestry and horticulture land uses in this project. Surveyed the different districts viz. Bhiwani, Mahendragarh, Rohtak, Jhajjar and Yamunanagar in this year in Haryana. Selected the sites at different locations and collected the soil samples under forests; plantations; agroforestry

and horticulture land use. Little over 1000 soil samples were collected from different land uses for soil organic carbon estimation and bulk density and coarse fragment estimation from more than 150 locations.

Identification of Suitable Tree Species and other Vegetation for Bio-drainage in Bargi Command Area (Jabalpur, M.P.)

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 left bank canal of Bargi command area, Jabalpur. Out of seven tree species planted along canal, *Eucalyptus* hybrid (FRI-4 and FRI-5 clones), followed by *Terminalia arjuna* and *Pongamia pinnata* showed a better performance of growth and biomass and lowered down the water table, regularly measured by observation wells. Lysimetric experiments conducted to simulate the field experiments also showed the similar trend.

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 mine-1 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. Fe, Mn, Zn and Cu. Seeds of the selected species viz, *Albizzia lebbeck, Acacia auriculiformis, Cassia siamea, Delonix regia, Emblica officinalis, Mangifera indica Moringa oleifera, Dendrocalamus strictus, Terminalia bellerica* and *Gmelina arborea*, were sown in polybags for raising seedlings. Seedlings are being maintained in the nursery. Further work is under progress.

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

Plantations were carried out in three different bamboo species (*Bambusa balcooa, B. nutans* and *Oxytenanthera parvifolia*) in selected sites of Karbi Anglong District, Assam. Sites were selected based on the criteria like willingness of farmers, status of degraded jhum land, easily approachable for monitoring etc. Geo-coordinates of the project site has been recorded and mapping done on image obtained through Google earth. Documentation of bamboo resources were carried out through extensive survey. Progressive growth data, plant and soil carbon, bulk density, biomass estimation of different species of bamboo in different spacing were carried out at regular intervals. Results showed highest value of plant carbon in *B. balcooa* followed by *O.parvifolia* and *B. nutans*, respectively. Growth and biomass estimation also follows the same trend. No significant difference was noticed in terms of soil carbon and bulk density up to second year of study.

Enhancing Productivity of Saline Wastelands in Kachchh-Through Improved Tree Planting Techniques and Silvipasture

Research trials were laid with *Acacia ampliceps, A. bivenosa* (exotic) and *Salvadora persica* (indigenous) on black silty clay (medium), soil depth: 40-75 cm at Kordha, Sami Range in Patan, Gujarat at the fringe of Wild Ass Sanctuary (WAS) in July 2007 to find out suitable exotic and indigenous fodder plant species with appropriate planting practice. *S. persica* proved to be the best species surviving in the extemely harsh conditions of high salinity, heat stress after two consecutive summers (2009 & 2010) and one drought year (2009) suffering almost no casualities and maintaining nearly the same mean survival (91.5%) after 45 months of planting . Fifty per cent

prunning was done in winter 2009 to over come water stress. *A. bivenosa* was at second place surviving one summer and one drought year with 77.3% at 30 months . However, survival was significantly reduced in summer 2010 and recorded as 46.3 % at 45 months. Survival of *A. ampliceps* was drastically reduced to only 12.7% ranging from 06.0 % in control to 18.7% in T_3 (Wheat husk) treatments. In general, causalities were high in shallow soil depth for both the *Acacia* spp.

S. persica attained height after pruning with a mean increment was 12.1%. Despite suffering with high casualities, *A. bivenosa* attained height (mean 126.7cm) in all the treatments. However, there was no growth in crown diameter. Treatments influenced the biomass yield and all the treatments recorded higher biomass as compared to control (3.43 kg).

Aacacia bivenosa (up) and *Salvadora persica* (down) in Salt Affected Site after 38 and 46 Months, Respectively

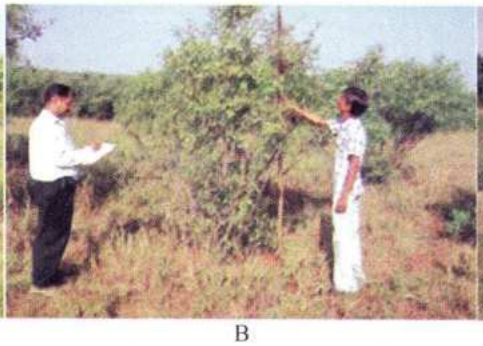
Zygophyllum simplex (Pat Lani)

Taverniera cuneifolia (Jathi moth)

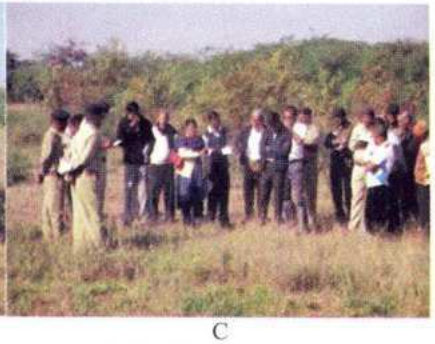
Maximum 12.68 kg biomass yield was obtained for T_3 (Wheat straw) treatment, followed by 10.22 kg for T_2 (FYM) treatment.

Green weed-mass was studied by laying random quadrats (1m x 1m) size in the entire experimental area. Among the plant species, halophytes were not dominated during 2010-11 due to very good rain creating water logging and salt leaching and favoured species appearance. Grasses dominated and *Chloris virgata* was the most dominant species, followed by *Dactyloctenium aegypticum, Cynodon dactylon, Aristida* spp, *Cyperus* spp. and *Echinochloa colonum. Sporobolus* spp. also appeared for the first time. Among herbs, *Zygophyllum simplex* was the most dominant, followed by *Taverniera cuneifolia*

A
Z mauritiana,



B
C. ciliaris and *Cordia gharaf*



C
Field Visit of VVK Trainees at Mochirai, Bhuj

(Jathi moth), *Sueada fruticosa, Vernonia cinerea* and *Polygala erioptera* .

Overall 406 gm^2 yield was recorded however, tree species-wise, variation was observed and it was 419.0 gm^2 (*A. bivenosa*) 391.2 gm^2 (*S. persica*) and 357.9 g in the shallow water logged area.

Silvipastoral Study: Trials with four tree species, viz; *Cordia gharaf, Prosopis cineraria, Zizyphus. mauritiana* and *Colophospermum mopane* and two grass species, namely, *Cenchus ciliari* and *C. cetigerus* were laid in RBD in three replication at Mochirai, Bhuj in July 2006.

Survival: In both the experiments, survival at 52 months was 93.8 % in *C. setigerus* and 92.6% for *C. ciliaris*. There was no significant difference between with grass and control treatments. Species-wise, *Cordia gharaf* recorded overall highest 98.6% survival, followed by *Z. mauritiana* (92.1%) and *P. cineraria* (88.8%).

Height: Plant species attained height between 38-52 months growth period. The mean incremental height was more of *C. setigerus*, 13.7 & 23.5% as compared with *C. ciliaris* 7.1 & 9.3% for control and with grass treatments, respectively. In *C. setigerus* experiment, the mean height was more for control plants (188.2 cm) as compared with grass treatment (148.3 cm), while reverse was true with *C. ciliaris* (Control-(184.9cm) and with grass treatment-166.5cm). During this period, species wise *Z. mauritiana* and *C. gharaf* recorded same mean height (221.0 cm), followed by *P. cineraria* (74.5 cm), although incremental height was maximum in *P. cineraria*.

Crown Diameter: After good rains in the year 2010, crown diameter at 52 months, the incremental crown growth was 20.0 & 32.7 % and 6.7 and 9.9 % for control and with grass treatments respectively, in *C. setigerus* and *C. ciliaris* experiments. *Z. mauritiana* continued to attain significant crown growth (211.3 cm) as compared to *C. gharaf* (190.0 cm) and *P. cineraria* (63.2 cm). It recorded 81% & 22.3% incremental crown growth with grass treatment and 41.5% & 10.3% in control with *C. setigerus* and *C. ciliaris,* respectively as compared to growth at 38 months, while it was 6.0 & 0 and 4.6 & 4.3 % only for *C. gharaf* at the same time.

Green Grass Yield: A long heat spell delayed monsoon, followed by downpour resulted in water stagnation, which adversely affected the green grass yield in both the experiments in the year 2010 and it was 0.67 and 0.45 kg/m2 for *C. ciliaris* and *C. setigerus* , respectively.

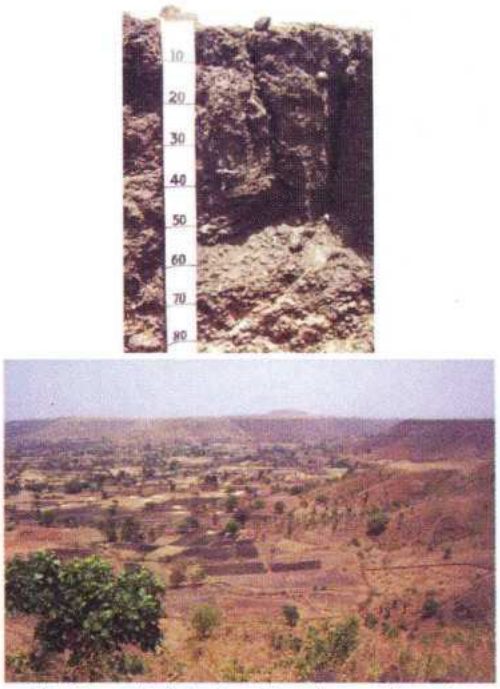
Physico-chemical Properties: Soil samples were collected in March 2010. In case of *C. ciliaris*, soil pH values were in normal range (>8.2) for both the soil layers (0-25 & 25-50 cm) inside plant pit and at a distance of 2 m from plant pit. However, with *C. setigerus* values were slightly higher both for pH and EC inside plant pit. Due to depression in field water collection resulting in hydrolysis of salts from soil.

In the summer months, percent (SOC) inside plant pit was higher in case of *C. setigerus* for both the soil depths. In both the experiments, control recorded lower SOC values as compared to with-grass-treatment. Percent SOC values at 2 m distance were higher for both the soil depths as compared to plant pit for control and with grass treatments.

A field visit of participants officials to Silvi-pastoral trial at Mochiri, Bhuj was also organized during three days of the farmers and forest officers (Guards, Foresters, RFOs and ACF) training, organized by VVK, Rajkot, AFRI, Jodhpur at Van Chetna Kendra, Bhuj from 14th to 16th December 2010.

Characterization and Classification of Forest Soils of Rajasthan

The project was initiated in September 2007 with the objective to characterize and classify the forest soils of Rajasthan following the USDA classification system. During the reporting period, soil profiles were studied at 215 places in Chittorgarh, Bhilwara, Jaisalmer, Baran, Tonk, Alwar, Bharatpur, Dungarpur, Jaipur, Pratapgarh, Jodhpur and Rajsamand districts covering 207 forest blocks. Soil texture, structure, consistency, colour, pH, electrical conductivity, organic carbon, NO_3 and NH_4–nitrogen and phosphorus were estimated for 780 samples covering 12 districts. In the vast sandy northwestern region, soils were predominantly saline or alkaline and sandy in nature. Sand content varied from 66% to 93%. In the eastern and southern districts, soils are neutral to alkaline in nature and soil texture varied between loamy sand to sandy loam with few soils in the category of sandy clay loam (22% clay content). Highest clay content of 32% was found in Bandikui, Dausa and Guapada, Banswara.Overall 46% soils were found to be sandy loam, 29% - loamy sand, 20% - sandy, 3% - sandy clay loam, 1.5% - loam and 0.5% - clay loam. In general, soils of western districts are poor in nitrogen and phosphorous. Available nitrogen and phosphorus varied between 7- 42 kg ha^{-1} and 8-56 kg ha^{-1} respectively. Soils of Chitrimata block (Fig 6), Pratapgarh has higher nitrogen (86 kg ha^{-1}) and phosphorus (78 kg ha^{-1}) content.

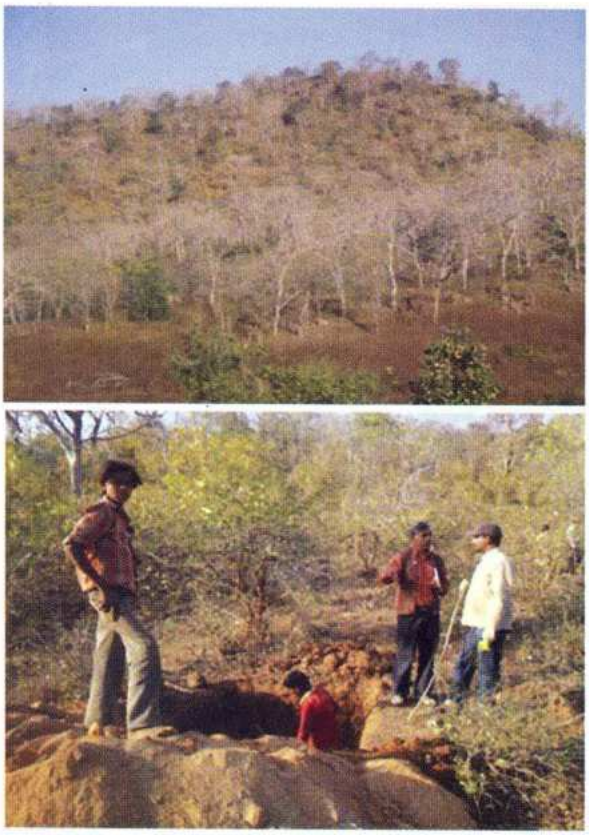


Clay Loam Soil (up) and Landscape (down) at Guapada Forest Block, Banswara

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

This project was started with the objectives (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, for its utilization in assessing land degradation and rehabilitation programme. The study areas are Aravalli/upper Malwa plateau covering five different locations with varying rainfall i.e., Banswara (Bara Nandra kho forest block), Rajasmand (Sabalia forest block) and Pali (Borvad forest block) in Rajasthan and Sabarkantha (Motimori forest block) and Palanpur (Trisulia forest block) in Gujarat.

Twenty five plots of 0.1 ha were laid out in 1 km^2 area following systematic sampling. Number of trees and shrubs were counted and measured for diameter at breast height, crown spread and height. Bara nandra kho site showed highest number of tree species, species richness and species evenness. The highest tree population (32.48 tree 0.1 ha^{-1}) and species diversity (1.08) were in Trisulia, whereas, highest tree dominance (0.54) was at Motimori forest block. *Tectona grandis, Lanea coromandelica*, *Anogeissus pendula*, *Wrightia tinctoria* and *Tectona grandis* were the dominant tree species in Banswara, Rajasmand, Pali, Palanpur and Sabarknatha sites, respectively. Total number of species was highest (12 ha^{-1}) at Banswara site, but species population was highest (95.56 trees 0.1 ha^{-1}) in Motimori forest block. Species richness (0.57) and diversity (1.18) were highest in Borvad forest block, whereas dominance (0.84) was at Trisulia forest block for shrubs. *Nyctanthes arbor-tristis* as shrub dominated both sites in Gujarat, whereas, *Euphorbia caudicifloia*, *Lantana camara* and *Rhus mysorensis* dominated at Borwad, Banswara and Rajsmand sites, respectively in Rajasthan.



Trisulia Forest Block Dominated by *Wrightia tinctoria* Trees (up) and Pit Opening and Growth and Diversity Study (down) near Ambaji in Palanpur division in Gujarat

Species Suitability and Reclamation Strategy for Degraded Forest Soils of Chhotanagpur Plateau, Jharkhand

Developed 0.10 ha nursery and prepared 2.41 ha land for field trials and raised 100-150 seedlings of 60 species for species suitability studies and 2000 seedlings of *G. arborea,* 1000 of *Madhuca indica,*1000 seedlings of *Pongamia pinnata* for reclamation of degraded soils. Rehabilitation and restoration of degraded sites through tree plantation with suitable species hold promise because of soil improvement, economic gain, ecological stability and landscape beauty and, thus, the objectives of the present project are relevant considering the constraints associated with the degraded soils of Chhotanagpur plateau. Over more than four years' of observations with 60 species, we have shortlisted 21 species, performing better in degraded soil of the region. Higher doses of NPK (50:30:30 g for 1-2 yrs & 100:50:50 g for 3 yrs old *G. arborea, M. indica* & *P. pinnata*) in addition to 1.5 kg Organic Manure for 1-2 yrs & 3.0 kg for 3yrs supplemented with 100 mg each of B, Fe, Mn, Zn , 25 mg Cu & 2.5 mg Mo per plant for 1-3 yr are essential for normal growth. Liming with either Lime or dolomite enhanced nutrient (N,P,K, Ca & Mg) uptake by *P. pinnata* than *M. indica* and improveed their growth. OM addition improved soil moisture status under *G. arborea*, more with rice husk and saw dust but for limited period (25-35 days). Liming reduces soil moisture more under *P. pinnata* than *M. indica*.

Development of Low Cost of Enriched Vermicompost for Commercial Production

A permanent low cost vermicomposting unit has been established at FRC, Mandar. The nutrient content of vermicompost has enhanced

significantly through application amendments (oil cakes, poultry feed, poultry manure and phosphobateria). Enriched vermicompost applied in different doses along compost and fertilizers on food crops viz., potato, tomato, radish and beans and their effects were documented. Enriched vermicompost @ 5 ton/ha and 10 ton/ha were showed highly significant results on growth and yield food crops. Vermicompost was also used as component of potting media. The enriched vermicompost production technology was imparted to 200 local farmers through 11 one day trainings. The results of field trials too were demonstrated to the famers.

2.2.5 Watershed Management

Efficacy and Economics of Water Harvesting Devices in Controlling Run-off Losses and Enhancing Biomass Productivity in Aravalli Ranges

Experiment was started in July 2005 with financial assistance from Rajasthan Forest department upto three years, later on by ICFRE with the objectives (i) to study the potential of different rainwater harvesting (RWH) devices in controlling run-off losses in different topographical conditions; (ii) to study the effect of different rainwater harvesting devices on biomass productivity and (iii) to study the economic viability of RWH devices for their adoption in large scale. For this, a total 75 plots of about 700 m^2 area were laid in 0-10, 10-20% and >20% with control, contour trench, gradonie, Box trench and V-ditch rainwater harvesting treatments. Seedlings of different species were planted and run-off measuring device installed. Plant growth, soil nutrients, run-off water and nutrient losses, soil water content and vegetation diversity and productivity were recorded throughout the study period.

Pooled data of four years indicated an average run-off of 12.58% of the total rainfall. Most effective rainwater harvesting treatments for controlling run-off losses are V-ditch in <10% slope and Contour trench in 10-20 and >20% slope area. The run-off was 14.63% from 10-20% slope area as compared to 10.22% from <10% slope and 12.90% of the total rainfall from >20% slope area. Among the treatments, highest run-off (13.55%) was from the control plots, whereas the lowest water loss was from V-ditch plots (11.05%). Overall soil loss of 3.43, 2.40, 1.21, 0.90, 0.24 and 0.19 g soil l^{-1} water was observed from the area in September 2005, July 2006, October 2006, July 2007, August, 2007 and July, 2009, respectively. This indicated a decreasing trend in soil loss per litre of water loss under increased vegetation cover in the area.

Growing vegetation influenced PAR reaching to the ground surface and maximum reduction in PAR was in 2010 by both tree and herbaceous vegetation. Soil water, which was retained under the influence of diverse vegetation during monsoon period, was utilized efficiently in rainfed period. There was a decrease in soil pH, EC and nitrogen and increase in PO_4-P (by 2.04-fold) in June 2010 than in June, 2005. The decrease in nitrogen concentration was lesser (by 9.7%) whereas the increase in PO_4-P was greater in >20% slope (greater than in <10% slope). The decrease in soil pH, EC and available nitrogen was greatest in gradonie, contour trench and control plots, respectively but the increase in the concentrations of PO_4-P was highest in the control plots.

Application of rainwater harvesting, improved plant growth. Soil characteristics was the most dominant factors influencing survival and growth, indicating greater height and collar growth of *Acacia catechu* and height of *A. indica*, *E. officinalis* and *Z. mauritiana* in >20% slope (relatively heavy and well drain soil) than in 10-20% slope (shallow loamy sand soil). Plant growth and MAI was lowest in the control plots, but gradonie structure was poor for plant growth. Plants were taller with highest MAI for height in CT plots, but thickness was relatively greater in

BT plots. *Dendrocalamus strictus*, *Emblica officinalis*, *Zizyphus mauritiana*, *Holoptelia integrifolia* and *Syzygium cumini* were the best suited to contour trench, *Acacia catechu* and *Azadirachta indica* were best suited to VD structure and *Gmelina arborea* was the best suited to BT rainwater harvesting structures. Interestingly, all the species of *Acacia* either planted or regenerated performed the best with V-ditch RWH treatment.

Number of herbs and grass species increased from 39 in 2005 to 92 at the end of the experiment. The number of species, population and species dominance increased with time. Species diversity and richness decreased to the lowest value in 2010. Pooled data for the dry biomass of six years ranged from 275.39 to 535.22 gm^{-2}. The lowest biomass was in <10% slope and the highest ($P<0.05$) was in >20% slope area (26.7% increase over <10% slope). It was lowest in the control plots. The increase in herbage biomass over the control plots were 28.22% in CT, 34.92% in Gradonie, 23.95% in BT and 18.84% in VD plots. But most interesting is the positive relation of species dominance (which increased with time with negative relation with species evenness) with herbage biomass and vegetation height. In general, grass production increased from 15 ton in 2005 to 36 ton in 2010 in about 17 ha area.

Treating the area with different rainwater harvesting structures/ plugging of the drainage lines in 2006 enhanced the water availability, which was utilised by ladies for bathing purpose and by livestock for drinking. Soil fraction, Soil Organic Carbon (SOC) and soil carbon stock increased significantly in June, 2010 and average increases in soil fraction were 3.7-fold in <10% slope, 3.2-fold in 10-20% slope and 4.1-fold in >20% slope. The increase in SOC and soil carbon stock were 0.98-fold and 3.6-fold in <10% slope, 1.3-fold and 4.36-fold in 10-20% slope, and 1.4-fold and 5.9-fold in >20% slope, respectively. Among RWH treatments, the increase in soil fraction was from 3.4-fold in control to 4.2-fold in VD plots, but SOC increased by 12.20% in BT to 28.16% in CT plots. The increase in soil carbon stock was by 4.1-fold in BT plots to 4.9-fold in VD plots.

A General View of Plants and Growing Vegetation (top left) and Growing Plants (top right). Collection of Fuelwood and Fodder from the Experimental Area, Gauapada, Banswara (bottom Left & Right)

2.3 Genetic Improvement

Overview

The primary consideration to bring about genetic improvement in a particular species is the development of a sound scientific programme, based upon the available genetic variability and application of appropriate breeding methods to utilize the variability. Genetic improvement process increases the value of a tree species by (1) selecting the most desirable trees from natural stands or plantations, (2) breeding or mating these select trees and (3) testing the resulting progeny. ICFRE institutes have been adopting this process for the selected tree species in different eco-climatic zones across the country. The entire program of selection, breeding and testing at different generations has shown improvement in various tree species. In this process, the production populations in the form of seed orchards and vegetative multiplication gardens have been established to meet commercial planting demands for seed and vegetative material. The quality of seed planted in the nursery is of crucial importance, since seeds are the most basic input into any planting programme. Improved seeds from Clonal Seed Orchards and Seedling Seed Orchards of Casuarina, Dalbergia, Eucalyptus and Neem are already made available by the ICFRE Institutes for planting to user agencies.

Clonal propagation is one of the indispensable components in tree improvement programme by means of mass multiplication of superior genotypes for clonal forestry programme and thereby, improve productivity. Therefore, selection of superior trees, clonal multiplication and establishment of clonal plantation has been taken up in ICFRE institutes. Reproductive biology, fruit setting and qualitative characteristics of seed and seedlings are important for production of improved seeds in tree improvement programme. DNA based tools and techniques are being used for population and conservation genetics of natural forests, identifying trait specific markers, timber forensics and molecular based taxonomy.

Summary of the Achievements Under the Theme

Eucalyptus

Through systematic selection and multilocation testing, one clone of *Eucalyptus* hybrid (*Eucalyptus camaldulensis* Dehn. X *E. tereticornis* Sm.) developed by FRI, Dehradun has been recommended by the Regional Variety Testing Committee for release. Through controlled crossing work at FRI, F1 hybrids of *E. pellita* x *E. urophylla* were produced and are being evaluated in the field. IFGTB, Coimbatore has also made a comparative study and released four clones of *Eucalyptus camaldulensis* for cultivation in farmlands. Demo clonal plantations of the released four clones have been established. Efforts are also made to improve the quality of the seeds through progeny testing and establishment of Clonal and Seedling Seed Orchards. To facilitate registration of these new clones, guidelines for Distinctness, Uniformity and Stability (DUS) testing in Eucalyptus have been developed.

Casuarina

In Casuarinas, the major thrust is to move the ongoing breeding programme at IFGTB to the second generation and disseminating the output of one generation of breeding to all stakeholders especially to the farming community. Genetic gain tests conducted with seeds of first generation orchards revealed that they are capable of yielding 13 to 28% additional wood in plantations depending upon the site conditions. Through systematic selection and multilocation testing, four high yielding clones of Casuarina have been released for commercial cultivation. To facilitate

registration of these new clones, guidelines for DUS testing in Casuarina have been developed and the guidelines are being validated with all available clones. Intra and inter specific hybrids of Casuarina (*C. equisetifolia* and *C. junghuhniana*) have been successfully generated and are being field-tested. A new concept of developing Community Seed Orchards has been developed to meet the enormous seed demand by involving farmers, traditional nursery workers and local forest department officials. Three such Casuarinas orchards have already been established in Tamil Nadu and Puducherry.

Dalbergia sissoo

Genetic improvement programme of *Dalbergia sissoo* is being executed in ICFRE institutes to cater the problem of poor stem form (crooked stem), forking, ramicorn branching and susceptibility to the dieback. The clonal trials established in northern India in previous years at Bithmeda (Haryana), Pantnagar (Uttarakhand), Hoshiarpur (Punjab) Ludhiana (Punjab) and Patiala (Punjab) were evaluated for various morphometric and wood traits. One productive and resistant (against wilt disease) clone of *Dalbergia sissoo* developed by FRI Dehradun has been recommended by the Regional Variety Testing Committee for release.

Melia composita

Candidate Plus Trees (CPTs) were selected from different geographical regions and analyzed for index value based on height, diameter at breast height, straightness, clear bole height, crown diameter and knots. The field trials of different progenies were established at various locations to evaluate their performance of different economic traits. Six such family evaluation trial were established at different locations of Punjab, Haryana, U.P. and Uttarakhand.

Pongamia pinnata

Promising genotypes of *Pongamia pinnata* were identified for higher seed productivity and oil content. Field trials have been raised with 49 selected families at Jhumpa (Haryana) and Pantnagar (Uttarakhand) for testing stability, adaptability and growth performance. Amenability of vegetative propagation and effect of maturation in Candidate Plus Tree of *P. pinnata* through rooting of stem cuttings/grafting treated with varying concentrations and combinations of auxins or other additives has been studied. DNA extraction protocol in *Pongamia pinnata* standardized for molecular based characterization of the germplasm.

Teak

Investigations on improvement of *Tectona grandis* on the aspect of genetic evaluation and reproductive biology have been carried out. Variation and inheritance of fruit and seed traits of teak from Dang region of Gujarat was studied for the first time. Genetic variation amongst half sib-families was studied. Estimates of heritability and genetic gains were computed and inheritance of growth traits was investigated. Selected 10 phenotypically superior trees of teak and established progeny trial of 28 families at Sajjangarh, Rajasthan.

Ailanthus

Tree improvement programme has been initiated in the indigenous species for boosting the productivity, yield and development of clones/genotypes. A Vegetative Multiplication Garden (VMG) of *Ailanthus excelsa* was established and research infrastructure created.

Red Sander

Survey taken up in natural Red Sanders bearing areas. Leaf samples were collected for population genetic analysis. Core samples have been collected from different aged populations in Southern part of Karnataka. Studies revealed that heartwood formation occurred in this highly endemic tree species in regions away from its natural habitat.

Bamboo

For establishments of Demonstration Plantations, multi-locational trials of *Arundinaria falcata* and *Thamanocalamus spathiflorus,* commonly known as Hill Bamboos having three replications each of the 22 identified clones were established in two sites at Naggar Range of Kullu Forest Division and in Kumarsain Range of Kotgarh Forest Division (H.P.). The clones were selected based on various morpho-metric traits.

A demonstration plot (50ha) of *Dendrocalamus hamiltonii* raised using both Tissue Cultured (TC) and cutting raised plants was evaluated and revealed that the survival percentage of TC raised plants was 88 % whereas that of the plants raised through cuttings was up to 95%. Optimised techniques for macro- and micro-propagation of bamboos of local importance with respect to nursery environment, propagation media, pot size and irrigation schedule etc. at Chotanagpur (Jharkhand).

Aquilaria malaccensis

Identified plus trees of *Aquilaria malaccensis* for production of quality agar-wood. The seeds from the plus trees were collected for the establishment of progeny trials.

Azadirachta indica

Progeny trials of neem were evaluated at AFRI Jodhpur. Progeny No. 327 was found to be tolerant against frost, whereas progenies of CPT No. 12 were severely (41.2%) affected during winter. Among the progenies of the 17 CPTs, progeny of CPT 7 has shown best performance based on the survival and growth parameters.

Hardwickia binnata

Survey 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/natural populations to document the variability for tree traits. Variability in seed traits has also been recorded.

Prosopis cineraria

Surveyed different area of Khejari and selected 20 candidate plus trees.

Molecular Characterization for Breeding Programmes

- Molecular characterization of Himalayan pines, *Cedrus deodara*, Eucalyptus and shisham germplasm has been completed.
- 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.
- Experiments were conducted (DNA extraction) for molecular characterization of 80 accessions of three important bamboo species viz. *Bambusa balcoa, B. tulda* and *B. nutans*.
- Application of regression equations to ISSR analysis of genomic DNA for total/ polymorphic amplified bands of selected sandal plants of Seoni plantations predicted, 2.56% oil content by TFRI reference trees and 1.4% oil content by IWST reference trees, at the plantation age of 25-30 years.
- DNA extraction protocol standardized for *Pongamia pinnata* (L.) Microsatellite primers were designed for the analysis of genetic variability in selected germplasm of this species.

Gene Isolation and Functional Analysis

- Identified salt tolerant plant *Lepidium sativum* was hydroponically grown. Four genes (NHX1, SOS1, HKT1 and ClC-c) were shortlisted and gene sequence alignment work was completed.
- An *in-vitro* process for development of transgenic composite plants in Eucalyptus for rapid functional analysis of genes and promoters was developed.
- Two pathogen defense-related genes were isolated, cloned and characterized from *Casuarina equisetifolia.*

- Study on salt tolerance through gene expression pattern analysis has also been initiated.

Micro and Macro propagation

- *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.
- Aseptic *in-vitro* cultures of five genotypes of *Rauvolfia serpentina* viz., GO-MN, OR-AG, KL-PB, GO-SG, KL-AJ, were established on MS medium supplemented with 1.5 mg l^{-1} BA.
- Maximum rooting of 44% was obtained on WP medium supplemented with 1.5 mg/l IBA for GBW 4 clone of *Dalbergia sissoo*. One field trial was established comprising 5 clones following RBD design and 81% survival in FZB 1 clone was recorded.
- Endogenous auxin (IAA) in selected trees of *Dalbergia latifolia* from Jabalpur, Chandrapur and Jagdalpur showed significant seasonal/genotypic variation. Juvenile and mature shoot cuttings of *Dalbergia latifolia* had 36% and 11% rooting response, respectively.
- 0.3% $HgCl_2$ and 3% Bavistin® significantly produced highest aseptic cultures in *Albizia procera*. BA and kinetin were the best source of cytokinin for shoot multiplication and kinetin was better than BA for preventing callus formation at the base of the *in-vitro* shoots.
- Shoot multiplication medium for *Dalbergia latifolia* and *Pterocarpus santalinus* has been standardized.
- In *Dipterocarpus retusus*, vegetative propagation protocol has been standardized and a micro-propagation protocol for this species is being developed.
- On-farm innovation in macro-proliferation technique and promotion for commercial plantation of an edible bamboo shoot species (*B. balcooa)*.
- Micro-propagation technique was standardized for clonal multiplication of *Aquilaria malaccensis* Roxb.
- Micro propagation of *Capparis decidua* have been initiated and axillary bud break was achieved and *in-vitro* shoots were multiplied.
- For micro-propagation of *Salvadora persica, a*uxiliary bud break was achieved on MS medium supplemented with BAP and IAA. Two and half fold shoot multiplication was obtained on MS medium supplemented with 5.0mg/l BAP.
- *Jatropha curcus,* plants were produced from somatic embryogenesis and hardened. The problem of bacterial infection of cultures was also remedied.
- Somatic embryo based plant production protocol was scaled up for *Commiphora wightii* and tissue culture raised hardened plants were planted in field where survival rate was 100%.
- In bamboo, efficient micro-propagation protocol in economically important species viz. *Bambusa tulda* was standardized.
- Inventorization for *ex situ* conservation of Bamboo and Rattan resources from different regions of Northeast India was carried out.
- In order to study the effect of humic acid on rooting behaviour in selected tree species, organic humic acid production method and purification method was standardized in the laboratory.
- Leaves and flowers of genuine *Embelia ribes* were collected from Bangalore and culturing on different media in the TC Lab is going on for conservation and priming.

Identification of DUS Traits

Three populations of *Pinus roxburghii* and *Cedrus deodara* were surveyed for distinct traits. The observations with regard to needle length and colour have been found to vary considerably in Lahhul forest of deodar and Platau forest for Chir pine.

Seed Technology

- Seed germination studies for both *Canarium strictum* and *Hydnocarpus pentendra* revealed that both the species were dormant in nature. Natural regeneration was very poor in *Hydnocarpus pentendra.*
- Viability of seeds of *Jatropha curcus* and *Bambusa bamboos* could be prolonged for 24 months if seeds stored at 15^0 C.
- Based on the 2009-2010 year's results on flower induction, chemicals viz. paclobutrazol (3g/tree), ALAR-85 (250 ppm), salicylic acid (200 ppm), potassium nitrate (2%) and PEG (10%) were found to be best performing when tested in non flowering trees in test orchards.
- Studies were carried out on seed viability in three recalcitrant species viz. *Dipterocarpus retusus* Bl. (Hollong), *Shorea assamica* Dyer (Makai) and *Aquilaria malaccensis* Lamk for moisture content and storage.

Non Wood Forest Product (NWFP) Species

- *Calophyllum inophyllum* is an important Tree Borne Oilseed used for biofuels and medicinal purpose. Tree improvement of *Calophyllum* through selection of high fruit yielder has been initiated.
- The germplasm of *Diospyros melanoxylon* was collected from four locations in three agroclimatic zones of Chhattisgarh. Morphometric field data on number of leaves per shrub, leaf area (cm^2) and leaf dry weight were recorded.
- Under the project entitled "Domestication, mass multiplication and popularization of *Moringa oleifera* genotypes with superior leaf nutritive and cytokinin content", cuttings were collected from identified CPTs/ superior seed sources from different locations of Jharkhand, West Bengal, Bihar and Orissa and clonally multiplied and maintained as germplasm garden.
- For selection and improvement of Natural Dye Yielding Plants, laboratory protocols are being developed for extraction of dyes from *Mallotus philippensis* and *Wrightia tinctoria*.

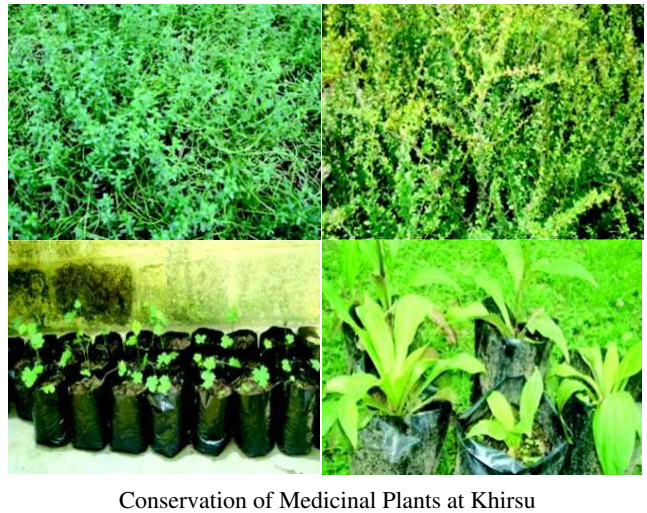
Projects under the Theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	18	40	25
Externally Aided	9	9	9
Total	27	49	34

2.3.2 Conservation of Forest Genetic Resources

In-situ conservation of Medicinal Plants

At 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

Cedrus deodara

The genetic diversity and population structure of Himalyan deodar forests was investigated using micro-satellite markers. A total of twenty one large contiguous deodar populations/forests were selected for the investigation that includes forests from Uttarakhand, Himachal Pradesh and Jammu and Kashmir. Using 10 chloroplast simple sequence repeats (cpSSRs) markers, a maximum of 5 cpSSR alleles and 46 cpSSR size variants were found among 21 populations. The total gene diversity ranged from 0.60 to 0.71 with a mean of 0.67 and the within population gene diversity ranged from 0.43 to 0.57 with a mean of 0.53. The highest genetic diversity of 0.67 was recorded in population from Batote (Jammu & Kashmir). Most of the variation in *Cedrus deodara* occurs within populations and small (16.28%) portions of the variation existed between populations. Estimated gene flow between the populations was moderate (Nm=1.89). The high differentiation among natural populations and moderate gene flow indicates inefficient long-distance gene flow or hindrance in the gene flow among populations resulting in heterogeneous genetic structures.

The investigation revealed that majority of the deodar forests of Himachal Pradesh are very rich in genetic diversity, particularly, the forests viz. Rampur (Bhurja, Punan), Karsog (Seri range), Wildlife Chamba forest division (Kalatop), Chopal (Sarain range), Anni (Luhri and chowai range) and Theog forest divisions (Cheog range). On the other hand, some forests particularly Chopal (Chopal range), Binno, Kullu (Naggarjhir and Phetavan) and Churah (Khani reserve forest) have considerably low level genetic diversity. These forests need special attention for their scientific management for increasing diversity level. Also these forests will be more susceptible to environmental variations. The forests of deodar of Uttarakhand possess considerably low level of genetic diversity in comparison to there of Himachal Pradesh and Jammu & Kashmir. Deodar forests of Gangotri and Jageshwar depicted lowest level of genetic diversity in the Uttarakhand. The deodar forest of Batote (J&K) revealed maximum level of genetic diversity in comparison to all the studied forests and hence was identified a main reservoir of genetic variation and can be used for genetic conservation programme.

Acorus calamus

Acorus calamus L. (family Acoraceae), commonly known as sweet flag, is an important medicinal and aromatic plant used in several drugs of the Unani and Ayurvedic health care systems. The essential oil obtained from the rhizome called calamus oil contains 'β-Asarone', which is found carcinogenic in nature. The genetic diversity and population structure of fifty populations of *A. calamus* from different geographical regions of its range of distribution in India was studied through morphometric traits and DNA markers (RAPD and chloroplast microsatellite). Genetic diversity was found high among populations in comparison to among individuals within populations. The collected sources were also evaluated for β-Asarone content. From the investigation, six sources have been identified bearing low β-Asarone content (16−25 %) in their rhizome. Out of the identified low β-asarone containing populations, one was identified as diploid while other five were identified as hexaploids. The frequency of diploid and hexaploid populations from all the collected sixty-five populations was found less i.e. only 1:65 and 5:65 respectively. Utilization of the identified high valued low β-asarone containing populations in medicines as well as in the food-stuffs will enhance the economical and medicinal value of Indian *A. calamus*.

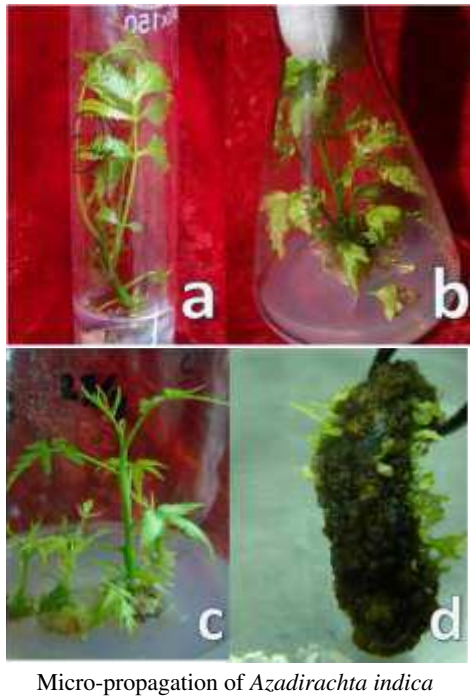
Pterocarpus santalinus

Field surveys were taken up in the natural Red Sanders bearing areas falling under eight forest ranges of Chitoor and Kadapa districts of Andhra Pradesh. Leaf samples were collected

from 8 populations and preserved for genetic analysis. Sixteen hundred Red Sanders seedlings were raised for establishment of germplasm bank. Core samples have been collected from different aged populations in Southern part of Karnataka. Studies revealed that heartwood formation occurred in this highly endemic tree species, in regions away from its natural habitat. Considerable variability for heartwood content was recorded in 20 years old plantation suggesting that while selecting superior genotypes, taking into account heartwood content is also essential. Few wavy grained genotypes were also identified.

Azadirachta indica

Studies on variations with respect to *in-vitro* azadirachtin production in selected high yielding populations of *Azadirachta indica* were carried out in the plant material collected from five locations of M.P., viz., Chhatarpur, Katni, Sehore, Khandwa and Bargi. Aseptic conditions were standardized for the micro-propagation. Method for isolation and quantification of azadirachtin was also standardized. Azadirachtin content of samples collected from different places of Madhya Pradesh was quantified.



Micro-propagation of *Azadirachta indica*

Medicinal plants

Seed germination studies for both *Canarium strictum* and *Hydnocarpus pentendra* revealed that both the species are dormant in nature. Natural regeneration was very poor in *Hydnocarpus pentendra.* Seed storage studies revealed that *Canarium strictum* seeds can be stored up to one year and *Hydnocarpus pentendra* seeds have low viability.

In order to study the variation in reserpine content in some high yielding genotypes of *Rauvolfia serpentina* produced through *in-vitro* and seeds, the shoot cultures of five genotypes namely, GO-MN, OR-AG, KL-PB, GO-SG, KL-AJ were established for *in vitro* multiplication.

Bamboos and Rattans

- Viability of seeds of *Bambusa bamboos* lost very rapidly (by 1 to 4 months) for the seed stored at high RH of 95%, 88% and 75% 35°C. Seeds stored at 15°C remained viable for 24 months.
- For the inventorization and *ex situ* conservation of Bamboo and Rattan resources of Mizoram, Tripura and Barak Valley of Assam, some of the potential Rattan growing areas were surveyed. Inventorized rattan species viz. *Calamus acnthospathus, C. khasianus, C. flagellum, C. gracilis, C. tenuis, C. erectus, C. guruba, C. inermis, C. latifolius, Daemonorops jenkinsianus* and *Salaaca secunda* and collected for introduction in the Canetum at the ARCBR campus. The locations and geo-coordinates were recorded for future reference. Established bamboo nursery for mass propagation through culm cutting and branch cutting from the selected superior clones. Germ plasm of 20 different bamboo species collected and conserved at ARCBR Campus. Some of the species conserved are: *Melocana baccifera, Dendrocalamus hamiltonii, Dendrocalmus longispathus, Bambusa bamboos, Bambusa balcooa, Bambusa tulda* and *Bambusa nutans* etc.

Demonstration Plantation of Hill Bamboos (*Arundinaria* spp.)in Chhichhar Forest of Kumarsain Range, Kotgarh

Establishment of Clonal Banks of Hill Bamboos (*Arundinaria* spp.)

- For the ecological assessment, collection, multiplication and establishment of clonal banks of superior genotypes of economically important Hill Bamboos (*Arundinaria* spp.) in Himachal Pradesh, three districts namely; Kullu, Shimla and Sirmour were selected for further detailed investigations and exact occurrence and extent of these species. It was observed that the *A. falcata* form moderately dense to dense under growth in the ban oak and deodar forests especially where the tree canopy has a natural break. *T. spathiflorus* forms big patches in the fir, spruce and moru oak forests. In general, both these species have been found to occupy moist, cool niches along streams or on steeps slopes forming origin of many hill streams. A total of 22 locations in three districts viz. Kullu, Shimla and Sirmour were identified for collection of superior genotypes for establishment of Clonal Banks. Two sites measuring 2 ha each, have been established as Clonal Banks with selected 22 genotypes of hill bamboos in the forest areas adjoining Bruhandhar Research Station falling in the Naggar Range of Kullu Forest Division and in Kumarsain Range of Kotgarh Forest Division.

2.3.3 Tree Improvement

Jatropha curcas

Performance of different accessions of *Jatropha curcas* in un-reclaimed sodic soils was found to be unsatisfactory. At four and half years of age, the plants exhibited poor survival and growth. None of the accessions could record growth comparable to plantation of this species on a good site. Seed yield has been negligible. In Dehradun valley, at three years of age and 2m x 2m spacing, higher seed yield was recorded.

Populus deltoids

A nursery of the selected clones was raised for the establishment of multilocation clonal trials and study wood anatomical properties and cellulose content clones of *Populus deltoids*. Germplasm bank was re-established and maintained. Wood anatomical properties of 10 clones have been studied.

Bamboo

Enriched field germplasm bank of *Dendrocalamus strictus* (Lathi Bans) and Hill Bambusetum (Field Germplasm Bank of Temperate and high altitude Bamboo species). The clonally multiplied ramets of *Dendrocalamus strictus* have been prepared at Shatabdi Van Vigyan Kendra, Forest Research Institute, City Centre, Dehradun for field planting.

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 UP, 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, 36 and 24 clones respectively have been established at different locations following proper statistical design in the states of Punjab, Haryana, Uttarakhand and Uttar Pradesh. The earlier trials consisting of 36 clones planted at Hoshiarpur, Ludhiana and Bithmeda were evaluated as per schedule on various morphometic and wood traits.

One productive and resistant (against wilt disease) clones of *Dalbergia sissoo* developed by FRI Dehradun have been recommended by the Regional Variety Testing Committee for release.

Eleven populations from the states of Himachal Pradesh (HP) and Jammu & Kashmir (J&K) were analysed for genetic variation and it was observed that the populations of J&K and HP have more genetic diversity compared to the populations from Uttarakhand. The selected clones of Shisham in CSO were analysed for genetic variation and the stress resistance. The selected clones planted at Jawalajee (HP) and Basanterbela (J&K) were evaluated for growth and adaptability.

Melia composita

The natural forests and the plantations of the species were surveyed in different states to select plus trees. A total of 230 Candidate Plus Trees (CPTs) were selected from different geographical regions covering the northeast and analyzed for index value based on height, diameter at breast height, straightness, clear bole height, crown diameter and knots. The mean index value for CPTs was calculated to 44.39, however, the trees with index value of more than 75 (58 trees) were considered as plus trees with average index value of 81.81. Further, the field trials of different progenies were established at various locations to evaluate the performance of different economic traits over the locations.

Ten plus trees, each of *Melia composita* and *Melia azedarach,* were selected from Karnataka, Tamil Nadu and Andhra Pradesh. Progeny trials of both species were established at Hyderabad and Bangalore. Morphological attributes and oil content of seeds of *M. azedarach* and *M. composita* were studied and recorded. Growth performance evaluation of the progenies showed the superiority of CPT's collected from Karnataka (Kushalnagar, Kodagu).

Pongamia pinnata

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

Eucalyptus

Through systematic selection and multilocation testing, one clone of *Eucalyptus* hybrid (*Eucalyptus camaldulensis* Dehn. X *E. tereticornis* Sm.) developed by FRI, Dehradun has been recommended by the Regional Variety Testing Committee for release. Through controlled crossing work at FRI, F1 hybrids of *E. pellita* x *E. urophylla* were produced and are being evaluated in the field. A few promising F1 hybrids have been clonally multiplied and established in vegetative multiplication garden. IFGTB has also made a comparative study and released four clones of *Eucalyptus camaldulensis* for cultivation in farm lands. Demo clonal plantations of the released four clones have been

established in three different locations. About 30 clones are being planted and tested in different regions. Efforts are also being made to improve the quality of the seeds through progeny testing and establishment of Clonal Seed Orchards (CSO) and Seedling Seed Orchards (SSO).

Best performing 50 clones were identified based on three clonal trials in Karunya Nagar, Coimbatore and Sathyavedu and the poor clones present in the trials were culled. Seeds were collected from the best performing 50 clones and progeny trials were established in Puthukottai and ANGRAU, Hyderabad. At the same time, the same clones were mass multiplied and CSO using these clones were established in Salem and Nellore. SSOs at Coimbatore and Chennai were also established.

To facilitate registration of these new clones, guidelines for DUS testing in Eucalyptus have been developed under a project funded by the Protection of Plant Varieties and Farmers Rights Authority (PV & FRA), Government of India and the guidelines are being validated with all available clones.

In order to evolve methods for enhancing seed production in seed orchards, experimental results showed that three cycles of watering accompanied by soil working enhanced the seed production in CSO. Culling operation in SPA was also found to improve seed production in Eucalyptus.

For characterization of Eucalyptus clones for physiological and nutritional parameters, field trials were established at four locations viz., Pudukottai, Tirunelveli, Sivagangai and Coimbatore. The short-listed 30 Eucalyptus clones are being evaluated for physiological and nutritional parameters.

Suitability evaluation of various clones of *Eucalyptus tereticornis* and *E. camaldulensis* under multilocation tests for various agro-climatic zones of Southern India revealed that based 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.

Development of micropropagation protocol for promising mature superior recombinants of F2 generations of *Eucalyptus* hybrid (*E. citrodora* Hook. x *E. torelliana* F.v. Muell.) is under the process of development for the multiplication of the genotype and its deployment in the field.

Casuarinas

In Casuarinas, the major thrust is to move the ongoing breeding programme at IFGTB to the second generation and disseminating the output of one generation of breeding to all stakeholders especially to the farming community. The goal is being achieved through a NFRP project under which many second-generation breeding populations have been established with selections from the first generation orchards and infusions from unrelated populations. Genetic gain tests conducted with seeds of first generation orchards revealed that they are capable of yielding 13 to 28 % additional wood in plantations, depending upon the site conditions. The task of converting this genetic gain into economic gain for farmers was achieved through supply of seeds collected from orchards. A new concept of developing Community Seed Orchards has been developed to meet the enormous seed demand by involving farmers, traditional nursery workers and local forest department officials. Three such Casuarinas orchards have already been established in Tamil Nadu and Puducherry.

Through systematic selection and multilocation testing, four high yielding clones of Casuarina have been released for commercial cultivation during February 2010. Mass multiplication of these clones is being done for making them available to farmers with a buy back guarantee from the paper industries. To facilitate registration of these new clones, guidelines for

A Community Seed Orchard and Nursery of *Casuarina Equisetifolia* at Valluvamedu Village, U.T. of Puducherry Managed by Traditional Nursery Operators under AusAID-Funded Project

DUS testing in *Casuarina* have been developed and the guidelines are being validated with all available clones. Following validation, the DUS guidelines will be notified in the Gazette of India.

Intra and interspecific hybrids of *Casuarina* (*C. equisetifolia* and *C. junghuhniana*) have been successfully generated. The hybrid progeny have been subjected to field-testing in contrasting environments and outstanding individuals have been selected and vegetatively propagated. At present, the hybrid clones are under multilocation testing and the most outstanding of them will be released for commercial cultivation in the next few years.

The second-generation progeny tests established during the previous years at Nellore, Puducherry, Salem and TNPL were assessed for growth and stem straightness. Significant differences were observed among progeny of different first generation orchards for these traits. In general, progeny from Karunya orchard performed better than entries from other orchards. Data recording will continue in the third year based on which ranking and thinning of the progeny tests will be undertaken.

Short-listed 95 clones of *C. equisetifolia* for field testing and prepared the planting stock. Considerable variation was observed with reference to the rooting percentage. Assessed the survival in all the field trials established in the previous years. So far, the top 10 ranking genotypes are Clones 01, 12, 11, 31, 83, 21, 49, 29 Seed lot 01 and Seed lot 02. At Sirugramam, the better performing clones 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.

For developing cloning techniques for raising high yielding clonal plantations, nine years old trees of *C equisetifolia* were coppiced at various heights (15, 30, 45 and 60 cm). Pollarding at 1 and 1.5 m height from the ground level was also carried out. Coppice shoot initiation was observed in 89% of the cases within 21 days. Stumps cut at 45 and 60 cm from the ground level were found to yield significantly higher number of coppice shoots when compared to those coppiced at 15 and 30 cm. The results could be successfully replicated in selected clones maintained by the Tamil Nadu Newsprint and Papers Limited at Kagithapuram, near Pugalur, Tamil Nadu. Experiments with pollarding did not yield promising results. Cladodes and needles collected from the coppice shoots were treated with IBA 2000 mg/l and placed in moistened vermiculite grade IV. Needles recorded a maximum rooting percentage of 65, whereas, for sprigs, it was above 90. Attempts were made to develop plantlets from individual needles for mass multiplication of limited rejuvenated plant materials and succeeded in developing plantlets from individual needles rooted through the cost effective hydroponic technique.

A total of 220 clones of *Casuarina* were screened for natural incidence of the targeted pests, *Icerya purchasi* and *Eumeta crameri*. Biology of the pests of *Casuarina* was studied and completed on live host. Clones free from attack of these pests short listed and controlled condition studies, in respect of determination of true and pseudo resistance, with *E. crameri* was completed for 70 of the 88 short listed clones. 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*.

Madhuca longifolia

For quantitative and qualitative improvement in flower seed and oil yield, field surveys were conducted in various parts of Uttar Pradesh viz. Allahabad, Pratapgarh, Jaunpur, Azamgarh, Mirzapur, Kaushambi, Kanpur, Unnao, Rai Bareilly, Varanasi, Sultanpur and Faizabad districts for selection of superior trees. A total of 52 candidate plus trees selected for screening. Corola of flowers from the selected CPTs were collected for qualitative analysis. After drying and processing and samples have been prepared for chemical screening. Samples are being analysed at Chemistry of Forest products Division, FRI. Seeds from selected CPTs have also been collected for qualitative analysis.

Acacia mangium

For the development of advanced generation, seed orchard of *A. mangium*, based on biomass and wood density, seeds were collected from 125 selected superior trees in Nilambur, Karunya, Panampally and Palode. The half-sib progenies were evaluated in nursery for variation in growth and establishment of seed orchard.

Acacia auriculiformis

For the selection of clones of *Acacia auriculiformis* with desirable stem form and wood properties, wood samples of various families from a progeny trial were extracted and sent to IWST, Bangalore for evaluation. Superior trees based on stem form and growth selected in Wadkkancherry (15), Panampally (30) and Nilambur (17) Palode (25). Trees were initially coppiced in Panampally for young shoot production for further rooting. Initial rooting experiments have shown that good percentage of rooting can be obtained with 2-3 months old terminal cuttings obtained by coppicing.

Pterocarpus santalinus

To study the variation in *Pterocarpus santalinus* for growth and heartwood content according to edaphic and climatic factors in Tamil Nadu, a mixed plantation of Albizzia and *Pterocarpus santalinus* near Mettupalyam was visited and growth data recorded. Soil samples were collected in two plantations in Amrethi and three plantations in Banavaram in Vellore Forest Division for analysis.

Teak

Teak improvement programme through selection, quality seed production, hybridization and clonal evaluation is being executed in ICFRE Institutes. Teak fruits were collected from 230 selected trees in different SPAs at Parmbikulam, Topslip, Konni, Tholpatty and Nilambur. The morphological character of fruits and seed filling per fruit analysed. Germination studies were carried out for 82 trees. Flowering and fruiting was assessed in 475 trees in Walayar CSO and 170 trees in Panampalli CSO. Assessed all clones for flowering and fruiting behavior in three CSOs and one SSO (1500 trees). Pollinator visitation per unit time per tree was assessed in both the CSOs. The progeny trial established in Nilambur was evaluated. Trees were selected at Walayar for carrying out the control crosses. Following partial diallele crossing, crosses were made in teak at Panampally field trial (TNT19 x TNT10, TNT20 x TNT10 TNT19 x TNT20). Control Pollinated (CP) and Open Pollinated (OP) fruits were collected and morphological differences between CP and OP fruits analyzed. Seed setting of CP and OP were assessed using X-ray radiography technique. Significant differences were noted between CP and OP fruits in both morphological traits and seed setting.

Plus trees were selected and their 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.

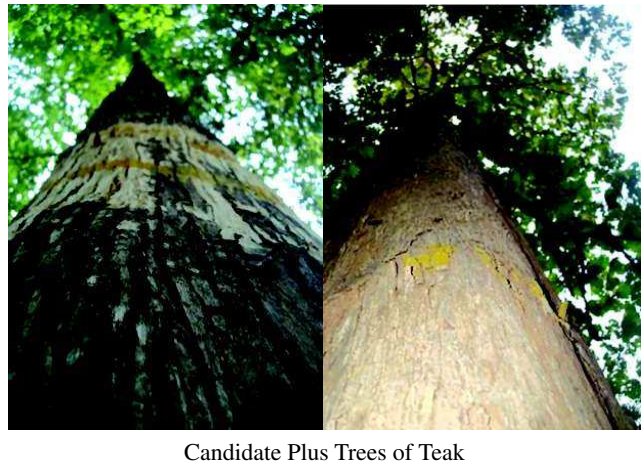
For realizing the genetic gain from teak seed orchards with regard to enhanced seed production and out crossing through cultural and ecological interventions, three teak orchards were visited and flower and fruit production assessed in 900 trees and seeds collected from 60 selected trees. Seeds were then subjected to X-radiography to determine seed filling. Based on flowering and seed filling status, 50 trees in each orchard were identified for imposing flower induction treatments. Flower-inducing plant growth regulator paclobutrazol was applied to non-flowering and low-flowering clones. Apiaries have been introduced in the orchard to increase the frequency of pollinator visits to teak flowers to promote cross-pollination and fruit and seed setting.

For standardization of flower induction schedule in *Tectona grandis* CSO and its impact on fruit set, out of 9 chemicals used in the previous year the best performing chemicals like, Paclobutrazol (3g/tree), ALAR-85 (250 ppm), Salicylic acid (200 ppm), Potassium nitrate (2%) and PEG (10%) were applied in different combinations to the low and non flowering trees in test orchards. The observations on flower induction and fruit set have to be taken at both the test orchards.

Genetic analysis of fruit and seed parameters in teak was investigated at AFRI Jodhpur. Open pollinated seeds from, 80 phenotypically superior trees from different locations were collected. Fruits from 41 trees of Dang region of Gujarat from this collection were used to carryout studies on seed morphological parameters. Investigation revealed highly significant variation for all the fruit and seed parameters in Gujarat teak except number of locules. Fruit and seed characters were found to be least affected by environmental variations. The investigation also revealed that, treated stone length, stone weight and treated stone weight were found to be the most heritable, whereas, stone length, stone width, and number of unfilled chambers were moderately inherited.

Genetic analysis of progeny trial and investigation on inheritance of growth traits in Gujarat Teak was carried out on a progeny trial established in 2008 at Shivrajpur (Gujarat) with 16 half-sib families of Teak. Height and girth exhibited very high estimates of narrow sense heritability at individual as well as family level. Family heritability values were considerabely higher for all the traits suggesting effectiveness for family selection. Genetic advance estimates for these traits also followed similar trend. Study indicated the presence of both additive and non additive gene action in Gujarat teak.

A progeny trial comprising of 28 families in RBD with four replications was established in 2010 at sujjangarh, Udaipur, Rajasthan. Data on survival and growth were collected. In addition to this, ten new CPTs of teak were selected in different location of Gujarat



Candidate Plus Trees of Teak

Ailanthus excelsa and *Ailanthus triphysa*

In order to study the reproductive biology and breeding systems in *Ailanthus excelsa* and *Ailanthus triphysa,* seeds were collected from Kerala Forest Research Institute and Palakkad

Division, KFD. *Ailanthus triphysa* germplasm bank has been established at Panampalli field research station. Karyotyping work of *Ailanthus triphysa* has been initiated. Pollen viability and male & female structural variation in *Ailanthus triphysa* have been studied. Key pollinator (*Apis cerena indic*) Indian Honey bee) and Dammar bee *(Trigona iridipennis)* have been identified. Long term Pollen storage is being standardized.

For developing clonal technology for raising clonal Plantation of *Ailanthus excelsa* and *Ailanthus triphysa* in Tamil Nadu and Kerala, survey and selection of trees (37 male and 20 female trees of *Ailanthus excelsa*) have been made. A total of 120 CPT's of *Ailanthus triphysa* have been identified in Kerala and Tamil Nadu. Standardization of the vegetative propagation of *Ailanthus excelsa* is in progress.

Tamarind

Evaluated Tamarind orchards located at Neyveli, Thoppur, Theni & Mullangaddu for flowering and fruiting. Recorded very low percentage of fruit setting. Soil samples were collected from four different tamarind orchards and analyzed for micro and macro nutrients. Estimation of phenol, carbohydrates, protein and CN ratio is under progress. The data on flowering and fruiting behaviour have been recorded. The tamarind orchards were imposed to ploughing, mulching, light shoot pruning, heavy shoot pruning, root pruning, girdling and notching. The orchards are also subjected to organic, inorganic, micro nutrient and spraying of KNO_3, K_2HPO_4, SADH, Thiourea and Cultar in different concentration for improving flowering and fruiting.

Seed Improvement

For prolonging the seed viability of three recalcitrant species viz. *Dipterocarpus retusus* Bl. (Hollong), *Shorea assamica* Dyer (Makai) and *Aquilaria malaccensis* Lamk. (Agar), fruits were collected from 6 different localities in Assam. Evaluation was done on the basis of moisture content on seed longevity and consequences of storage condition on it. The effect of grading *Dipterocarpus retusus* (Hollong) fruits into big, medium and small on germination, indicated that smaller fruits should be discarded for nursery practices, as germination was poor in smaller seeds as compared to that of medium and big fruits. The viability of *Aquilaria malaccensis* (Agar) seeds fall with the reduction in moisture content. The seeds with 25% moisture content can be stored for a longer period when stored in polythene bags at 7ºC. Storage of *Dipterocarpus retusus* (Hollong) fruits in mud pots embedded in moist sand bed was found to be better in retaining the viability for a longer period as compared to in paper or cloth bags at room temperature, in polythene bags at 10ºC and by treating with liquid paraffin wax.

Validation of DUS Testing Guidelines for Casuarinas and Eucalyptus

DUS characters and guidelines developed for Casuarinas and Eucalyptus are being validated with other Paper industries, Universities, Forest Department and Research institutions. In *Casuarina*, methods were developed for recording the colour of the needles. Most of the clones are discriminated in two colours viz. dark green and yellowish green. Vegetative characters like deciduous branchlet, bark and lenticel characters are able to discriminate. In reproductive character, the anther of the male inflorescence discriminates three different colours viz Pink (CJ22, CJ30, CJ64, CJ41, CJ54CJ 56), reddish pink (CJ8, CJ10, CJ25, CJ68) and yellow (CJ23, CJ69). Similarly, the position of male inflorescence and cone and seeds characters were categorized for all IFGTB clone. In case of Eucalyptus, as per the recommendations of the technical workshop, the juvenile leaf characters were studied in 45 clones. All the clones available with IFGTB (75 clones) were characterized for the draft DUS characters. The commonly planted five ITC clones in Tamil Nadu were assessed for their uniformity with respect to all the DUS

characters. Studies in two regions of the Tamil Nadu Forest Plantation Corporation have completed.

Field Visit to Red Sanders Forest Areas in Andhra Pradesh for Making CITES Non Determent Study

Clonal Trial Raised at Nachiarpettai(Ariyalur) TN

Clonal Trial Raised at Kallakurichi

Neolamarkia cadamba

In order to improve *Neolamarkia cadamba* through selection in the natural population and existing plantation in different parts of Tamil Nadu, Kerala, A & N Island and North-Eastern states (Assam), candidate plus trees were selected in two plantation of Tamil Nadu

Candidate Plus Tree Selection in the Plantation

(Narasipuram and Devarayapuram) and in natural forest at Konni forest division of Kerala. Till date, about 50 Candidate Plus Trees have been identified. The coppice shoots were collected and tried for rooting and it was found that treatment of cutting with 2000 ppm of IBA gave better results.

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 collected from different aged plantations/ natural populations. Using the cores collected, variability has been observed for girth, sapwood, heartwood content and specific gravity. Calorific value is being estimated. Variation for seed and seedling traits are being recorded.

Diospyros melanoxylon

The germplasm of Tendu in the form of root suckers was collected from three agro-climatic zones of Chhattisgarh that produce good quality Tendu leaves. The root suckers were planted in field conditions for further growth.

Buchnania lanzan

Through extensive surveys, 33 phenotypically superior candidate plus trees were selected from Chhindwara, Gondia and Raigarh. Seeds were collected from 25 Candidate Plus Trees and progeny trial established at the Centre for Forestry Research and Human Development.

Aquilaria malaccensis

The range of distribution of *Aquilaria malaccensis* (plantation/natural region) was surveyed in North-East and phenotypically superior trees (CPT) were selected from different provenances on the basis of height, DBH, crown area, wood density and degree of infection. Methodology for extraction of DNA from the leaves was also developed.

Bamboo

Genomic DNA of 80 Bamboo accession has been extracted and checked by running a 1% agarose gel. PCR protocol was optimized for *B. balcooa* for fingerprinting of its accessions.

Azadirachta indica

Progeny trial of Neem, established in the year 2002 at Govindpura, Jaipur with 17 CPTs of high Aza content revealed significant variation in flowering and fruiting at the age of 8 years. Overall fruiting and flowering was very poor. Moreover conversion rate of flowers into fruit was also very poor. Data analysis revealed that overall 16.5% trees of total progeny trail were affected by frost and progenies of CPT No. 3, 4, 5, 6 and 7 were tolerant to frost.

Neem Progeny Trial Established at Govindpura, Jaipur Exhibiting Poor Leaf Biomass.

Tecomella undulata

Progeny trials of *Tecomella undulata* with 40 CPTs were established at Bikaner and Jodhpur during August 2008. The survival percentage was high at Jodhpur (90%) as compared to that at Bikaner (60 %) at the age of 30 months. The progeny of CPT-19 from Chohtan (Barmer) gave best growth at Jodhpur with the height of 102.5 cm and minimum is CPT-2 (Mohangarh) of 73.06 cm in height at Jodhpur. At family level, highest survival (97.2%) was found in CPT-15 (Daichu) and minimum (75%) in progeny of CPT-23 (Chohtan). In Bikaner, CPT-3 (Mohangarh) exhibited highest survival (75%) and minimum (36%) in progenies of CPT-4 (Mohangarh). In general, growth performance of progeny trial was poor at Bikaner as compared to Jodhpur.

Progeny Trial of *T. undulata* at Bikaner after 30 Months

Progeny Trial of *T. undulata* at AFRI after 30 Months

Moringa oleifera

Superior seed sources were identified at 25 different locations (8 in West Bengal, 6 in Orissa, 7 in Jharkhand & 4 in Bihar). Accessions from the identified sources were clonally multiplied and maintained in Lagutwa germplasm garden.

Gmelina arborea

Potential seed source of *Gmelina arborea* were identified in Jharkhand and Orissa. Seeds have been collected from selected CPTs for progeny trial. Clonal trial of stem cuttings of 25 CPTs has been initiated at FRC, Mandar.

Identification of Distinct Traits for DUS for Conifers

Three populations of *Pinus roxburghii* viz. Platu forest, Nihari and Malan forests and *Cedrus deodara* viz. Rohanda forest, Cheog and Madgraon forest in Lahul valley were surveyed for distinct traits. The observations with regard to needle length and colour have been found to vary considerably in Lahul forest of Deodar and Platu forest for Chir pine. More populations in Chopal, Karsog Chail and Kinnaur are also being surveyed for identification of individuals with distinct traits.

Bark Pattern of *Pinus roxburghii*

Selection and Improvement of Natural Dye Yielding Plants

A total of 17 superior dye yielding trees of *Mallotus philippensis* and 6 of *Wrightia tinctoria* were selected. Fruits were collected and dyes were extracted from Mallotus. Laboratory protocols are being developed for extraction of dyes from *Mallotus philippensis* and *Wrightia tinctoria.*

2.3.4 Vegetative Propagation

1. Vegetative propagation of *Dalbergia sissoo* and Eucalyptus clones carried out. In *D. sissoo* 75 clones were multiplied and about 15000 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. Disease tolerant clones were assessed for morphological characters, biomass production, and nodulation behaviour, nitrogen fixation and nitrogen assimilation activity. In all the clones, profuse nodulation was observed.
2. Rooting has been achieved in some difficult to root commercially important tree species viz. *Diploknema butyracea* and *Adina cordifolia* through branch cuttings. However, *Lagerstroemia parviflora* and *Anogeissus latifolia* did not respond to air layering.
3. Vegetative propagation of *Arundinaria falcata, Thamnocalamus falconeri* and *Sinarundinaria jaunsarensis* revealed 65%, 65 % and 40% success respectively through culm cuttings with root promoting hormones.
4. Vegetative propagation of *Saraca asoca* performed just before monsoon through air layering/wiring, resulted in 70% success with IBA 500 ppm. The air layers/propagules obtained through wiring when transplanted in earthen pots revealed nearly 95% survivability.

FRI Wire Technique

Successful Air Layers

5. A total of 56 superior teak trees were selected in different parts of Kerala, multiplied through coppice shoots and established in a Vegetative Multiplication Garden (VMG). The clones were multiplied from VMG and a clonal trial has been established. The clones showed outstanding growth performance in the field.
6. Rooted cuttings from 25 clones of *Casuarina equisetifolia* produced to evaluate tolerance against salinity. The hardened cuttings were subjected to sodium chloride treatments of varying concentrations. Two experiments were conducted, one with fixed concentration of sodium chloride, and in the other, the concentration was gradually increased following which the plant samples were tested for morphological, physiological and biochemical responses. A demonstration trial to test the clonal performance on saline soil was also established.
7. A Vegetative Multiplication Garden (VMG) of *Ailanthus excelsa* was established in ½ ha area.
8. For the vegetative multiplication of *Calophyllum inophyllum* using stem cuttings, 1000 and 2000 ppm IBA have been found to be suitable for most of the populations.
9. Experiments conducted for testing rooting potential in selected trees of Jabalpur, Chandrapur and Jagdalpur. Endogenous auxin (IAA) level was estimated. Significant seasonal/genotypic variation was recorded in endogenous auxin (IAA) level. Basal dip treatment of 5mM IAA for 4 hrs promoted adventitious rooting up to 11.33% compared to 1.33% in control. Study revealed a weak relationship between endogenous IAA and rooting potential of selected trees.

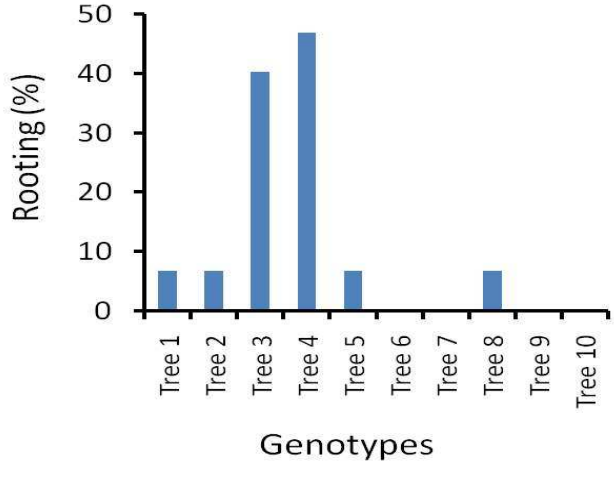
Experiment on Rooting Potential of Selected Trees of *Dalbergia latifolia*

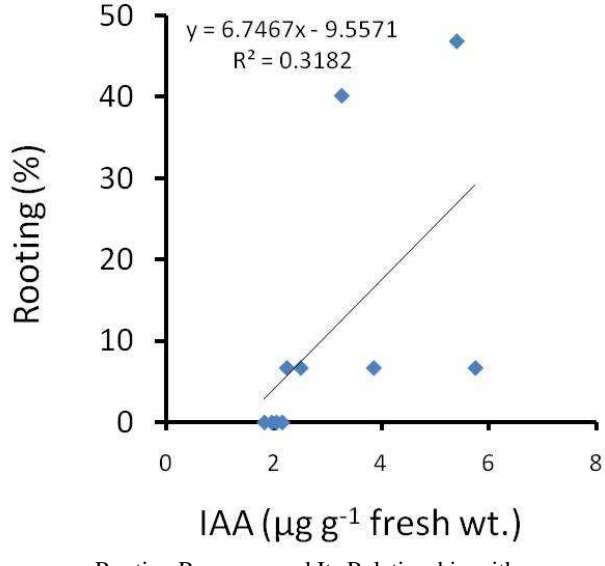
Adventitious Rooting in Seedling Cuttings

Hardening of Rooted Cuttings

IAA: Variation in Progeny of Selected Trees

Experiment on Rooting of Seedling Cuttings





Rooting Response and Its Relationship with Endogenous IAA in Rosewood Genotypes

10. For development of vegetative propagation protocol of selected bamboo species viz. *Bambusa polymorpha, B. bamboos, Teinostachyum dullooa* and *Melocanna baccifera*, it has been observed that IBA at 200 and 300 ppm concentration was effective in root prolifileration in cuttings.
11. Grafting technique for mature trees of *Ailanthus excelsa* developed (Grafting success ¡ 50%). At present, this grafting method is more efficient over any other clonal technique. Wedge grafting gives better success than patch grafting. This technique can easily be performed by farmers and field staff of SFDs.

Demonstration Trial of Male and Female *Ailanthus excelsa* (Grafted)

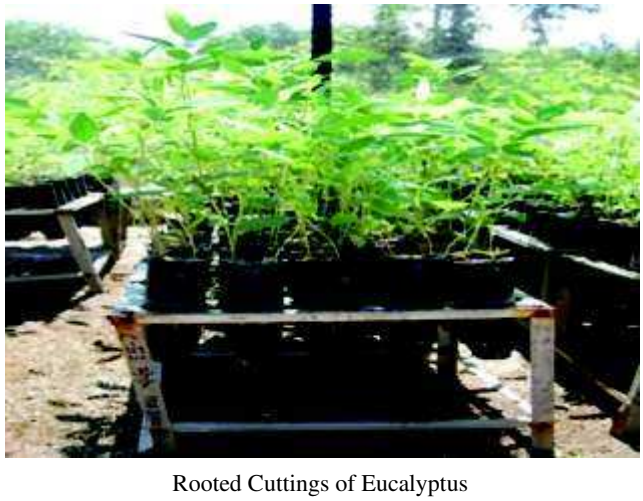
12. The micro-propagation method for *D. asper* has been refined and better rooting and shoot initiation has been achieved with Coumarin and Benzyl Amino Purine (BAP) respectively. Polypot size 16" x 20" favoured better propagation (culming intensity and culm growth) of out planted plants. For survival under agro-shade, weekly irrigation was essential for tissue culture raised *D. asper* and culm raised *B. nutans*. While *D. strictus* could withstand irrigation at 2-3 weeks interval.
13. Upto 30% success in rooting of mature stem cuttings of candidate plus tree of *P. pinnata* was observed in selected superior trees. Higher rooting was observed in cuttings taken

from seedlings. Variability in grafting response among plus trees was also observed.

14. Humic acid extraction method has been standardized using classic alkali/acid fractionation method. The preliminary results showed that humic acid had positive effects on rooting of cuttings collected from young trees/saplings of Shisham and Gamhar.

15. A hedge garden of selected clones of *Eucalyptus camaldulensis* was established. Successful studies on micro and mini cutting with a success of 80-100% rooting was recorded. Study on the rooting responses of 22 clones was carried out using mini cutting technique and resulted in significant improvement in rooting in 13 clones.

Juvenile Shoots of Eucalyptus



Rooted Cuttings of Eucalyptus

2.3.5 Biotechnology

DNA Profiling

- DNA fingerprinting using SSR markers is being carried out to understand the complex genetic structure of trees with particular reference to delineation of provenances and study of genetic diversity, molecular characterization of germplasm, inheritance pattern and establishment of genotype and species specific markers. Molecular characterization of Himalayan pines, *Cedrus deodara*, Eucalyptus and Shisham germplasm has been completed.
- Sixty eight clones of *Casuarina equisetifolia* were profiled using ten RAPD primers. The Binary data was analysed using RAPD Distance and NTSYS softwares. Dendrogram was made for the profiled clones.
- Four SSR targeted primers were developed from the *Casuarina equisetifolia* through ISSR-PCR products. The new sequences were deposited in the NCBI library. Sixteen individuals in one population were screened with four SSR primers.
- For assessment of variability and genetic fingerprinting in *Pongamia pinnata* (L.), accessions of the species have been maintained in the Institute. DNA extraction protocol has been standardized using different plant material.

Use of Molecular Markers in Breeding Programmes

- Based on the association mapping, the SSR loci Embra40 was significantly associated (P=0.0012) with low rooting percent in *E. tereticornis* accessions. Similarly, *Embra7* was correlated with shoot length. The loci Embra67 and Embra39 were correlated with root length and shoot length of the vegetative propagules in *E. camaldulensis* accessions.
- Efforts were made to develop Eucalyptus us hybrids between the species *E. camaldulenis* X *E. tereticornis*, particularly for salinity

tolerance traits. Considering the species differences and based on salinity stress studies, controlled hybridization was carried out and F1 hybrids were generated. For the development of genetic linkage map followed by localization of QTLs for the salinity tolerance traits, SSR markers were cross amplified and about 200 loci were tested for polymorphism between the parents. The mapping population, thus, generated will be used for phenotyping and genotyping for marker-trait associations.

- Efforts were also made for developing genetic linkage maps and identification of QTLs responsible for wood property and adventitious rooting, as they are the major industrial traits.

Gene Isolation and Functional Analysis

- The programme on gene discovery from woody perennials and medical plants is underway and isolation and characterization of genes, targeting the cellulose biosynthesis pathways and biotic defence–related pathways have been attempted.
- Two pathogen defence-related genes isolated, cloned and characterized from *Casuarina equisetifolia,* including the class I chitinase (CeChi1) and glucanase (Ceglu). They are the first report on full-length gene isolation from this species. Further, the expression pattern of several transcripts identified during the Casuarina–Trichosporium interaction was analyzed using qRT-PCR.
- A partial transcript of lectin was isolated and sequenced from the leaves of *Withania somnifera*. Research is in progress to isolate the full-length gene and characterize it for antifungal and antipest properties.
- Primer pairs for the gene responsible for vascular system development were synthesized and amplified in genomic DNA of *E. tereticornis.* The Amplicon size ranged from 1.5 kb-2.5 kb and the sequences showed similarity to HD-Zip class III TF from *Malus domestica*, *Populus trichocarpa, Arabidopsis thaliana, Picea glauca* and *Medicago truncatula*. A putative conserved domain MEKHLA was identified in the sequence, which is characteristic Class III HD-ZIP TFs.
- In order to study the salt tolerance through gene expression pattern analysis, a list of genes based on clustal W2 multiple nucleic acid sequence alignment was prepared. These genes are; Salt Overly Sensitive (sos1), High Affinity Potassium Transporter (hkt1); Sodium Protein Exchanger (nhx1) and Chloride Channel –c (clc-c). Survey of Sambhar salt lake (saline wet land) region for selection of halophyte was conducted. *Lepideum sativum* has been finalized as the halophytic species for the studies in this project. An ultra low cost hydroponic system has been developed in-house and tested.
- An *in-vitro* process for development of transgenic composite plants in Eucalyptus for rapid functional analysis of genes and promoters was developed. Gene homologues for sodium transporters from salt tolerant tree species were also sequenced.
- Unravelled partial gene sequence of *LiCHS1* and *Liefli alpha* that represent the first genome sequence information for *L. invasa*.

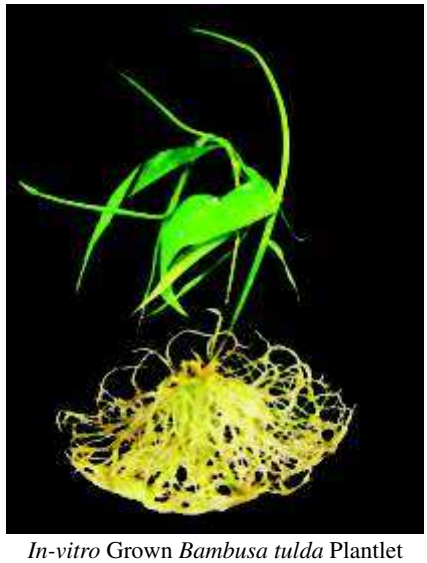
Development of Micro-propagation Technique

- Rhizogenesis in five clones *of Dalbergia sissoo* viz. GBW 4, JB 1, FZB 1, FZK 1, RSK 1 was evaluated by conducting experiments. The explants inoculated on WP medium produced a maximum of 33% rooting followed by 22% rooting in MS medium. Similarly, 44% rooting was obtained on WP medium supplemented with 1.5 mg/l IBA. For studies on organogenesis from callus culture, 0.5 mM putrescine resulted with 58% organogenic callus formation. One field trial was established comprising 5 clones and 81% survival recorded with good growth of the plants.

- Endogenous hormones (IAA, GA3) were estimated for the samples of ten male and ten female Casuarina clones in flowering and non flowering stages through HPLC. Higher levels of IAA correlated with female sex expressions, whereas, a greater amount of, gibberellins favours the differentiation of male sex organs.
- Techniques for macro and micro-propagation were conducted in *Melia dubia.* Propagation ability of the material is found to vary with the girth size of coppice shoots. Best results, however, were obtained on MS + BAP (1 ppm) where 4-5 shoots regenerated from a single shoot apex.
- In Sandalwood, *in-vitro* rooting percentage and quality of plants improved by changing carbohydrate source from glucose to sucrose, by addition of polyamines and pulse treatment of shoots by IAA, IBA along with auxin conjugates. In *ex-vitro* rooting shoots pulse treated with 2500ppm IBA favoured 62% rooting in medium with 75% sand + 25% Soilrite. Use of mannitol (1%) and sucrose (1%) in liquid medium during maturation and mannitol 2% during germination, resulted in synchronized and higher conversion rate of embryos and better quality of plantlets.
- For development of micropropagation protocols for production of superior germplasm of *Dalbergia latifolia* Roxb. and *Pterocarpus santalinus,* performance of basal media like MS, B5 & WPM along with different plant growth regulators were compared. Two different explants types were compared 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.
- 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), were used for molecular characterization and identification of molecular marker associated with wood quality traits in *Tectona grandis*. Genomic DNA extracted from the selected genotypes and STMS analysis carried out in collaboration of TERI. STMS analysis validated ramets and progenies commensurate mostly with their plus trees.
- For *in-vitro* induction of essential oil components of Agar plant, a very efficient callus induction protocol along with cell suspension culture technique has been standardized. Cell suspensions and callus, thus produced, were treated with various elicitor molecules for induction of essential oil and/or oil components. Initial screening of the extracts from treated and untreated cell extracts with Thin Layer Chromatography (TLC) showed some difference which may be due to induction of essential oil components.
- For clonal multiplication of *Aquilaria malaccensis* Roxb. through *in-vitro* culture, methodology for production of aseptic culture from node, shoot tip and leaf from matured plant was standardized. Optimum shoot regenerating media with high frequency multiplication of healthy shoots were achieved from node explants. These multiplied shoots were rooted *in vitro* condition and also established outside the laboratory condition.
- Macro and micropropagation of selected clones of *Dipterocarpus retusus* Bl. Syn *D. macrocarpus* was carried out. The best suitable season for collection of shoot cuttings, optimum root initiating hormone, optimum root initiating media was standardized for 18 selected genotypes and propagated. Rooted shoot cuttings were established in field condition from mist

chamber. For micropropagation, establishment of aseptic culture has been standardized from leaf and petiole explants. Regeneration of somatic embryonic callus, distinct globular, torpedo and dicotyledonous embryos were observed from embryonic callus. Histology of callus showed the embryos.

- *In-vitro* shoot multiplication protocol has been standardized for *B. tulda* and *in-vitro* regenerated plantlets have been established in the green house.



In-vitro Grown *Bambusa tulda* Plantlet

- *In-vitro* shoot multiplication protocol has also been established for *Dendrocalamus hamiltonii*. Presently experiments to induce roots in the multiplied shoots are under progress.
- Studies on development of *in-vitro* regeneration system for *Albizia procera* revealed that MS medium supplemented with BA and Kinetin proved to be the best sources for shoot multiplication. However, the administration of kinetin prevented callus formation at the base of the *in vitro* shoots giving its preference over BA.
- Protocols of *in-vitro* plant propagation through somatic embroygensis and axillary shoot proliferation were developed for *Jatropha curcas*. The protocols were based on somatic embryogenesis and using axillary bud proliferation pathway.
- In order to develop refined protocol for rapid and mass clonal production of plus trees/superior genotypes of *Salvadora persica*, experiments were conducted. MS medium supplemented with BAP (7.5 mg/) proved the best and favoured multiple shoot induction (2-3 shoots/explants) in 4 weeks at 25^0 C temperature for 12 h photoperiod and 2500 lux intensity of light.

Shoot Initiation in *Salvadora persica*

Shoot Multiplication in *Salvadora persica*

Bio-pulping of Bamboo Chips

On the basis of chemical analysis and SEM, pre-treatment of Bamboo chips and mechanically processed fibres with identified fungus *Trametes versicolor* kraft pulping was carried out. 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.

2.4 Forest Management

Overview

Summary of Achievements under the Theme

The wood volume equations assume importance in projecting the total volume at different stages (thinning and final harvest) of plantation growth. Such equations, being developed in respect of *Tectona grandis*, *Prosopis cineraria* and *Ailanthus excelsa* will be of great use to State Forest Departments and other stakeholders. Information Communication Technology (ICT) based information systems being developed on various subjects and species of plants and insects will enable the users to get the desired information satisfying a particular or multiple criteria and obtain the complete datasheet on area of interest. GIS and remote sensing based mathematical models for monitoring lac host belts, discussion forum on forestry, etc. are innovative applications of ICT that are being developed in the council. Mathematical models are in process of development which will help in understanding infestation patterns of destructive insects. Documentation of agroforestry systems, wood flow and market surveys of timber related information provide useful information for various end-users. Study on sustainable development of quality bamboo resource were conducted to help in employment generation and socioeconomic development of various categories of stakeholders. For sustainable management of forest resources, the National Working Plan Code is being revised for MoEF.

Projects under the Theme

Projects	Completed Projects During the Year	Ongoing Projects	New projects Initiated During the Year
Plan	4	13	8
Externally Aided	1	2	0
Total	5	15	8

2.4.2 Sustainable Forest Management (SFM)

Haliyal and Yellapur teak belts in Karnataka were found to be seriously affected by the teak heartwood borer during preliminary surveys. The specific field sites were identified for studying spatial distribution and adult emergence. In another project, research was carried out for development of clump management practices for important bamboo species for enhanced production of quality culms and edible shoots. Sustainable development practices of bamboo resource are being developed for employment generation and socio-economic development in north-eastern India by combining different bamboo species with preferred crops suitable at different localities. Yields of intercrops were studied under different species and spacings of bamboos. Fertilizer application before emergence of new shoots resulted in an increase in culm diameter and internodal length. Studies revealed that farmers prefer to plant horticultural plants and cash crops such as tea, rubber, etc. to bamboo. A training-cum-workshop was organized for farmers on bamboo cultivation and management.

The identification of forest fringe villages in rainfed area of the country was initiated. The determination of socio-economic status of the people residing in forest fringe villages and the ecological status of the adjacent forest areas was carried out in Dehradun district.

2.4.3 Forest Economics

Data pertaining to demand, supply, market intelligence, etc. of bamboo resources were collected from markets of Punjab, Haryana, Chandigarh and Delhi and the same were analysed for quantitative assessment of their production and consumption. In another study, survey was carried out to document the agroforestry systems practised in nine districts of Tamil Nadu.

Information was collected on farm forestry and captive plantations undertaken by TNPL and Seshasayee and contract farming systems adopted by the paper, pulp and match industries throughout the state of Tamil Nadu. Data were compiled on the extent of area covered under tree cultivation in private lands in some districts of Tamil Nadu. Data on wood flow from outside into Tamil Nadu, wood flow to pulp and paper industries, district-wise details of saw mills and the demand and supply of timber in saw mills were documented. The supply chain existing between farmers and industries, particularly paper and matchwood industries, was also documented.

As a continuing process, market price data of commercially important species of timber, fuelwood and Bamboos were collected from selected markets and SFD/Forest Corporation depots all over India. The collected data were compiled, published and disseminated as "Timber and Bamboo Trade Bulletin" to various stakeholders.

2.4.4 Forest Biometrics

Reconnaissance survey was conducted on teak plantations in eight forest divisions of Karnataka and twenty seven sample plots were laid out for productivity studies and growth data were recorded. Similar survey was conducted at 32 sites in nine forest divisions of Gujarat on teak plantations; out of it sixteen sites were selected. Permission was obtained from State Forest Department for felling representative sample trees. Seven sample plots were laid out of *Prosopis cineraria* and *Ailanthus excelsa* in Rajasthan for productivity and biometric studies and preliminary data were collected. Sixteen sites were selected for productivity study and modelling of growth in teak plantations in Gujarat. Permission for felling of sample trees was sought from the State Forest Department.

2.4.5 Policy and Legal Issues

The MoEF, Govt. of India is revising the National Working Plan Code. The task of revising National Working Plan Code was carried out by FRI on behalf of MoEF, Govt. of India. The draft of revised National Working Plan Code was submitted to MoEF, Govt. of India along with the annexures on "Micro Plan Process for JFM Areas" and "Micro Plan of Eco-development for Wildlife Areas". The criteria and indicators for sustainable forest management were subjected to the process of finalization with the MoEF for incorporation in the document.

2.4.6 Information and Communication Technology (ICT)

Work was conducted for development of Deodar (*Cedrus deodara*) and Kail (*Pinus wallichiana*) Information System using remote sensing & GIS techniques. The literature was compiled and edited. The Deodar and Kail maps of Uttarakhand state were prepared and verified by ground truthing. Similar maps for Himachal Pradesh and J&K are also being developed.

For data mining of wood forming genes of Eucalyptus, sequences were downloaded for forty three wood forming genes. Identification of conserved regions and primer designing was carried out for the above genes. Transferred downloaded sequences and results obtained in to Excel sheets for the genes and siRNA design carried out for the genes. DNA fingerprint information was collected from researchers on Eucalyptus and Casuarina using ISSR/FISSR, RAPD and AFLP markers for development of tree DNA fingerprint database. Standardization of format was completed.

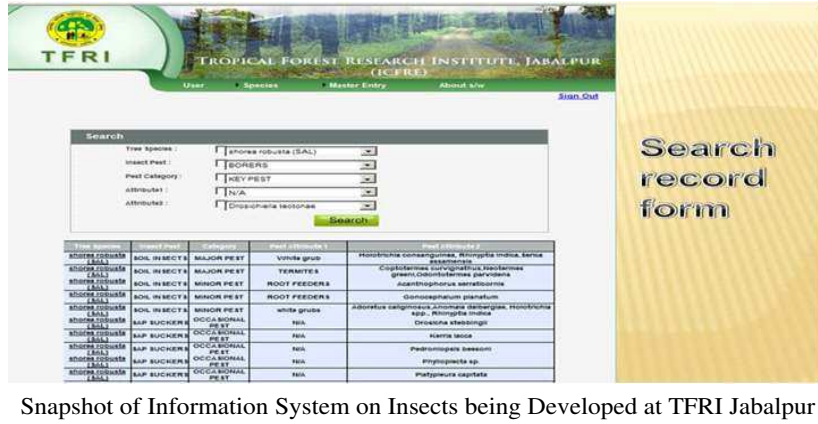
Documentation of information regarding production of lac was done for districts surveyed in Chotanagpur region to apply GIS/RS for identification and monitoring of lac host belts in this region.

An information system is being developed for forest tree species associated insect and their management with special focus on central India. Data were collected for the insect pests associated with *Shorea robusta, Dalbergia sissoo, Dalbergia latifolia, Acacia catechu, Acacia nilotica, Albizia lebbek, Ailanthus excelsa,* Bamboo, *Tectona grandis* and *Butea monosperma* based on scientific name, common name, distinguishing characters, nature of damage, host range, natural enemy and control measures technique. The system provides various combination of key strokes viz. tree species, insect pest, insect pest category and insect pest sub category for data retrieval.

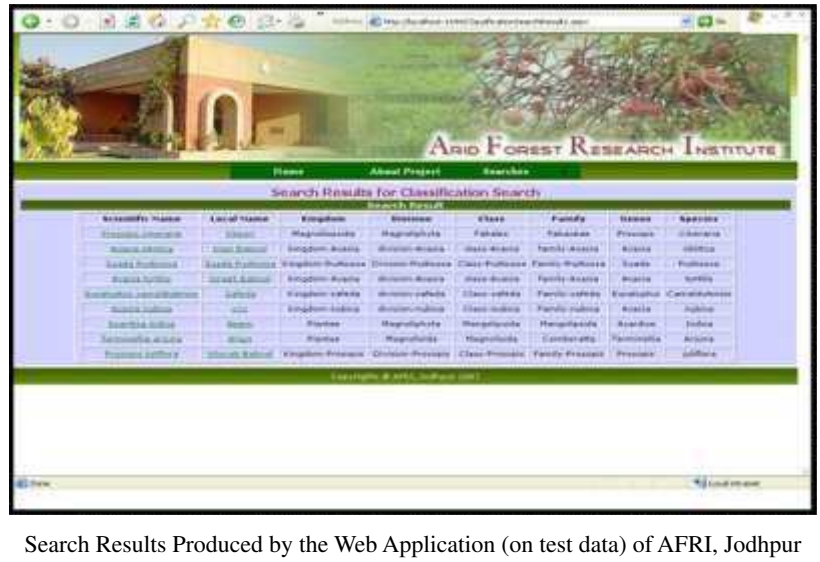
A dynamic database is being developed for forestry discussion forum. Outline of the possible forms for various internet pages, database structure with all possible records and E-R diagram were prepared with identification of all possible records, fields and relationships between entities, design and development of the graphical user interface.

For development of "Commercial Timber Information System", necessary software and literature were purchased. Information on required parameters of around 150 commercially important timbers species was collected. Information on timber market was collected. Detailed design of the website diagram was prepared and system coding and testing is under the progress.

Websites of ICFRE and its institutes were continuously updated and upgraded.



Snapshot of Information System on Insects being Developed at TFRI Jabalpur



Search Results Produced by the Web Application (on test data) of AFRI, Jodhpur

2.5 Wood Products

Overview

Current research in the field of wood, its constituents and wood products is to utilize every bit of woody and ligno-cellulosic raw material available. 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, development of ecofriendly preservatives.

Jute-Polypropylene, Wheat straw–Polypropylene and Bamboo–Polypropylene composites prepared using m-Isopropenyldimethylbenzyl-isocyanate (m-TMI)-Poly Propylene (PP) coupling agent and evaluated mechanical properties. Nanoclay was compounded with polypropylene to study the effect of concentration of nanoclay, effect of coupling agent, and type of nanoclay. Experiments on extraction of cellulose nano-whiskers by acid hydrolysis were completed. Effect of temperature, sonication time, acid concentration on yield and morphology was also studied, and the process of extraction of nano-cellulose was standardized.

The effect of coating the surfaces of two timber species with multiple layers of two film forming finishes was investigated. It was found that Poly Urethane is much better in blocking moisture and giving a shiny look to the surface of Shisham and mango wood surface as compared to shellac polish. In fact, the first three coats of shellac polish are practically not capable of controlling the entry of moisture into both the species studied. The application of both these finishes resulted in slightly thicker coat in the case of Poly Urethane on both the surfaces. Multiple coats of PU will provide better moisture protection to both the species studied than even with six coats of spirit shellac.

Environment friendly preservative ZiBOC was developed and patented. Twenty imported wood species are being studied for their natural durability under Indian climatic condition. Studies on the performance of imported wood species untreated and treated with newly developed and conventional preservatives are also carried out. Treatability evaluation is also being done of few imported wood species. Different treatment regimes were developed for the treatment of difficult to treat species to give appropriate retention of preservatives.

Anatomical approach was applied to evaluate treatabilty class of plantation grown *A. auriculaeformis, A. mangium, E.eurograndis, E.tereticornis, G.arborea, G.robusta, H. brasiliensis, M. dubia* and *P.deltoids.* For water borne preservatives, *G. robusta* and *H. brasiliensis* were classified under 'a' treatability class, *E. eurograndis* and *M. dubia* were classified under 'b' treatability class and *A. auriculaeformis, A. mangium, E. tereticornis*, *G.arborea* and *P. deltoids* were classified under 'c' treatability class. Whereas, for oil type preservatives, *Grevillea robusta* classified under 'a' class, *Acacia mangium, Hevea brasiliensis, Melia dubia* and *Populus deltoids* 'b' class. *Eucalyptus eurograndis* and *Eucalyptus tereticornis* classified under 'c' class, *Acacia auriculaeformis* and *Gmelina arborea* 'd' class.

The timber of plantation grown *Acacia mangium* was observed for its durability in the graveyard test and it was found that the controlled samples (untreated) were not attacked more than 2% after 3 years of exposure, whereas, treated samples were all intact without any damage. Few products were prepared and observed the performance. The timber was found to be

dimensionally steady and has very good working qualities especially for handicrafts.

Gas permeability of five imported hardwood species - Gurjan- *Dipterocarpus* spp., Pyinkado - *Xylia dolabriformis,* Merbau-*Instia bijuga,* Red meranti- *Shorea* spp., and Balau-*Shorea* spp., was studied. Gurjan was found to be the higher flow rates than the rest of the species of timber tested. Balau- *Shorea* spp. was found to be the most impermeable species of timber and is highly refractory.

The data on old doors, used windows, used frames and shutters were evaluated both by conventional test method and ultrasonic method (Non-destructive technique) in order to see the degradation of strength with time. Both the methods were in agreement which shows that the ultrasonic method which is a non-destructive method can be useful to find the service life of used structures and will give the guidance for reusing the same.

The sensitivity of teak wood to the changes in climate was studied; cross dating and standardization of discs were carried out. Chronologies based on growth rings/expressions of growth periodicity and vessel morphology were developed from available information on temperature fluctuations, rainfall and soil type, atmospheric disturbances to ring analysis and wood quality.

Studies on evaluation of wood quality parameters with respect to the growth rate i.e. girth carried out on *Melia dubia* of same age but varying girth showed that there is not much significant variation in the formation of heartwood while comparing the three girth classes (big, middle and small). The overall higher values in the shrinkage indicate that the timber should be properly seasoned by following proper kiln schedule. In air-seasoning, care must be taken by painting both the ends of timber so that defects like twist, cupping, crook and splits etc. can be avoided. The strength properties (compression parallel and perpendicular to grain and hardness) were found to have higher values for tree of middle girth class which confirms the hypothesis that higher the specific gravity higher the strength properties.

An indigenously designed laboratory based convection heating type vacuum kiln has been installed last year in the Wood Seasoning Discipline, FRI, Dehradun.

A field workshop was organized by IWST, Bangalore in association with Karnataka State Handicrafts Development Corporation Limited, for the benefit of the handicraft artisans of Multicraft, Metugally, Mysore on 25th March 2011. It was a lab to land extension programme conducted for extending the newer findings on the methods of production and protection of wooden handicrafts.

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	13	10	12
Externally Aided	3	3	0
Total	16	13	12

2.5.2 Wood and other Lignocellulosic Composites

Particle boards prepared with lops and tops of poplar at two pressure levels of 17.5 kg/cm^2 and 21 kg/cm^2 with 6%, 8% and 10% resin content with out and with 0.5%, 1.0% and 1.5% wax as sizing showed that particle board can be prepared with 21 kg/cm^2 specific pressure and 10% amount of resin without wax as sizing material. However, with addition of 1% wax as sizing material, particle board can be prepared with 17.5 kg/cm^2 lower specific pressure and 10% amount of resin and with addition of 0.5% and 1% wax as sizing

material particle board can be prepared with 21 kg/cm^2 specific pressure and 8% lower amount of resin. Particle boards prepared with lops and tops of eucalyptus at three pressure levels of 17.5 kg/cm^2, 21 kg/cm^2 and 24.5 kg/cm^2 with 6%, 8% and 10% resin content showed that particle board can be prepared with 24.5 kg/cm^2 specific pressure and 10% and 12% amount of resin. Particle boards with lops and tops of five poplar to eucalyptus particle ratio (100:0, 75:25, 50:50, 25:75 and 0:100) were prepared at two pressure levels 17.5 kg/cm^2 and 21 kg/cm^2 with 6%, 8% and 10% resin content, with and without addition of thermally conductive filler. The addition of thermally conductive filler showed improvement in internal bond strength, water absorption, and thickness swelling due to surface absorption, length expansion and width expansion of the boards. Therefore, thermally conductive filler can be used in particle board manufacture as a sizing material as well as for improvement of internal bond strength.

Mechanically blended UF and PF adhesives cannot be effective for Boiling Water Resistance (BWR) grade plywood. Therefore, phenol, urea and formaldehyde have to be reacted at the resin preparation level itself in the resin kettle. The Phenol Urea Formaldehyde (PUF) adhesives of Boiling Water Resistance (BWR) grade can be prepared at 150^{0}C pressing temperature using Phenol Urea Formaldehyde (PUF) adhesives with 70:30, 60:40 and 50:50 phenol to urea molar ratio having 30 minutes condensation reaction time during resin preparation.

Jute–PP composites using m-TMI-g-PP coupling agent showed the significantly high improvement in mechanical properties as compared to virgin PP followed by Bamboo and wheat straw composites. These composites can be moulded to any shaped articles. The applications are in the field of moulded products (furniture components, automobile interior, electrical/ electronic appliances). In recent years, wood fibres have gained significant interest as reinforcing material for commercial thermoplastics. They are now fast evolving as a potential alternative to inorganic fillers for various applications. Wood fibre offers several advantages like low density, high specific properties, low cost, etc. However the primary drawback of using wood fibres for reinforcement is the poor interfacial adhesion between polar-hydrophilic wood fibres and nonpolar-hydrophobic plastics. This results in poor mechanical properties of the final product. The interfacial adhesion can be improved by using compatibilizers or coupling agents. In this study, two coupling agents (MAPP and m-TMI-g-PP) investigated with six natural fibres (jute, bamboo, rubber wood, wheat straw, dry leaf litter and Lantana) using polypropylene thermoplastics. Rheological properties were also evaluated using torque rheometer. Results indicated that Jute-PP composites with m-TMI-g-PP coupling agents improved the maximum mechanical properties. The tensile strength increased by 78% as compared to PP and Flexural strength increased by 65% as compared to PP at 50% filler content. Wheat straw-PP composites and Bamboo-PP composites showed almost the same properties. Results clearly indicated that dry leaf litter can not be used in making natural fibre-thermoplastic composites as its processing becomes difficult and also there was no improvement in the properties at all.

Under the studies on co-polymerization kinetics using filler supported catalyst system, glass ethylene was polymerized using cellulosic filler supported catalyst system and studies on effect of temperature, monomer concentration (pressure) and catalyst concentration were completed. Using this novel technique, very high catalyst efficiencies (upto 50,000 kg of PE/mol of TM/h/[M]) could be achieved with almost no reactor fouling even at very high solid content in the slurry. A kinetic model for ethylene polymerization using ?ller supported catalyst

system was also developed to predict the instantaneous reaction rates.

In another study of synthesis and characterization of hybrid Polypropylene-Montmorillonite-Wood Fibre Nano-composites, nanoclay was compounded with polypropylene. Specimens as per ASTM standards were prepared and mechanical properties (tensile, flexural, compression and impact strength) were determined. Micro-mechanical and macro-mechanical modelling of the composites was also completed. Further, hybrid composites of nanoclay-wood flour-polypropylene were prepared using twin screw extruder. Specimens as per ASTM standards were prepared and mechanical properties (Tensile and flexural strength) were evaluated. Micro-mechanical and macro-mechanical modelling of the composites is under progress.

Under the study on cellulose nano-whiskers from bamboo, experiments on extraction of cellulose nano-whiskers by acid hydrolysis were completed. Effect of temperature, sonication time, acid concentration on yield and morphology was also studied, and the process of extraction of nano-cellulose was standardized. The product was characterized using scanning electron microscopy. Further work on preparation of nano-composites is in progresses.

2.5.3 Wood Processing

Drying behaviour of timbers of deodar and toon was studied in a convection type vacuum kiln. The drying time of these two 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.

Treatment techniques for difficult to treat species were developed. In stake size of specimens, complete impregnation of preservative was achieved in industry important douglas fir species.

Timber engineering museum was completely renovated for architect, builder, students and general public.

Different types of joints with round Bamboo fabricated and tested for mechanical strength. New computerized universal testing machine was also installed which is also capable in cyclic testing.

2.5.4 Value Addition and Utilization

To determine the natural durability of imported timbers in Indian condition, observation on the natural resistance of twenty species of imported woods were taken upto thirty six months after implantation in Trivandrum, Nallal, Visakhapatanam, Hydarabad, Jodhpur and Jabalpur and upto 24 months in Dehradun. In marine condition, the resistance was observed at the exposure of 36 months. These timbers are classified for their resistance against wood decay fungi. 11 species, viz. teak from different countries, different species of Shorea, Pterocarpus, Dryobalanops and Xylia species showed good resistance against both the brown and white rot fungi (less than 10% of weight loss) and these timber species were grouped under "high resistance class". *Fagus sylvatica, Fagus* sp, *Fraxinus angustifolia, Fraxinus excelsior, Acer pseudoplatanu, Acer* sp. and *Havea brasiliensis* decayed very fast with more weight loss, and they are grouped under "non-resistant class" (weight loss was around 35-40%). Indian *Michelia champaka* also did not show good resistance and it is grouped under class-3.

Studies on durability of *Acacia auriculiformis, A. mangium, Grevillea robusta, Eucalyptus terreticornis, Maesopsis eminii, Melia dubia, Ailanthus malabaricum* and *Ailanthus excelsa* plantation timbers from different age

group against decay fungi and termites were carried out. *A. auriculiformis* and *A. mangium* of 10, 15 &20 yrs timber can be classified under Class I, whereas, 5 yrs comes under Class II. *E. tereticornis* showed good resistance against decay fungi (Class I). *G. robusta* belongs to class III and *M. dubia* falls under "non-resistance class (IV)."

Treatment of red, yellow and white meranti with ZiBOC and CCA preservative showed white meranti easily treatable whereas red & yellow meranti were difficult to treat. Different imported species namely *Pterocarpus* spp. from Giabom-West Africa and Indonesia, Maple wood (*Acer* spp.) from Germany, *Intisia* spp. from Malaysia and Australia, *Tectona grandis* from Myanmar, South Africa, Ivory Coast and Malaysia, *Xylia dolabriformis* from Myanmar, *Shorea* spp. from Malaysia, *Hevea* spp. from Malaysia, *Pinus* spp. from New Zealand and Australia, *Grevilea robusta* from New Zealand and Australia etc. received from IWST Bangalore were tested for natural durability. It was observed that all the species are exhibiting moderate to bad termite and fungus attack within 28 months of grave yard test. Treatment schedule was developed for *Melia azedarach* and *Eucalyptus tereticornis*. It was observed that retention of preservation was increased by initial dipping in hot water, before pressure treatment followed by diffusion treatment with conventional and newly developed preservative. Performance of ZiBOC treated imported wood species was studied in different agro-climatic regions. It was found that ZiBOC treated wood performing at par with CCA treated wood even after 58 months of field installation.

Penetration of two different fluid types, silver nitrate in water and Red oil dye (molten wax) was studied in *Acacia auriculaeformis, Acacia mangium, Eucalyptus eurograndis, Eucalyptus tereticornis, Gmelina arborea, Grevillea robusta, Hevea brasiliensis, Melia dubia* and *Populus deltoids.* A penetration index of more than 0.66 indicates more or less uniform distribution of the chemicals in all the structural elements and easy to treat which are classified as class "a", *Grevillea robusta* and *Hevea brasiliensis* were classified under "a" treatability class. Penetration index falling between 0.33 and 0.66 classified as "b", which showed some deficiency in fibre penetration or partial blocking of the flow paths. *Eucalyptus eurograndis* and *Melia dubia* were classified under "b" treatability class. *Acacia auriculaeformis, Acacia mangium, Eucalyptus tereticornis*, *Gmelina arborea* and *Populus deltoids* were classified under "c" treatability class with silver nitrate solution (water soluble type preservatives). Whereas *Grevillea robusta* classified under "a" class, *Acacia mangium, Hevea brasiliensis, Melia dubia* and *Populus deltoids* "b" class. *Eucalyptus eurograndis* and *Eucalyptus tereticornis* classified under "c" class, *Acacia auriculaeformis* and *Gmelina arborea* "d" class with red oil dye (oil type preservatives).

Three species of cane viz. *Calamus thwaitesii*, *Calamus dransfieldii* and *Calamus vattayila* were treated with CCB and Boric acid preservatives by vacuum pressure impregnation method following 3 different treatment schedules. Retention of the preservative was determined by weight gain basis. Qualitative analysis of the treated cane specimens were determined by spot test. The preservative content was determined quantitatively by chemical assay method. The results show that in green condition when the diameter of the specimens was bigger the absorption was lesser. In dried specimens the diameter does not make any difference in the absorption of the preservatives. The treatment schedules show that the green specimens can be successfully treated to the BIS recommended absorption, 8kg/m^3, by vacuum pressure method

at 30 minutes initial vacuum followed by 3kg/cm^2 for 2hours followed by finial vacuum for 15 minutes. The absorption of Boric acid preservative was always higher than the CCB. In dried specimens the required absorption was achieved at 1hour treatment schedule itself. The penetration tests show the complete penetration of both the preservatives through and through.

Under the study on effect of treatment with micronized copper preservative on the strength, treatability and durability of selected wood species, procured the timber and converted into planks for air-seasoning. Designed, got fabricated and installed the vacuum pressure treatment plant. A small laboratory vacuum system was developed for treatment of small blocks using preservative chemicals. Samples were treated with water as control for comparing with the chemically treated samples. Treatments of planks/wood samples with chemicals were carried out. Specific gravity studies were completed and shrinkage and certain mechanical properties evaluated.

In another study on screening of oil of *Pongamia pinnata* Linn., *Jatropha curcus* Linn. and *Simarouba glauca* D.C. for developing eco-friendly wood preservatives, literature survey was made. Seeds of *Pongamia pinnata* and *Jatropha curcus* were procured and oil was extracted. Incorporated copper metal in *Pongamia pinnata* and *Jatropha curcus* oils by refluxing with cupric oxide for 4 different time periods viz, 8, 16, 32 and 64 hours. Rubber wood was procured and converted into specimens. Specimens of rubber wood were given prophylactic treatment with boric acid. Under screening of certain plant extractives for developing ecofriendly wood preservatives literature survey was made. The barks of *Acacia auriculiformis, Acacia nilotica*, leaves of *Gliricidia sepium* were collected and extracted with 4 different solvents (Petroleum ether, ethyl alcohol, ethyl acetate and water). Incorporated copper metal into the extractives by refluxing with copper oxide for 4 different time periods viz, 4, 8, 16, and 32 hours. Rubber wood was procured and converted into specimens. Specimens of rubber wood were then given prophylactic treatment with boric acid.

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. Dimensional stability and photo-stability of rubber wood esterified with a series of fatty acid chlorides (Hexnoyl (C_6), decanoyl (C_{10}) and tetradecanoyl chloride (C_{14}) has been investigated. Esterified wood exhibited good dimensional stability, degree of dimensional stability increased with increasing carbon chain length. As the chain length of acid chloride increases, thermoplastic property also increases which leave the surface of the wood softer. Fatty acid chloride treatment was only partially effective in inducing stability against UV light irradiation. Decay resistance of esterified wood was also evaluated. Unmodified and modified samples were exposed to a brown rot (*Polyporus meliae*) and white rot *(Coriolus versicolor)* fungus. Modified wood samples exhibited very good resistance to brown and white–rot fungi.

Attenuation constant (at microwave frequencies) increases with increasing moisture content in timber even above the F.S.P. in both directions-longitudinal and transverse. Therefore, relationship between attenuation content and moisture constant may be of practical importance for industries, to measure moisture content during the processing of timber. Relationship of ultrasonic velocity (measured by direct pulse

transmission method) has been established with each Modulus of Elasticity (MoE), Modulus of Rupture (MoR), Compressive Stress at Elastic Limit (CS at EL) and Maximum Crushing Strength (MCS). On the basis of developed regression models of ultrasonic velocity with strength properties, timber material may be sorted out/graded into the different grade (strength-wise). Ultrasonic velocity decreases with increasing moisture content in timber up to the Fibre Saturation Point (FSP) as well as above the FSP and ultrasonic velocity was found to be higher along the longitudinal direction than transverse ones (radial/ tangential) of timber. Generated data on defect, indicates that speed of ultrasound decreases significantly in the presence of structural irregularities (centre hollowness, cracks etc.) in timber. Centre hollowness/ cracks and its size detected successfully by ultrasonic technique in the log. Exponential transducers were fabricated to make testing more effective without couplent.

The data on old doors, used windows, used frames and shutters were evaluated both by conventional test method and ultrasonic method. The values obtained through ultrasonic method (NDT) were close to the values measured using conventional method which shows that the ultrasonic method which is a non-destructive method can be useful to find the service life of used structures and will give the guidance for reuse the same.

NIR methods have been developed for specific gravity, shrinkage, bending properties (MoE- modulus of elasticity, MoR- modulus of rupture and FS at LP – Fibre stress at limit of proportionality), and lignin and holocellulose estimation. The methods are now ready for use in place of conventional one. Wide variations in properties of 47 phenotypes of *E. tereticornis* were observed. Specific gravity had 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 holo-cellulose 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.

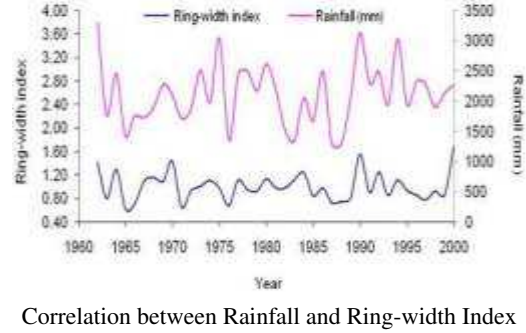
Under the study on constraints in the export of carved out wood products and its economical and social impact on the livelihood of dependent people in North India, literature regarding distribution of Wood Carving Industry, its economic contribution and identification of problems with focus on raw material procurement, manufacture of carved out wood products and their marketing was studied. Ten (10) 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, and constraints in the development of skill, economic upliftment.

As a part of extension, regular surveys were conducted in timber depots and workshops to ascertain the powder post beetle problems and monitoring their occurrence in field. A field workshop was organized by IWST, Bangalore in association with Karnataka State Handicrafts Development Corporation Limited for the benefit of the handicraft artisans of Multicraft, Metugally,

Mysore on 25th March 2011. The meeting was attended by 71 wood craftsmen of Metugally who are living in Multicraft Complex and mainly engaged in production of wooden handicraft articles. It was a lab to land extension programme conducted for extending the newer findings on the methods of protection of wooden handicrafts. The methods to detect the pest attack and manage the problem were explained. It was emphasized that prevention is better than control. It was pointed out that by avoiding sapwood pest attack, can be avoided. Ecofriendly methods of wood protection and methods of curing of the infested wood were explained. Phosphine fumigation for curing the infestation was also demonstrated.

Gas permeability of five imported hardwood species - Gurjan- *Dipterocarpus* spp., Pyinkado- *Xylia dolabriformis,* Merbau-*Instia bijuga,* Red meranti- *Shorea* spp., and Balau-*Shorea* spp., was studied. Gurjan was found to be of the higher flow rates than the rest of the species of timber tested. Balau- *shorea* spp. was found to be the most impermeable species of timber and is highly refractory. Longitudinal permeability in balau and red meranti is extremely low and requires improvement. The permeability variations in longitudinal and transverse directions are considerably very large that signifies the complex nature of the hardwoods. Both longitudinal and transverse permeability varied between species of timber. In general, there is not much difference between radial and tangential permeability though the radial permeability for a given species tends to be slightly higher than tangential permeability. The timber species used for permeability study were evaluated for durability under local condition. The observations revealed that except gurjan all other species exposed to termites were found to be in sound condition even after three years of exposure.

Under the Investigation on Tree ring analysis of certain species in Western Ghats to monitor climate changes and its relevance to wood quality, the main objective was to infer available information on temperature fluctuations, rainfall, soil type, atmospheric disturbances to ring analysis and wood quality and test the sensitivity of the species to the changes in climate and develop chronologies based on growth rings or expressions of growth periodicity and vessel morphology in teak and *Myristica fatua*. Collected meteorological data and information on sites from Karnataka and Maharashtra. The sensitivity of teak wood (collected from Madikeri, Mundagod of Karnataka and Thane, Chandrapur from Maharashtra) to the changes in climate was studied. Cross dating and standardization of discs were carried out. Chronologies based on growth rings/expressions of growth periodicity and vessel morphology were developed from available information on temperature fluctuations, rainfall, soil type, atmospheric disturbances to ring analysis and wood quality.



Correlation between Rainfall and Ring-width Index Chronology of Teak Collected from Madikeri

For the assessment of wood quality, characteristics of *Melia dubia* Cav of Seedling Seed Orchard, the billets of same age but varying girth *were* received. The billets were divided into three girth classes (large, middle and small) to study wood quality parameters with respect to the growth rate i.e. girth. Accordingly, different anatomical, physical and mechanical properties were evaluated. From the studies it was found that there was not much significant variation in the

formation of heartwood while comparing to the three girth classes. The timber from trees of middle girth class was found to have higher specific gravity as compared to large and small girth class trees. The overall higher values in the shrinkage indicate that the timber should be properly seasoned by following proper kiln schedule. In air-seasoning, care must be taken by painting both the ends of timber so that defects like twist, cupping, crook, splits etc. can be avoided. The strength properties (compression parallel and perpendicular to grain and hardness) were found to have higher values for tree of middle girth class which confirms the hypothesis that higher the specific gravity higher the strength properties.

In an effort to study the performance of coatings on modified wood surfaces, work on standardization of reaction conditions of acetylation and benzoylation for optimum weight gain was carried out. Stands for natural weathering were designed and got fabricated. Chemically modified wood specimens of rubber wood and Radiata pine were prepared for application of coatings and weathering exposure. The modified wood panels (benzoylated and acetylated) with average weight gains of 10-20% were prepared and were coated with a transparent and opaque polyurethane exterior paint. Coated and uncoated panels have been exposed to outdoor weathering and samples are being periodically examined for weathering deteriorations. Results show that modified wood performed very well as compared to unmodified specimens. Study on Grafting of UVA's (functionalized benzophenon) on wood surfaces carried out. The performance of UVA grafted wood specimens under accelerated weathering conditions is in progress.

In another study, chemical modification of wood (rubber wood, silver oak) using octanoyl and lauoryl chloride has been carried out. Chemical modification of wood using alkylene epoxides viz., propylene oxode and butylene oxide carried out. Esterified/ etherified wood was characterized using FTIR and NMR spectroscopy. TGA analysis of esterified/ etherified wood was carried out. Study in thermo –plasticization of modified wood and evaluation of its properties is in progress.

Under utilization of *Bambusa bamboos* (L.) and *Dendrocalamus strictus* (Roxb.) as an alternative for wooden dunnage pallets, procured bamboo machineries (bamboo cross cutting, bamboo splitting and bamboo external knot removing machines). Studied on various physical properties such as moisture content, specific gravity and shrinkage, culm wall thickness and diameter were carried out. Study on mechanical properties is in progress. The objectives of these studies are to find the suitability of bamboo for dunnage pallets.

Under comparative study of clones of eucalypts and *Acacia* hybrid for handicraft sector, procured *Eucalyptus tereticornis* and *E. eurograndis* clones and studied specific gravity and shrinkage properties. Mechanical properties under green conditions were also studied. Air seasoning behaviour on small planks was also investigated. The properties are being evaluated to assess the wood quality of clonal material for handicraft sector.

Under the study on enhancing dimensional stability and durability of wood for flooring application by ecofriendly thermal processing, designed the micro-processor controlled vacuum heating oven. Procured and installed the equipments (vacuum oven and swellometer). Procured timber and converted into planks and kept for air seasoning. Heat treatment was carried out at different temperatures and durations under vacuum, nitrogen and inert environments and atmospheric pressure. Specific gravity and EMC (control and treated specimens) were determined. Mechanical properties of control and heat treated samples were also evaluated.

A new study to enhance the strength of finger joints through manipulating the L/P ratio of the profiled fingers has been initiated.

2.5.5 Pulp and Paper

Under the evaluation of alternative raw materials for pulp and paper making, the raw materials viz. *Melia composita* and *Prosopis juliflora* was provided by State Forest Department, Punjab. Procurement of *Gmelina arborea* from RFRI, Jorhat is under progress. The procured raw materials were subjected to debarking and chipping prior to pulping experiments. The procured raw materials viz. *Melia composita* and *Prosopis juliflora* was chemically analyzed for extractives, holocellulose, lignin and ash content as per TAPPI standard methods, in order to check the suitability of these raw materials for pulp and paper making. The analysis revealed that *Melia composita* possesses 2.75% extractives content, 67.40% holocellulose, 27.50% lignin, 3.50% ash content however it was 0.58% extractives content, 73.20% holocellulose, 28.00% lignin and 1.00% ash content in case of *Prosopis juliflora*. The species chemically analyzed possesses adequate amount of cellulose content required for paper making. Anatomical analysis in terms of fibre length, fibre diameter was carried out for *Prosopis juliflora* and *Melia composita*. In case of *Prosopis juliflora* the average fibre length at pith, middle and outer part was 778.4µ, 852.8µ and 890.0µ respectively, however the average fibre length range of pith, middle and outer part varies from 600µ-940µ, 630µ-1080µ, and 690µ-1120µ respectively. The average fibre length of *Melia composita* at pith, middle and outer part was 785.2µ, 933.2µ and 946.4µ respectively, however the average fibre length range of pith, middle and outer varies from 570-1020 µ 670-1220 µ and 660-1200 µ respectively. Kraft pulping of *Melia composita* and *Prosopis juliflora* is under progress.

In another study of biodeinking of waste paper, ten White rot and Brown rot fungi *(Schizophylum commune, Trametes versicolor, Oligoporus placentus, Lenzites striata, Coprinus disseminatus, Trametes incerta, Funalia leonina, Oxyporus ravidus, Trichoderma viridae* and *Trametes lactiana)* were collected from the Forest Pathology Division, FRI for the screening of best cellulose producer. In addition to this, twenty one decaying wood samples were also collected from the wild for isolation of microbes. The ten identified white rot and brown rot fungi collected from the Forest Pathology Division, Forest Research Institute, Dehradun along with twenty one unidentified samples collected from the wild were screened for best cellulose producer on the basis of primary screening method e.g. plate zone assay. On the basis of plate zone assay, *Coprinus disseminatus, Trichoderma viridae,* Isolate No. 14 and Isolate No. 2 were found excellent cellulase producer. Screened microbes (*Coprinus disseminatus, Trichoderma viridae,* Isolate No. 14 and Isolate No. 2) were further screened on the basis of indirect plate zone assay method in order to check the activity of the enzyme. On the basis of standard screening methods, *Trichoderma viridae* has CMCase and FPase activity 1.4702 and 0.210 respectively; however, it was 1.3670 and 0.198 in case of *Coprinus disseminatus.* The mixed office waste paper was collected locally.

2.6 Non Wood Forest Products (NWFPs)

Overview

Summary of the Achievements under the Theme

Researches on Non Wood Forest Products have been covered extensively during the year. Focus has been given on species conservation, sustainable and non destructive harvesting procedures, post harvest treatments and processing techniques, bioactivity evaluation, resource development through forest enrichment with natural species, chemical profiling of wild edibles, gums and other useful NWFPs have been undertaken. Various works on biofuel carried out by the ICFRE Institutes include multilocational trials of different provenances and clones of *Jatropha curcas,* genetic improvement works, evaluation of superior clones and also bamboo charcoal and tree borne oilseeds. Works on treatment of wood and bamboos with preservatives have been taken up. Cultivation of NWFP bearing species, propagation, population assessment and identifying superior chemotypes of a number of medicinal plants have been undertaken.

Projects under the Theme

Project	Completed Project	Ongoing Project	New projects Initiated During the Year
Plan	12	26	22
Externally Aided	6	9	5
Total	18	35	27

2.6.2 Resource Development of NWFPs

Field trials for increasing NWFP Productivity using *Piper pedicellatum: Piper pedicellatum* plant which grows naturally in moist tropical and sub-tropical forest areas, has the potential to be profitably utilized to increase forest productivity. Domestication and cultivation of this wild species is possible and so field trials at Dehradun area has been taken up. Nursery technique developed and standardized. Selected 2 sites for field trial- FRI Campus under *Prunus cearasoides* plantation and Lachhiwala RF area under *Dalbergia sissoo* plantation of Dehradun. Preparation for final plantation works in the field is also being carried out.

Vegetative Propagation and Seedling Production

Data Compilation of R & D in Medicinal and Aromatic Plants by ICFRE Institute and Other Institutional Projects funded by ICFRE: A lot of information on different aspects of medicinal and aromatic plant sector has been generated over the years, however, this information is scattered, and often inaccessible to less citation and also likelihood duplication of the works. They are also not fully disseminated to the stakeholders. Therefore, compilation of the large data generated under various research programmes for dissemination to stakeholders besides its application for easy reference, planning of new projects is being taken up. Works being done include screening of ICFRE funded final project reports and library search on R&D in MAPs by ICFRE Institutes for the last 50 years. Two JRFs are actively engaged in the work. Field visits made to HFRI, Shimla, AFRI, Jodhpur for R&D data collection. Consulted project completion reports (46 nos.), research papers (44 nos.) and up-dation of R&D information on 36 medicinal plants is in progress.

Standardization of Drying and Storage Protocol and Quality Assessment of Selected Commercially Cultivated Medicinal Plants of Uttarakhand: Standardisation of optimum drying and storage conditions for *Aconitum heterophyllum, Withania somniferra, Asparagus racemosus, Picrorrhiza kurroa* and *Rauvolfia serpentina* is being carried out in order to get quality products. Work on the evaluation of the effect of drying and storage conditions on the quality of selected cultivated medicinal plants is being carried out. The research is also to develop drying and storage package of practices for farmers and traders.

During the year, experimental differential drying and storage of five medicinal plants under cultivation has been undertaken and quality parameters like LOD, Total Ash, Acid Insoluble Ash, Water and Alcohol Soluble extractives have been assessed for up to 18 months of storage . The chemical markers specific to each species have been estimated at different storage intervals. The project is in the final stages.

Under Integrated Approach of Bamboo Improvement, various works such as bamboo conservation, propagation and development of agroforestry models of selected Bamboo Species is being carried out at IWST, Bangalore. Collected offset cuttings/plants from CPCs of selected Bamboo species and maintained plants in nurseries. Planted 16 different bamboo species including 9 CPCs in germplasm bank, Gottipura. Carried out experiment on the effect of types (culm cuttings, branch cuttings and rhizomatous cuttings) on rooting in *Dendrocalamus brandisii.* Rhizomatous cuttings and culm cuttings proved better for rooting. Intercropping was done with horse gram, field bean and cow pea in Hoskote Devon plantations, Koppa, Chickmagalur District and in Bittangala, Virajpet, Coorg. Experiment was carried out to study the effect of different size (big, medium, small) and type of cuttings (branch cuttings and rhizomatous cuttings) on rooting in *Dendrocalamus brandisii.* Different growth hormones like; IBA, NAA, IAA and NOA were also tried. Initial results indicate that rooting was better in big size rhizomatous cuttings and growth hormones IBA and NAA enhanced rooting percentage. New agroforestry trials were established at Devon plantation Chickmagalur and Kodagu, management and observation on growth parameters recorded. Leaf litter traps carried out and litter decomposition trials carried out in Nallal, Hoskote for productivity studies and monthly observations were recorded.

Protection of Bamboo and Products: Experiments on bio-deterioration-pest and disease in nurseries, plantations, seed and culm storage, bamboo products, durability and integrated pest/disease management is being carried out at Bangalore. Surveys were carried out to investigate the pest and disease problems associated with cultivated Bamboos. The major bamboo species studied

were *Bambusa bamboos, B. nutans, B. balcooa, B. pallida, B. tulda, Dendrocalamus asper, D. brandisii, D. hamiltonii, D. stocksii, D. strictus,* and *Guadua angustifolia*. The pests include sapsuckers and defoliators. Aphids and Delphacids were the major pests on different species of bamboos. Collected diseased bamboo leaves and culturing of fungi was carried out. The following pathogens were isolated and identified. *Pestaliopsis guepinii* (desm) Stey causing leaf spot on *B. bamboos*, *Fusarium* spp. close to *F. equiseti* (Corda) Sacc. causing leaf infection in *D.asper*, *Pseudofusarium* causing leaf-spot on *D. stocksii*. The following insect pests were identified and biological studies are being undertaken -*Eleamea* spp., *Tesserotoma javana, Purohita* spp., in *D. brandisii, Eucyrtus cocinus, Pseudoregma bambusicola* and *Gnamptoloma aventiaria* in *B. balcooa, M. notobitus, Astegopteryx bambusae, Purohita* spp., in *D. strictus, Astegopteryx bambusae, Morillia* spp., *Matapa acia* in *B.bamboos, Eleameasecurigera* spp., in *D. hamiltonii.* Commonly used insecticides were tested against major pest in the nursery. *Metarhizium* spp. were used as botanical and bio-control agents against aphids. Predatory potential experiment done with *Astegopteryx bambusae* and *Coccinella septempunctata.* The insecticide/ preservative/botanical treated *B. bamboos* and *D. stocksii* were evaluated for durability under lab and field conditions. Six *Trichoderma* spp. were tested against the pathogens (*Fusarium oxysporum, F. verticilloides, Pestalotiopsis* spp. and *Dreschlera* spp.) *in vitro* by adopting methods like dual culture test and production of volatile and non-volatile compounds. The blocks of D. *asper, D. stocksii, D. strictus, B. pallida, B. balcooa* and *B. nutans* were treated with 1% and 2% concentration of Prosopis extract and Bark extract of *Cleistanthus collinus* by pressure treatment for the durability test against the rot fungus/borer and termites. Natural durability of *B. balcooa* and *B.pallida* was tested against two white rot and brown rot fungus. Prepared checklist of pest and diseases on bamboos in India. Data on various experiments are compiled and report is under preparation.

Seasoning and Preservation of Bamboo: Experiments on drying of Bamboo (*D. Stocksii* and *D. strictus)* using microwaves at different microwave intensity and exposure times are completed. Experiments on kiln drying and microwave drying of *Bambusa bamboo* carried out. Analysis of preservative absorption at different treatment parameters and along the length of the Bamboo (*D. stocksii*) completed. Analysis of preservative absorption in *D. strictus* completed. The results showed that the retention of preservative is significantly higher in MW dried than that in kiln and air dried samples. A research paper entitled "Microwave drying of Bamboo" published in European Journal of Wood and Wood Products.

Fuel Properties, Carbonization and Characterization of Charcoal from Selected Bamboo Species: It was observed that the basic density ranges from 0.48$\pm$ 0.03 to 0.61$\pm$ 0.03 in four bamboos species. Its value was found to be highest (0.61$\pm$ 0.03) in *B. bamboos*. Elemental analysis (ultimate carbon, hydrogen, nitrogen, oxygen and sulfur content determination) of *Bambusa balcooa* with age (1 to 4 years) and height (top, middle and bottom) was carried out. Proximate analysis of four bamboo species was carried out. The ash percentage of *B. bamboos* was found to be quite low (1.41$\pm$ 0.002) whereas comparatively higher ash (3.02$\pm$ 0.03) was found in *D. strictus*. The fixed carbon ranges among different bamboo species ranges from 17.61 to 18.14 percent. Calorific value of four bamboo species was determined using oxygen bomb calorimeter. Highest calorific value (4580$\pm$ 0.04 kcal/kg) was found in *B. bamboos* and the lowest (4496+ 0.02 kcal/kg) in *D. strictus*. The variation

in calorific values of two bamboo species may be due to difference in the ash content. Thermo-gravimetric Analysis (TGA) of selected bamboo species was also carried out. Preparation of charcoal at different carbonized conditions (temperature, heating rate and soaking time) is under progress. Ash elemental analysis of four selected bamboo species was carried out. Order has been given for fabrication of portable charcoal making kiln.

Integrated Approach of Bamboo Improvement Propagation, Agroforestry Models, Protection, Processing and Utilization: A pamphlet on "sap displacement method of treating bamboo poles" was published in Kannada and English. A pamphlet on "infrastructure requirement and vegetative propagation of *Dendrocalamus stocksii* by culm cutting" has also been prepared. A video film on bamboo and institute activities of approximately 15 minutes each prepared. 19 demo Programmes has been organized in Karnataka, Andra Pradesh and Kerala as per the action plan. A National seminar on "Recent advances in Bamboo propagation, management and utilization" was organized by IWST on 17th and 18th February 2011.

Effect of Fertilizer Application on Growth and Yield: *Salvadora persica* and *Acacia ampliceps* plantations, both 10 years old under silvipastoral system on arid salt affected soil is going on at AFRI, Jodhpur. Field trials were laid out of *Salvadora persica* and *Acacia ampliceps* in 1997 and 1998 on saline alkali sandy soil in Jodhpur.In case of *S. persica,* thirteen treatments viz; 1.Control; 2. FYM (10 Kg/plant); 3. FYM + Urea (500 g N) 4. FYM + $ZnSO_4$ (25 kg/ha) 5. FYM + K_2SO_4 (50 g K_2O) 6. FYM + SSP (500 g P) 7. FYM + Urea + $ZnSO_4$, 8. FYM + Urea + K_2SO_4 9. FYM + Urea + SSP, 10. FYM + $ZnSO_4$ + K_2SO_4 11. FYM + $ZnSO_4$ + SSP, 12. FYM + K_2SO_4 + SSP 13. FYM + K_2SO_4 + SSP + Urea + $ZnSO_4$ and in case of *Acacia ampliceps* ten treatments viz. 1.Control; 2. FYM (10 Kg/plant); 3. Urea (500 g N) 4. SSP (500 g P) 5. $ZnSO_4$ (25kg/ha); 6. K_2SO_4 (50 g K_2O) 7. FYM + Urea 8. FYM + $ZnSO_4$ 9. FYM + K_2SO_4 10. FYM + SSP were applied in January 2009 to study the effect of fertilizer treatments on growth and yield.

Salvadora persica

After deficient of monsoon, the fruit yield in April, 2010 was maximum (971g) in T_{13}(FYM+U+Zn+K+SSP) treatment, followed by T_4(FYM+Zn) 681g and T_7 (U+Zn) 670g. Yield in other treatments was ranging from 20 to 123g with no fruit yield in T_6 (FYM+SSP) with T_{10} (FYM+Zn+K) treatments. Oil yielding was estimated and pink fruit's seed yielding with least 37.5%, while purple and white yielded 40.8 and 39.6%, respectively. Oil yield varied from 30.5 to

Salvadora persica in Fruiting Stage

43.1% with no effect of treatments. Phenological observations in 2010, recorded and early flowering found in 93.6% plants in late October. Mostly multicolored fruits were observed, but only white fruits were observed on six plants. Immature fruit without seed were formed, but aborted and fresh flowering initiated in early December. A total of 93.1% tree flowered second time in February 2011. Fruit setting took place in March.

Annual growth data for the year 2009-10 indicated that treatments are significantly (P-0-00) influencing the height, crown and collar diameter as compared to control. T_{12} was the best treatment recording, maximum overall growth -13.6, 26.6 and 40.1% for height, crown and collar diameter, respectively, followed by T_4 (FYM+Zn) 7.8, 26.5 & 35.3

Acacia ampliceps

Early flowering was observed in *A. ampliceps* and 90 % trees flowered in the first week of November 2010 and maintained upto Jannuary 2011 in a well distributed monsoon year with pod setting in 72.5 % plants, which was better as compared to 45% flowering in 2009 with no pod setting. Maximum pod setting was in T_7 (91.6%), followed by T6 88.8% and minimum (44.4%) was control in March 2011.

After deficient monsoon, *A. ampliceps* recorded a mean 18 % casuality in different treatments during summer of 2010, maximum (42%) morality was in T_4 (FYM + SSP) treatment. The incremental tree growth showed that T_6 (32.2 & 34.2 %) , T_8 (31.4& 36.3%) and T_{10} (26.4 & 29.4%) recoded maximum collar and crown diameter, respectively, however, height growth was maximum for T_{10} (37.1%), followed by T_9 (28.8%) and T_8(25.8%) treatments.

Grass Trial:

Field trial was laid with two grass species viz *Cenchrus ciliaris* and Sporobolus diander on three soil structures (i) raised platform (ii) raised bund and iii) control for Silvipastoral study in three replications.

In a good monsoon year, soil structures influenced the green grass yield and it was 906 and 894 g/m^2 for the platform and slope soil structures, respectively as compared to control (465 g/m^2) in *S. diander*. In case of *C. ciliaris,* slope was the best structure with 1104 g/m^2 and yield is 6.5% more than control(169 g/m^2) indicating the positive effect of leaching.

1. Platform

2. Control
Sporobolus diander

3. Slope

4. Control
Cenchrus ciliaris

HFRI, Shimla

Podophylum hexandrum: Identification of Superior Chemotypes and e*x-situ* Conservation of the species from Himachal Pradesh and Jammu & Kashmir (Ladakh Valley) is going on. After extensive survey, 28 nos. sites were identified for collection of *Podophyllum hexandrum* species from different geographical locations of Himachal Pradesh (HP) and Jammu & Kashmir

Studies on *Podophyllum hexandrum* at Kargil (Ladakh), Jammu & Kashmir

(J&K). Each site was geo-referenced along with characterization of micro-habitat. The samples of *Podophyllum hexandrum* were collected from the identified sites and the same were sent to the Institute of Himalayan Bio-resource Technology (IHBT), Palampur for carrying out a/i (active ingredient) analysis for identification of superior chemotypes. By using the germplasm collected from 34 sites, Field Gene Bank (FGB) has been established at Field Reserach Station, Brundhar, Jagatsukh, Distt. Kullu, Himachal Pradesh (H.P.). Seed and vegetative propagation trials have also been initiated to develop user friendly propagation trials of *P. hexandrum*. After a/i analysis of samples, data have been statistically analysed to identify the superior chemo-types from most probable geographical locations of Himachal Pradesh and Jammu & Kashmir (Ladakh Valley).

Picrorhiza kurro and *Valeriana jatamansi:* 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 (HP and Uttarakhand) is being carried out at Shimla. Extensive survey were carried out to select the sites by the

One of P.kurrooa site at Chamba (H.P.)

respective teams covering the most probable sites viz. Rampur, Shimla, Chamba, Dharamsala, Nahan, Kullu and Mandi forest circles of Himachal Pradesh. Geo-referenced the sites and carried out population assessment study along with characterization of the micro-habitat. Collected the medicinal plants samples (*P.kurroa*- 81 nos. and *V. jatamansi*- 40 nos.) for carrying out a./i. analysis for identification of Superior Genetic Stock. Sent the medicinal plants samples for a./i. analysis to the Institute of Himalayan Bio-resource Technology (IHBT), Palampur, District. Kangra, (*P.kurroa*-75 nos., *V. jatamansi*- 84 nos.) and Jai Prakash Univeristy of Information Technology, District. Solan, Waknaghat (*P.kurroa*- 74 nos.). Preparation of field beds at Shillaru and Brundhar nursery for establishing FGB. Maintained the existing strains at FRS Shilly, Shillaru and Brundhar nursery.

Utilization Study of NWFPs: Mode of collection, processing, sale and utilization of NWFPs in tribal pockets of Jharkhand has been completed during the year by IFP, Ranchi and studied 320 samples of NTFPs and medicinal herbs collected from different markets. A consolidated list has been prepared of the suppliers of medicinal plants in the eastern region.

Conservation of Medicinal Plants: Commercial cultivation and value addition by Joint Forest Management Committees/panchayats and farmers in eastern Himalaya and its socio-economic impact is going on. Total QPM Created 280483 and QPM Distributed for cultivation 77200 to the JFMC member through State Forest Department and Farmers for cultivation commercially, free of cost to motivate the farmers for cultivation. Supplied 43800 QPM to the farmers for commercial cultivation at minimum rate i.e. ` 1.00 and utilized 30950 nos. of QPM for seed garden at Udai Singh Joth and IFP Ranchi, Lalgutwa and trail plot. Seven Workshop/Training programme were organized and motivated 113 farmers of Mangalkata Village, Banarhut; Angrabhasa Grampanchayat, Jalpaiguri District; Lingsay Village, Kalimpong Sub-division, Darjeeling District.; Rangbhang Village, Darjeeling District; for commercial cultivation of medicinal plants through NTFP Division, North Bengal; Divisional Forest Officer, Jalpaiguri. Technical assistant was provided to cultivator from time to time. Preparation and maintenance of 10 trail plantations of 6 species of medicinal plants viz. *Rauvolfia serpentina, Withamia somnifera, Stevia rebaudiana, Asparagus racemosus, Gymnema sylvestre* and *Abolmoschau moschatus.*

Medicinal plants garden and propagation centre in Chhotanagpur plateau for conservation and production of QPM for promotion of ex situ cultivation has been established where, 20 different species have been planted in 300 beds and 1,10,000 seedlings/plantlets produced and distributed. A National Conference of Medicinal plants was also organized by IFP, Ranchi.

Cultivation & Marketing : Standardization and dissemination of complete package in relation to principal active ingredient of ten selected medicinal plants of Jharkhand, Bihar, West Bengal and Orissa is being carried out. Companies based on medicinal plants have been approached and maximum of them have given the data asked for experimental trial seedlings have been prepared. Experimental plot has been laid in two States i.e. Jharkhand and West Bengal in open and agronet conditions. One awareness training on selected medicinal plants was organized in ERS, Sukna and a practical demonstration of cultivation of selected medicinal plants was given to the farmers, NGOs etc.

Nursery Technique: Nursery technique of highly exploited medicinal plants viz. *Celastrus paniculatus* and *Vitex peduncularis* has been initiated. Three natural sites of *Vitex peduncularis* in Ranchi and 2 sites of *Celastrus paniculatus* in Ramgarh identified. Three trees of *V. peduncularis* and one plant of *C. paniculatus* (climbers) have been selected with healthy, vigorously growing propagules. Shoot cuttings were obtained from *V. peduncularis*. Mature seeds of *C. paniculatus* have been collected and subjected to various physico-chemical treatments for germination experiments.

Multilocational Trial: Multilocational trial of Jatropa in different agro-climatic zones and study of agronomic practices were also initiated. Planting material collected from Hyderabad, Indore & Lucknow. Field preparation & planting is completed. Agronomy trial, MLT trial & Silviculture trial have been taken up. Established irrigation facility, casualty replacement and termitecide application and maintenance of plants in the field were also provided.

2.6.3 Sustainable Harvesting and Management

Creation of Seed Production Area and Commercial Cultivation Trials of *Uraria picta*: The population of herbaceous dashmula plant, *Uraria picta* is falling into a threatening position in the natural forest areas. It is being collected from the wild. The future availability is at stake unless it is protected and conserved. Therefore work on establishment of seed bank, undertaking experimental cultivation and to estimate the economics of its cultivation has been taken up.

During the year, 450 mother plants collected and established at Mother beds at FRI campus collected (NWFP Garden). Collected Seeds from Uttarakhand and MP and nursery raising achieved. Seed Bank has been established and it is being enriched with more plants for seed production. Approximately 1.739 kg of seeds from the seed bank were produced. Seeds collected from UK and MP and Seed Bank established at FRI have been sown and nursery raised for cultivation trials. Over 2000 seedlings have been raised and maintained.

Testing of Vegetative Multiplication Technique *of Microstylis wallichii* in its Natural Habitat: Vegetative Multiplication Technique of *Microstylis wallichii* is known but its' lab to land procedures has not been developed. Therefore, the developed techniques are being tried in its natural habitats in Dehradun hill areas. Surveys were conducted for occurrence of species in Mussoorie, Chakrata, Nanital, Almora, and Narendra Nagar Forest Division. Field testing of vegetative multiplication techniques of the species are in progress at 3 sites namely-Chakrata, Mussoorie and Danolti. Growth observation, data recording and maintenance of experimental plots are in progress.

Vegetative Multiplication Technique of *Microstylis wallichii*

Field Trial of Bore Hole Method of Resin Tapping for Chir Pine of Uttarakhand for Better Oleoresin Yield: Need for effective pine resin tapping technique is essential to increase the productivity and for protecting the trees from its harmful effect of traditional tapping methods. Survey was conducted for taking up field trial. *Pinus roxburghii* growing areas of Mussoorie Forest Division were selected and three plots at different elevations marked. One site at FRI in Champion, Block was also selected for demonstration and extension purpose. Selection of trees for tapping and markings at Magra comp. No.2 was also done. A total of 195 trees were marked for tapping resin using bore hole method. The yield is compared with the prevailing rill method.

Selection of Trees

Rill Method

Bore Hole Method

Collection and Drying of *Thymus serpyllum* for Study of Essential Oils

Study of Essential Oils of *Thymus serpyllum* Grown in Different Altitudinal Locations at Different Stages of Harvesting: *Thymus serphyllum*, a wild plant of Lamiaceae family, bears important aromatic oils, made up of Lilanool and Linalyl acetate as major component. Oil content and composition depends on various factors effecting the growth of the plant. Therefore, estimation and analysis of essential oils from different stages of its development at different locations of Uttarakhand state were carried out. Field visits to know the occurrences were also made in different Districts. Result indicated that the oil per cent was not much different in wild and cultivated plants but the percentage of thymol and other compounds were highly increased in cultivated form. Findings have been sent for publication.

Results:- The oil obtained from dried aerial parts and analyzed by GC and GC-MS. Twenty two compounds were found from 88.46 to 93.95 % wild plants, and 93.63 % cultivated plants at High altitude area. In all the samples, Thymol (34.63-36.61%) was the most abundant component followed by p-cymene (10.74-13.68%) and -terpinene (7.94-13.4).

Development of Nursery Techniques of Fibre Yielding Himalayan Nettle: In order to ensure sustainable production and utilization of Himalayan nettle (*Girardinia heterophylla)* fibre, work relating to nursery development has been taken up. Nursery work such as seed sowing and germination trials, vegetative multiplication trials are in progress at Chakrata NWFP Nursery and NWFP Nursery FRI, Dehradun. Data recorded on seed germination in laboratory condition and in open nursery conditions.

Seed Germinated in Different Containers in Green House at FRI-NWFP Nursery

Plastic Trays | Root Trainers | Poly Bags

Seed Sown in Open Mother Lands at FRI-NWFP Nursery Experiment Site-I

Bed prepared for seed sowing

Seed germinated

Phytochemical Examination of *Acacia albida*: Isolation of bioactive compounds from *Acacia albida* have been taken up. Research activities include isolation and structure elucidation of chemical compounds present in the leaves and bark of *Acacia albida* and then to carry out studies on the antifungal activity of extractives on the *Cylendrocladium quinqueseptatum*, *Aspergillus niger* and *Rhizoctonia solanii*.To achieve the target, bark and leaves of *Acacia albida* were procured and processed. Bark and leaves were extracted with solvents and crude extracts were sent for screening of antifungal activity. Isolation of compounds by column chromatography is in progress.

Marketing Mechanism : Commercially important medicinal plants were taken for study in selected districts of Eastern Uttar Pradesh were taken for study i.e. Allahabad, Varanasi, two districts of Vindhna Plateau i.e. Mirzapur Renukoot and two districts at Tarai region of Eastern Uttar Pradesh i.e. Baharaich and Basti. Questionnaire for market survey was prepared and tested on farmers, market and industry and modified where ever necessary. Survey of Allahabad district has been completed and Varanasi district is under progress.

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 : Surveyed Amarkantak and East Karanjiya ranges, located in buffer and transition zones of Achanakmar-Amarkantak biosphere reserve and baseline information such as potential habitat areas, village forest committees etc. are collected. Localities of selected target species of medicinal plants,

such as *Thalictrum foliolosum, Embelia tsjeriam cottam, Rubia cordifolia* and *Celastrus paniculatus* identified. Observations on population size, structure of target species, habitat characteristics and associate species of selected medicinal plants recorded. Extension materials, such as posters and questionnaire were prepared for awareness programme and interface with villagers. Two interface workshops conducted with villagers of Damgarh, Umargohan and Kharidih.

Development of Alternative Methods of Sustainable Harvesting of Medicinal Plants: Experiments were laid out for standardization of alternative harvesting practices of designated species viz. *Bauhinia veriegata* (Kachnar), *Holarrhena antidysenterica* (Kutaj), *Oroxylum indicum* (Sheonak), *Saraca asoka* (Ashoka) and *Terminalia arjuna* (Arjuna) in the forests areas of Jabalpur, Balaghat, Rewa, Bodla (M.P.), Chandrapur, Tadgaon, Allapally, Tadoba, Nasik (Maharashtra) and Keonchi, Pendra Road, Bilaspur, Raigarh, Marvahi, Gariyaband (Chhattisgarh), Harishankar, Champagarh, Khurda and Koraput (Odisha). Various harvesting methods such as ? and ¼ blaze size, longitudinal strip (alternate and opposite strips) harvesting were experimented. Different plant parts i.e. trunk bark, branch bark, twig bark, twigs, leaves, flowers and root bark etc. were collected and analyzed for their phytochemical constituents (tannins, alkaloids, flavonoids, phenols and phenolic acids). 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. Data on bark regeneration revealed that bark recovery is faster in younger trees having GBH <80 cm. Complete bark recovery was observed in two years in trees having GBH <80 cm and three years in the trees having GBH >80 cm. Minimum harvestable girth varies from species to species. Bark can be harvested from the previously harvested trees after two years from opposite side of the blaze. 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. Antioxidant activity assay was also done in bark samples of above species in which *T. arjuna* was found to possess maximum antioxidant activity.

Terminalia arjuna Tree Showing a Blaze on the Trunk

Terminalia arjuna Tree Showing Regeneration of Bark

Sustainable Harvesting Practices for Arjuna (*Terminalia arjuna*) Bark: Experiments were laid out for standardization of sustainable harvesting practices for *Terminalia arjuna* (Arjuna) in the forest areas of Keonchi, Pendra Road, Bilaspur, Marvahi, Gariyaband (Chhattisgarh). Various harvesting methods such as ? and ¼ blaze size, longitudinal strip (alternate and opposite strips) harvesting were experimented. Different growth regulators e.g., IAA, IBA; bordeaux mixture, leaf extracts of Neem, Aak and 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, root bark, twigs, leaves and flowers etc. were collected and analyzed for their phytochemical constituents (tannins, ash, oxalic acid, gallic acid, ellagic acid, cardiac glycosides, flavonoids, phenols and phenolic acids). Regenerated bark was also collected and evaluated for their major

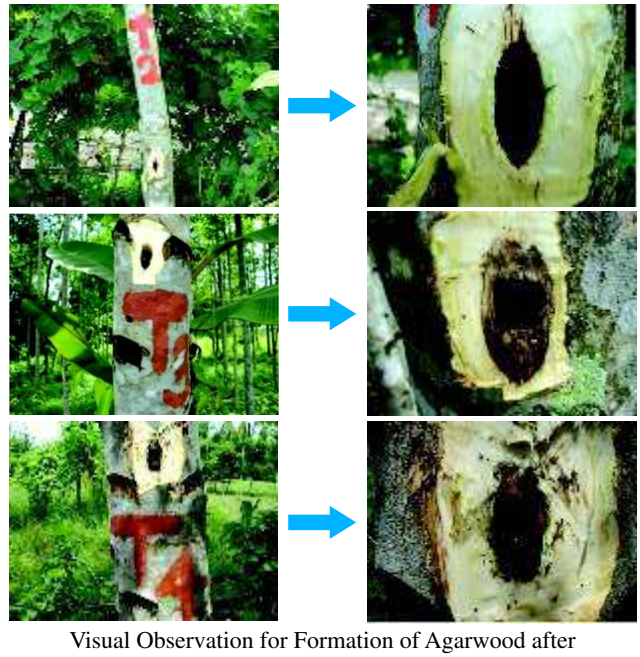
active ingredients. Bark regrowth results revealed that longitudinal strip harvesting method is superior to other harvesting methods. Data on bark regeneration revealed that bark recovery is faster in younger trees having GBH <90 cm. Minimum harvestable girth should be >60 cm. Study on different growth regulator and insecticide application is under progress. Phytochemical analysis of original and regenerated bark revealed that original bark contains higher amount of active ingredients than regenerated bark. Plant samples were also analysed for their antioxidant activity which was found maximum in bark samples.

Sustainable Harvesting Practices of Bhui-aonla (*Phyllanthus amarus*), Sal-parni (*Desmodium gangeticum*) and Baichandi (*Dioscorea hispida*): Experiments were laid out to standardize sustainable harvesting of *Phyllanthus amarus, Desmodium gangeticum* and *Dioscorea hispida* in Chhattisgarh. Further studies for standardization of harvest regimes is under progress in which entire plants will be harvested as per treatments e.g. HI (Control), H2 (40% harvest), H3 (60% harvest), H4 (80% harvest) and H5 (100% harvest) as well as cutting of plant up to collar level at all level of harvest.

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 antioxidant constituents viz. ascorbic acid, total phenols, phenolic acids and macroelements extimated. Further analysis is under progress.

RFRI, Jorhat

Inoculation Technique for Agarwood Formation in *Aquilaria malaccensis* L: Artificial inoculations of fungi were carried out in Tezpur for inducement of agarwood in agar trees under the project entitled "Standardization of inoculation techniques for agarwood formation in *Aquilaria malaccensis* Lamk." Fifteen trees were inoculated as per the technical programme. Inoculated trees were observed after 3 months for external symptom of agarwood 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.



Visual Observation for Formation of Agarwood after Inoculation with the Dominant Fungus After 3 Months

Commiphora wightii: Network Research Project on Guggal *Commiphora wightii* is Goung on.

Clonal performance trial was established in September, 2007 in RBD design with 4 replications with each replication, having 8 plants per accession. The trial is 41 months old.

Survival varied from 44% of Jalore to 100% of Jaipur, followed by 94% of Barmer, Bikaner and Dausa. Mean Plant height varied from 112.14cm of Bharatpur to 192.22cm of Tonk, mean crown diameter varied from 104.64cm in Jalore to 183.98cm in Sikar source, nearly followed by 183.52cm of Tonk source and mean number of branches ranged from (3.09) in Bhratpur to (5.61) in Jhunjhunu source. The data were significant for all the growth parameters at <0.01 probability level. On the basis of DMRT, height of all the 21 clonal sources was divided into10 groups, crown into 7 and branches divided into 6 groups.

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 = 2kg/pit; F_2 = 5kg/pit;F_3 = Urea 50g pit (46% Nitrogen); F_4 = SSP 50 g pit (20% Phosphorus);F_5 = 5kg FYM+ Urea 50g/plant;F_6 = 5kgFYM+ SSP 50g/plant;F_7 = Urea + SSP (50g each)applied in agri-trial of *Commiphora* after 40 months of planting in the field. Mean plant height (cm), number of branches and crown diameter (cm) ranged from 182.69cm in I_3 to 198.69cm 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.

Application of fertilizer treatment showed significant effect on growth of *Commiphora* plants. The mean height, number of branches and crown diameter varied from 182.24cm in treatment F_7 to 205.82cm in F_2, 3.98 in F_1 to 5.66 in F_7 and 160.97cm in F_5 nearly followed by F_1 (161.67cm) to 183.16cm in F_2, respectively. Analysis of variance revealed that effect of fertilizer on plant growth with respect to number of branches was highly-significant. The plant height and crown diameter were also significantly affected by fertilizers.

Non-destructive Gum Production:

Experimental trials of *Commiphora wightii* were maintained in Kumatia enclosure, Kailana Forest Area, Jodhpur. Protection measures (application of termiticide and fungicide) were applied in June 2010 and Monthly spray of fungicide and termiticide to all the plants was done from January to March 2011, while, GA_3 was sprayed once on pruned plants. Growth data (height, crown and collar diameter) and vegetation status were recorded in October-November 2010. In the experiment 1, the growth data of height ranges from 150 to 216.6 cm, crown diameter 210 to 307.5 cm and collar diameter 4.84 to 6.83 cm with 3-8 number of branches/ plant. In experiment 2, height ranged from 105 to 290 cm, crown diameter 175 to 345 cm and collar diameter 4.41 to 8.33 cm, having 3-7 number of branches/ plant.

Percent moisture in thinner branches (post ethephone treated plants) was ranging from 57.2 – 69.1 % in various treatments in the month of November 2010. Pre-ethephone solvent extractions (2009) with petroleum ether, ethyl acetate and acetone extracts were 1.76 to 1.9%, 0.97 to 1.31% and 0.52 to 0.89%, respectively. The powdered material of thinner branches (post ethephone -2009) was collected after second consecutive gum extraction. It was extracted with petroleum ether (60-80°), ethyl acetate and acetone. The maximum per cent extractives were recorded with petroleum ether. It was maximum in control 3.0 per cent, followed by 2.42 to 2.64 per cent for different doses of ethephone. In case of ethyl acetate, the range was 1.3 per cent for control, while 1.47 to 1.86 per cent for ethephone doses indicated that ethephone application is increasing the yield. It is also found that Guggulsterone came in ethyl acetate fraction. In case of acetone, the range was 1.40 per cent in control, while in different ethephone doses it was 1.28 per cent.

Table 1. Percent of Different Solvent Extracts of Guggul Branches (Post Ethephone, 2009)

Chemical Doses		W/o Irrigation and w/o FYM (I)	With FYM			Mean
			I_0	I_1	I_2	
C0	PE	2.30 %	2.57 %	3.02 %	3.41 %	3.0 %
	EtOAc	1.42 %	1.31 %	1.09 %	1.52 %	1.30 %
	Acetone	1.36 %	1.38 %	1.35 %	1.48 %	1.40 %
C1	PE	2.64 %	1.76 %	2.62 %	2.82 %	2.40 %
	EtOAc	2.26 %	1.97 %	2.55 %	1.07 %	1.86 %
	Acetone	1.25 %	1.26 %	1.20 %	1.35 %	1.27 %
C2	PE	1.87 %	1.31 %	3.52 %	2.68 %	2.50 %
	EtOAc	1.41 %	2.01 %	1.35 %	1.37 %	1.57 %
	Acetone	1.12 %	1.20 %	1.34 %	1.31 %	1.28 %
C3	PE	3.26 %	2.26 %	3.0 %	2.66 %	2.64 %
	EtOAc	1.58 %	1.79 %	1.16 %	1.48 %	1.47 %
	Acetone	1.40 %	1.10 %	1.32 %	1.42 %	1.28 %

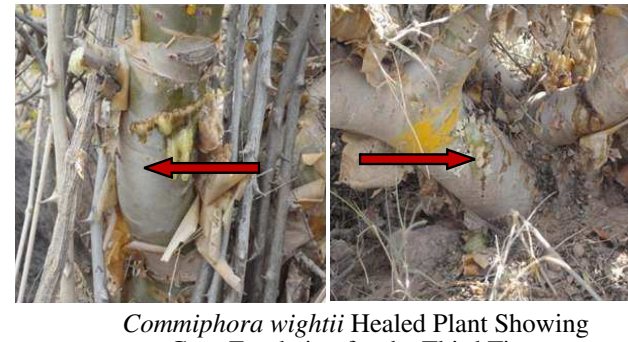
I: Without irrigation and without FYM
I_0 : One time irrigation with FYM
I_1: Irrigation at 20 days interval with FYM
I_2 : Irrigation at 30 days interval with FYM

PE= Petroleum ether extract
EtOAc = Ethyl acetate extract
Acetone =Acetone extract

In the second experiment (2010), soil analysis of plant pit samples collected in summer 2010 after cessation of gum exudation has been carried out. The ranges of pH_2, EC_2, % SOC and phosphorus were 7.1 to 8.1, 0.20 to 0.84, 0.21 to 1.30 and 4.21 to 13.88 kg/ha, respectively. There is no significant difference in soil surface and soil depth (0-20 cm).

Phenological observations were recorded on monthly basis for all the plants in exp. 1 and 2. Flowering was noticed in February 2010 in all the plants with leaf initiation in some plants. Sporadic fruiting was observed in almost all the plants in March, 2010 and become dense in April 2010. Plants were lush green after rains in monsoon (July to October 2010) with occasional fruiting. Leaf started yellowing in early November and all the plants were completely leafless in late Nov, 2010 with fruiting. In the year 2011, fruiting was observed in February which was one month early as compared to that of last year.

Tapping experiments were initiated in last week of March 2011 with varying ethephone doses (0, 175 and 225 mg) and injected at one place in a plant, and 3-4 cuts were given. First gum has been collected. Oozing of gum was observed in treated plants. So far all the trees are healthy. Branch cuttings (1.5 cm to 3.5 cm dia) from these plants were taken after gum exudation and planted. Sprouting was observed in 85% of the cuttings.



Commiphora wightii Healed Plant Showing Gum Exudation for the Third Time

Demonstrated ethephone injection based gum-oleo-resin extraction technology at DMAPR, Anand from 8 to 12 March 2011 on 9 years old 12 plants with four ethephone dosages viz; 0, 150, 160 and 170 mg. Collar diameter of branches, range from 2.60 to 6.91 cm.

Tissue Culture Protocol of *Commiphora wightii:* More than three years old embryogenic callus was maintained continuously by subculturing. Secondary and tertiary somatic embryos were also obtained. Cyclic embryogenesis was established and stabilized.

Matured white somatic embryos were used for germination of SEs on different concentrations of gibberellic acid supplemented in modified MS medium. The highest germination percentage (62.25%) of SEs was observed on modified MS medium supplemented with 0.8 mg/l gibberellic acid as well as on control with least abnormal germination of somatic embryos. Plantlet derived from somatic embryo was termed as embling (plantlets).

Harvested mature embryos upon germination and formation of complete plantlets acclimatized to make them ready for transplantation to field conditions. These emblings, 4-5 cm in height were acclimatized in a two step manner. During *in-vitro* hardening step, the survival was 61.5% and during *ex-vitro* hardening step, it was 100%. Hardened plants (10-12 cm in height) were transferred to polybags filled with mixture of soil and FYM in the ratio of 2:1 and were kept in 75% shade in agro-net shade for one month and, then, under tree shade, where they gained height upto 80 cm.

Fifty tissue culture raised hardened plants were planted in field in July, 2010. Out of these, 42 plants were derived from somatic embryogenesis pathway, while 8 plants were derived from axillary bud based micropropagation pathway. The plants are growing well in the field condition for the last 10 months with 100% survival. Six monthly growth data were collected.

Somatic embryogenesis (A- F)
A- Non-embryogenic Callus Turned in Embryogenic Callus;
B and C- Multiplication and Maintenance of Embryogenic calli;
D and E- Maturation of Somatic Embryos;
F- Germination of Somatic Embryos

Somatic Embryogenesis (G- M)
G- *In-vitro* Hardening of Emblings;
H, I, J, K- *ex-vitro* Hardening of Emblings;
L- Plantlets Under Green Shade House (Rajsamand district);
M- Plantlets Under Green Shade House (Ajmer district)

Field Plantation of Tissue Culture Raised Guggal Plants in July 2010

Sustainable harvesting: Harvest Limits of *Picrorhiza kurroa* & *Valeriana jatamansi* in Himachal Pradesh is being assessed at HFRI, Shimla. Reconnaissance survey was carried out in different forest divisions of the State and sites were selected for laying experimental harvesting trials. For *Picrorhiza kurroa*, two sites viz. Tino forests in Lahaul Forest Division and Banseru Dhar in Kullu Forest Division were selected for the study while for *Valeriana jatamansi*, three sites viz. Jagatsukh forests in Kullu Forest Division, Tikkar forests in Rampur Division and Chail forests in Chail Wildlife Sanctuary were selected. Population data of medicinal plants was collected following quadrat study in all the selected experimental sites. Experimental harvesting trials (control 25, 50, 75 and 100% harvest of selected medicinal plants) were established in all the five selected sites in July-August 2010 to determine optimum harvest limits of selected plants. The harvesting trials for both the selected medicinal plants were also replicated in nursery beds at Field Research Station (FRS), Brundhar of the institute. Population status, number of fruit/seed productions, growth, regeneration and the ability of the population to withstand the extraction is being monitored for the selected medicinal plants. To create awareness on medicinal plants among the field staff of state forest department, training was imparted on identification, conservation and sustainable utilization of medicinal plants of Himachal Pradesh on 25th February 2011 at Forest Training Institute, Chail.

2.6.4 Chemistry of NWFPs, Value Addition and Utilization

Chemical Investigation: A simple and facile process has been developed to isolate Hederagenin from seed kernel extract of *Sapindus mukorossii.* Hederagenin is a potential bioactive compound known for its anticancer, anti-inflammatory, antidepressant, antihyperlipidemic, antityrosinase, skin lightening, cure of nephritis and prevention and treatment of bone diseases alongwith a number of other biological activities.

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, Dehradun on Silkworm, *Bombyx mori* L. The product is capable of exceptionally reducing the complete spinning time from

32-36 hours to 15-18 hours. Application of "Samriddhi" reduces the cost of silk production in terms of feed cost (mulberry leaves), less mandays (Labour cost), space, infrastructure and time.

Chemical screening of *Diploknema butyraceae* seeds has indicated the presence of high fatty oil content i.e. 65% in the seeds. Phytochemical studies on medicinally important *Diploknema butyraceae* has also been initiated.Natural dyes and their different shades have been developed which are capable of dyeing different type of textiles (silk, wool and cotton). Twenty-five prospective plant species have been screened for extraction of dye for application on human hair.

Germplasm of *Eucalyptus tereticornis, E.* hybrid and six commercially used clones of eucalyptus was collected and analyzed for determination of marker constituents conferring CLSB resistance to the foliage. Results were indicative of the susceptibility of the germplasm to CLSB disease. Validation of chemical markers conferring *Cylindrocladium* leaf and seedling blight resistance in *Eucalyptus* germplasm has also been initiated. Refining of process for detoxification studies of Jatropha seed oil and chemoenzymatic saccharification of cellulosic biomass has been taken up by FRI, Dehradun.

Isolation and characterization of phytoecdysteroids from *Achyranthes aspera* and *Achyranthes bidentata* and their effect on economic traits of silkworm *Bombyx mori* L. has been completed. Ecofreindly PPD free natural hair colourants, utilization of economic potential of *Lantana camara* and pectic substances from the fruits of *Diospyros peregrine* have been studied at FRI, Dehradun.

Natural Dye: Development of commercially viable dye products from selected plants of North-east region has been taken up. Three species of North-East region were identified for development of natural dyes. The extraction of dyes has been done after optimization of concentration and time for different samples. The extracted dyes were tested for parameters of natural dyes. The natural dyes were developed from aerial parts of three species of North-East region-*Aporusa dioica* Syn. *A. roxburghii*, *Bacccaurea ramiflora* Syn. *B. sapida*, *Bischofia javanica*, which imparts different shades on silk, wool and cotton. The developed dyes qualify the various tests like different colour fastness properties such as washing, rubbing, perspiration and light. These developed dyes could be utilized for dyeing of different textile fabrics. The study, thus, established the target species as potential and easily accessible source of dye.

Pharmacological Investigations of *Aegle marmelos:* Successive extraction methods and fractionations of different tissues of *A. marmelos* leaves, ripened and unripened fruits were standardized and performed series of preliminary pharmacological evaluations. The combined extracts were evaluated for the three antioxidant activities, of which super oxide scavenging activity was found to be better. Three different tissues of *A.marmelos* were tested against organism to study the behavioural activity in two doses of 200 and 400 mg and found that leaves were having more behavioural activity. Haemtological parameters like RBC, WBC, Hb, Haematocrit, McB, McHc, leucocytes, differential leucocytes counts with respect to cell analysis after the treatment (ripen /unripe fruits =100mg /100mg =200mg) and other related parameters were also measured. Chemical characterization of the preformulations of ripe and unripe fruit extracts with special focus on pharmacopoeial standards has been documented to support the above studies. Forced swim test to report on antidepressant activity of the preformulation of *A. marmelos* against the experiment organism showed promising results to develop a product with high medicinal qualities.

Non-edible Oils Derived from Tree Borne Oil Seeds as Potential Pesticides: Tree Borne oil seeds of *Sapindus emarginatus, Pongamia pinnata, Moringa oleifera*, *Calophyllum inophyllum* and *Hydnocarpus pentandra* were collected and processed by hot and cold extraction procedures using non-polar solvent for oil extraction. Overall, hot extraction yields more oil than cold method except for *S. emarginatus.* The preliminary bioassay studies of the TBO, against teak defoliator showed promising results after 24 hours of treatment. Antifungal activity of TBOs oils tested against *Alternaria solani, Fusarium oxysporum, Cylindro cladium, Rhizoctonia solani* and *Trichosporium vesiculosum* in comparison with fungicide revealed no antagonistic activity but found to have synergetic activity.

Essential Oil of *Lantana camara* a Noxious Alien Weed as Biopesticide: Survey was made in different parts of Tamil Nadu and leaves of *L.camara* differing in flower colour (orange, pink, white pink, pink yellow, orange yellow) were processed for oil extraction. Essential oil percentage varied from region to region and was high with rose colour flower compared with others. Bioefficacy of the essential oil was evaluated against teak defoliator (*Hyblaea puera),* and fungal cultures such as *Alternaria solani, Fusarium oxysporum, Cylindro cladium, Rhizoctonia solani* and *Trichosporium vesiculosum* and observed larval mortality but antagonistic activity against fungal pathogens was not seen. A successful attempt was made to prepare handmade paper from this noxious weed.

Biotransformation of Secondary Metabolites: *Frankia* strain isolated from the surface-sterilized root nodules of Casuarina seedlings was cultured and monitored for the culture characteristics at different intervals of 15 – 30 days to analyze the bioconversive reactions. Different days of (15, 25 and 30) homogenized cultures were lyophilized to analyze the variation of signalling compounds which will modulate root physiology and root growth. The lipid and ethyl acetate extract of the lyophilized cultures were resolved in TLC and HPLC, and the HPLC fractions collected were analyzed in GC-MS-MS. The work is in progress for further characterization of secondary metabolites.

Bio-preservative: Synthesis of organo metallic complex replacing arsenic component in CCA and evaluate as semi bio-preservative has been taken up at IWST Bangalore. Effort has been made to develop eco-friendly wood preservative using naturally available plant by–products of *Cleistanthus collinus* and *Prosopis juliflora*. *Cleistanthus collinus* is known for being toxic which contains three identical compounds, viz. Cleistanthin A, B and C (diphyllin glycoside) in addition to other secondary metabolites. The *Prosopis juliflora* is known to possess two major chemical constituents viz. Juliflorine and julifloricine, the main alkaloids besides other minor compounds. Methanol extract of leaves and bark of these plants were tested for its anti fungal activity, termite and borers., both the extracts were found to be effective to inhibit the growth of white rot and brown rot wood decaying fungi. Lower doses of extracts were not effective to control borer and termite attack. Further, Methanol extract of leaves and bark plants have been reacted with Copper sulphate and Potassium dichromate solutions. Highly perishable rubber wood was treated with complex mixtures and exposed to wood decay fungi using standard method of "Laboratory testing of wood preservatives against fungi (IS- 4873)". Perishable rubber wood was not infected by the wood decaying fungi, whereas control samples are completely attacked by fungi. Test for Insect borer was done on Bamboo culms by dip treatment of complex mixture as per IS 4873. Field testing of bamboo species and rubber wood against termites was done at IWST field station as per IS 401 (1982). The complex mixture of *Cleistanthus collinus* and *Prosopis juliflora* treated under pressure and dip on Rubber wood and *Bamboo* spp. were found to be effective to

control termites and borers where as control specimens are deteriorated.

Evaluation of the Performance of Steam Volatile Creosote (SVC) as a Wood Preservative has been Tried: Wood samples of seven tree species were procured from different places in Karnataka and Kerala. Crude creosote was procured and Steam Volatile Creosote (SVC) was obtained by steam distillation. SVC was applied to wood surface of four selected tree species and kept for standardization to know its effectiveness. Synthetic dye in various concentrations and combinations was treated with SVC as wood coating to four tree species. Natural dye (*Dalbergia latifolia*) was applied in various concentrations and combinations treated with SVC as wood coating.Coating schedule was worked out for the treated four tree species.

Fatty Oil: Oil composition and utilization of lesser known tree borne oilseeds- *Givotia rottleriformis* Griff., *Madhuca insignis*(Radlk.) H.J.Lam, *Shorea tumbuggaia* Roxb, *Poeciloneuron indicum* Bedd, *Hopea parviflora* Bedd, *Mesua ferrea* L. and *Balanites roxburghii* Planch has been taken up at IWST, Bangalore.

Madhuca insignis- An Endangered Species of Western Ghats

Survey was conducted in 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 tumbuggaia* 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.

Pharmacological Evaluation: Pharmacological evaluation of the extract/active principle from *Garcinia indica* for anti diabetic property is under study. Fruits of *Garcinia indica* were collected from Subramanya and Puttur (Karnataka). The dry rind was subjected to sequential extraction with Petroleum ether, Chloroform, Ethyl acetate and Methanol. Methanol yielded highest amount (40% by weight) of extract. The crude extract of *Garcinia indica* fruit rind with methanol was further separated by column chromatography with different combinations of benzene and ethyl alcohol. Testing of two distinct fractions along with the crude extract for anti-diabetic property in mice by Streptozotocin induced model for Type-I and Type-II diabetes is in progress. Good results are obtained for acute studies using dosages of 400 and 200 mg of extract/kg body wt of mice.

Screening of Plants for Anti-malarial Activity: Selected members for Rutaceae from Southern India for anti-malarial activity is being screened. Survey was conducted in Devarayanadurga, Savandurga for collection of *Toddalia asicatica* plant material. All the plant parts viz. leaves , stem, root and root bark were processed dried and pulverized, then, extracted sequentially and quantified. The extracts were, then, tested for larvicidal activity against 3rd instar larva of

Aedes egyptii and the chloroform extract of root has given good results. Experiments are repeated for concurrent results.

Toddalia asicatica

Quantitative Estimation of Sandal oil : Sandal oil content has been determined by non-destructive method by collecting core samples from standing trees from sandal bearing areas of Karnataka. Colour reaction has been standardised using living bark tissue of Sandal tree by reacting with Guaiacol Peroxidase Reagent (GPR) and Benzidine Peroxidase Reagent (BPR) from IWST campus for field estimation of sandal oil content in standing trees to develop a field kit for on-site assessment of value of sandal tree based on oil content. Recorded data like girth, height, climatic factors to correlate with quality and quantity of sandal wood oil.

Collection of Sandal Wood Core Samples- A Non-destructive Method for Estimation of Sandal Oil

Nutritive Values and Value Addition of Bamboo: Fresh bamboo shoots of different species (*Dendrocalamus asper, D. strictus, Bambusa bamboos* and *B. tulda*) were analyzed for their nutritional constituents by TFRI, Jabalpure. Results revealed that there is a significant difference in the nutritional status among different species. *D. strictus* (commonly available species of central India) can be considered as a good edible species as it contains nutrients at par with *D.asper* (known edible species of Thailand) grown in Madhya Pradesh. Moreover, *B. tulda* and *B. bamboos* shoots have almost similar nutritional status as that of *D. asper*. Thus, all the three species have the potential to be explored for edible shoot production in central India. Simple, efficient and cost effective methods for processing of bamboo shoots were developed. The processing methods developed significantly reduce the amount of cyanogens and retain nutrients considerably, thus, may be utilized for pre-cooking processing of bamboo shoots to remove anti-nutrients. After processing of bamboo shoots, different products viz. bari, papad, crunches, sauce and pickle were made. The products made were good in taste and texture and, were accepted in terms of flavour, odour, appearance and taste. The nutrient contents of products (bari, sauce and crunches) showed a gradual decrease and should be consumed within 6 months from the date of preparation. However, in case of papad the carbohydrate content did not decrease much but the taste is not acceptable after 8 months, thus, they should be consumed within 8 months of preparation. Whereas, in case of pickles, nutrient

content decreased in 9 months but the product is acceptable in taste and good in texture even after one year of preparation. This study will popularize and increase the utilization of bamboo shoots. Being a lesser known food product, bamboo shoot processing has vast potential to be developed as a new, innovative and promising enterprise in central India.

Bamboo shoots

Bamboo Product (Bari)

Polysaccharides for the Development of Bioproducts: *Curcuma angustifolia*, *C. pseudomantana*, *Dioscorea bulbifera*, *D. hispida* and *Hyptis suaveolens* (seeds and aerial parts) were collected for isolation of polysaccharides. Physical and chemical properties of polysaccharides–starch and mucilage i.e. morphology, size, solubility, viscosity, extraction temperature, amylose, cellulose and oil per cent of polysaccharides samples were determined. Polysaccharides –starch from different species were modified by acetylation, hydroxyl-propylation and carboxy methylation. The densities of unmodified starches were ranged 1.29-1.50 g/cm^3 while modified starches showed significant variation. Degree of substitution of modified starches estimated 0.040-0.277. Starch polymers were prepared with native and modified starches and different additives. Physico-chemical properties i.e. solubility, swelling behavior, transparency and biodegradability test, FTIR, thermal, mechanical analysis and XRD analysis were then performed. The value of tensile strength of unmodified polyfilms was found to be 9.1 MPa, while significant variation i.e. 45MPa was found in modified polyfilm. Compatibility of starches with mucilage, polyvinyl alchohol, chitosan and bentonite and their effect on properties of polyfilms were also evaluated.

Polysaccharides were modified by different chemical treatments and evaluated compatibility of starches with different additives for the development of adhesives. Binding ability of adhesives with different substrate was evaluated. Properties of adhesives i.e. setting time, water resistivity, solubility in water and organic solvents and Thermal Gravimetric Analysis (TGA) were performed. Comparative efficiency of bioadhesives and synthetic adhesives were also screened.

Processing of *Aegle marmelos* (Bael) Fruits: Bael fruits of different maturity were collected from Barha (Jabalpur), Saliwada, NWFP Nursery (Jabalpur, M.P.), Pandariya (Kawerdha, CG). Samples of matured and immature bael were processed by different methods i.e. roasting in cow-dung, steaming, boiling in hot water at different duration and solar treatment for the extraction of pulp and dried in shade, sun, direct and indirect solar treatments. Assessment of

quality (riboflavin, carotene, carbohydrates, protein, fat, and fibre) of pulp samples, of matured fruits and immature processed fruits were undertaken. The edible portion and carbohydrate % of bael fruits pulp were found changed in different processing methods. Carotene and riboflavin % varied 25.6 mg/100 g to55.45% and 2 to8 mg/100g, respectively.

Physico-chemical properties of bael pulp samples, processed by tribals were also assessed. Samples were found to be damaged by fungal attack due to wrong processing. Stored samples of pulp were also analyzed and significant variation in carbohydrate, protein, minerals were recorded.

Food Products from *Madhuca indica* Flowers: Collection of *Madhuca indica* flowers from available source in Central India was done. Method of standardization for extraction and quantitative estimation of *M. indica* flowers for their nutritional constituents was also done. Quantitative estimation of mahua flowers for their nutritional constituents was also done. Four value added food products viz. jam, squash, sauce and chikki were developed using mahua flowers. Consultancy was taken from LIT, Food Technology Dept., Nagpur University, Nagpur as and when required. Further work is under progress.

Optimum Treatment Time and Durability Test of Bamboo: Commercially important bamboo species of North-eastern Region was studied. Freshly harvested 1 m long bamboos derived from top, middle and basal portions of B. *pallida* and *D. hamiltonii* were treated with Copper Chrome Boron (CCB) at 8%, 10% and 12% and instilled into the bamboo at 1 & 1.5 kg pressure using Boucherie Apparatus (Jagriti) with 5 replications each. During optimization, 360 bamboo samples of *B. pallida* and *D. hamiltonii* were treated and 5 replications of both the samples from top, mid and bottom regions of bamboo were kept for both the sites at Jorhat and Aizawl. Preliminary data showed that preservative treatment time required

Shooty Mould Infection

Infection by *Schizophyllum commune*

was from 25 to 90 minutes for completion of the treatment, depending upon the volume, moisture content, species and age of the bamboo. Completion of preservative treatment was ascertained by comparing the specific gravities of the stock solution with effluents coming out from the bamboo. The treated bamboo samples were dried under shade for fixing of the chemical preservative. Their weight, volume were recorded and tagged with unique identity number. Five replications of untreated (control) samples derived similarly were kept aside for the purpose of comparison. Five replications derived from all the samples including control, were powdered and kept for chemical analysis. Preliminary chemical analysis of the samples shows the average loading as Chromium=2.4 gm/sample; Copper=1.24 gm /sample and Boron=3.3gm/sample. Inspection of the test yard at Aizawl revealed that out of 105 samples of *Bambusa pallida* used in the test yard, 21% got infected by black sooty mould; 4.2% infected with *S. commune* and 12.6% infected with termite; 105 samples of *D. hamiltonii* used in the test yard were infected with 11.55% with black sooty mould, 27.3% with termite and there was no infection by *S. commune.*

Jorhat test yard inspection revealed: In *B. pallida*- Shooty mould 3.15%; Undetermined fungus 3.15%; *S. commune* 3.15% and Termite infection 2.1%. In *D. hamiltonii*-Black sooty mould 2.15%; Undetermined fungus 1.05%; *S. commune* 6.3% and Termite infection 1.05%.

Phyto-proteins from Plant: of North-East Region for the Production of Protein Concentrates with Greater Food Value

Leaf protein is bestowed with enormous nutrients almost equivalent to regular food sources and critical investigations of a number of researchers have provided evidence of it. An affordable alternative food source that can feed a large population who can spend too little for their living is definitely going to be welcomed around the globe. The unexplored plant leaves with greater food value and at minimum cost is the need of the hour. Besides, providing food with essential nutrients, "leaf proteins" have several other promises too. Therefore, with the aim to explore new plants as a potential source for Leaf Protein Concentrates (LPCs) and preparation of LPCs with high food values from selected species from NE region by RFRI, Jorhat, has been under taken. As the expected output of the project is to explore new plant/s for the production of LPC and evaluation of their food values, nine different plant species, viz. *Sambucus javanica* (Caprifoliaceae), *Antidesma bunius* (Euphorbiaceae), *Alocasia macrorhiza* (Araceae), *Cissus adnata* (Vitaceae), *Cissus repens* (Vitaceae), *Enhydra fluctuans* (Asteraceae), *Mimosa invasia* (Fabaceae), *Diplazium esculantum* (Athyriaceae) and *Samanea saman* from Assam has been selected for Nitrogen estimation. Selected plants have been screened for the N/protein content in leaves by using kjeldhal method. The nitrogen content has been determined in the range of 1.73-3.62 in these leaves. LPCs were prepared from fresh leaves of these species to find out LPC production potential. Leaves (100 g level) of the above reported species have been subjected to LPC preparation by following the method of Fellow (1987, Tropical Science, 27, 77-84). Maximum yield of LPC has been obtained in case of *Diplazium esculantum, Alocasia macrorhiza* and *Samanea saman.* Thus, these species have been selected for LM/LPCs production and their physico-chemical analysis. Best temperature and pH conditions has been optimized for *Diplazium esculantum* to increase the yield of LPC. Best temperature has been optimized for the yield production of LPC from *Alocasia macrorhiza* leaves. Leaf protein concentrate from *Diplazium* sp. have been prepared at laboratory level and analysed for Mositure, Ash, Crude Fibre, Crude Protein, Ether extract, N free extract by using standard chemical methods.

Nutritional Status of Wild Edible Plants: To document the information on wild edible plants, a questionnaire was developed and used for the documentation of wild edible plants. Information on this account was collected from different regions of Himachal Pradesh like Kinnaur viz Baspa valley (Raksham, Chhitkul, Batseri, Chansu & Boring sarin), Nichar area (Nichar, Nengani, Kashpo, Garadeh, & Bari), Ropa Valley (Shyaso, Giabong), Rupi Valley (Majgaon, Naling-I, Gurguri, Shingarcha, Hurua) and Sutlej Valley (Kalpa, Pangi, Akpa, Jungi, Rispa, Lippa, Asarang, Rarang, Labrang & Pooh & Mabber) covering all three blocks of the district. To document the wild edible plants, 178 people in total were interviewed in the above villages and 110 wild edible plant species were documented. Within the edible plants, fruits (33%) and leaves (27%) were the most widely used plant parts followed by roots and fruiting body with 11% and 6%, respectively. Within the edible plants, herbs (58%) and shrubs (22%) are the most widely used growth forms followed by trees (16%). Among the plant families, Rosaceae (15 species), Polygonaceae (6 species) and Saxifragaceae (6 species) are the important wild edible plant families in Kinnaur district. For prioritizing the most preferred wild edible plant species, different weightages were assigned to parameters, such as, no. of people who use the plant, seasonal availability, abundance, scope of market and other

traditional usage and species were prioritized for nutritional analysis. Among the prioritized wild edible species, fruits samples of *Elaegnus umbellata, Malus baccata* and *Rosa webbiana, Hippophae salicifolia* and *Berberis aristata* were collected for nutritional analysis. Total pH, Ascorbic acid, mineral nutrients, carbohydrate, total sugar and antioxidant activity were estimated. To disseminate the research findings to stakeholders, two interactive workshops on wild edible plants was organised and a pamphlet on wild edible plants was prepared to create awareness among the people.

Active Principles of Medicinal Plants: Studies on various factors effecting the quantity of active principles in some commercially important medicinal plants under cultivation was initiated at IFP, Ranchi. Two sites were identified for collection of propagules of *G. sylvestre* from natural sources.The dried leaves of *G. sylvestre* have been defatted with petroleum ether; Benzene and chloroform extracts have been prepared from the leaves of three years old plants.*G. sylvestre* plants have been raised under the shade of teak, sal and sissoo.

2.6.5 Biofuels and Bioenergy

Bioethanol Production: Effect of improved operational parameters on hydrolysis of lignocellulosic biomass to enhance total reducing sugar yield for bioethanol production has been taken up at FRI, Dehradun. Following the proximate chemical analysis and particle size optimization of *Lantana camara* and Pine needle, the raw materials were subsequently subjected to hydrolysis for the maximum extraction of total reducing sugars by using different acid/alkali concentration at the lower temperature. Total reducing sugars extracted during pre-hydrolysis was 9.27 g/l (5.69%) at 120^{0}C, 90 min. reaction time with the charge of 1% NaOH in case of *Lantana camara* while it was 8.27g/l (4.96%) in case of Pine needle under the same reaction conditions. The isolated wild strain of yeast from old contaminated *Lantana camara* hydrolyzate was cultured on Yeast Extract Peptone Dextrose Agar at 30^{0}C and was tested against the glucose in order to determine the fermentation efficiency and fermentability. The experiments of fermentation resulted in 11.15 g/l of ethanol with 85% fermentation efficiency against previously used fermentative yeast (*Saccharomyces cerevisiae*) which produced 10.31 g/l of ethanol with 80% fermentation efficiency.

Production of Clean Producer Gas from Woody Biomass :Experiments were carried out at IWST, Bangalore with the "clean the producer gas" from the wood wastes and thereby increasing its fuel efficiency. Wood chips, bamboo chips and saw dust were oven dried for biomass gasification. Producer gas was produced from wood chips and

Gasifier

Producer Gas

bamboo chips were analysed. Tested results showed that as compared to wood wastes, bamboo wastes were having high yield of carbon monoxide and hydrogen (near about two times more than wood waste) which are main constituent of the producer gas. Also, gasification of bamboo produces a range of valuable by-products like charcoal and activated charcoal. Producer gas was cleaned using dolomite and olivine sand and these cleaned gases were also tested with GC.

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 transesterification time under microwave reduces significantly. The optimization of reaction conditions i.e., catalyst concentration and temperature is under progress.

Charcoal Production from Bamboo: Charcoal production experiments in parts of Meghalaya, Mizoram and Manipur has been completed. Most of the sites visited revealed that the local people use traditional pit method or its variants to produce charcoal from timbers collected from the nearby forest areas. Unrestrained, heedless felling of timbers has led to shrinkage of the forest area and cover. Except for the report of bamboo charcoal from Tamenglong, Manipur everybody used any forest timbers for production of charcoal. Bamboo samples – *Bambusa tulda* and *Bambusa balcooa* has been collected, sized and readied for pyrolysis. For preliminary studies, some charcoal samples from *Bambusa bamboos, B. pallida, B. balcooa*, *B. tulda* and *M. baccifera* - were prepared at laboratory using aluminium method and calorific value of some charcoal worked out. Designs of Drum kiln, Brick kiln and Solar drying chamber have been finalized out of which drum kiln have also been fabricated.

Traditional Charcoal Making in Meghalaya

Wood Charcoal after Pyrolysis in Meghalaya

Bio-oil from Jatropha: National network programme on integrated development of *Jatropha curcas* has been taken up.

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 Vindhyan 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

Wood Charcoal Market in Manipur

Newly Designed Drum Kiln for Charcoal

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 centres. CSFER, Allahabad has received a total of 16 provenances from different institutes/centres. 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.

Integrated Development of Jatropha and Karanj:

Jatropha: One hundred seventy five CPTs were selected from different agro-climatic regions of Madhya Pradesh. Two Progeny trials comprising of 20 progenies each were established at Chhindwara and Baraha, Jabalpur. In progeny trials, Patna Satna, Khaerwani Tamrikala, Gesani Shivpuri-2, Gesani Shivpuri-3 and Gwalior-2 progenies have performed better. Multilocational trials in the form of national and zonal trials comprising of 22 and 14 accessions respectively were established at Institute campus. In National trial, TFRI-1& 2, IGAU-1, TNMC-22, PDKV-1 & 2, TNMC-7, Palampur-I, RJ-92, JCP-2, NRCJ-17 and TNJC-19 accessions were performed better on the basis of growth performances, fruits yield, seed characters and oil content. In zonal trial, TFRI-1, TFRI-2, PDKV-1, IGAU-2, PDKV-2 and PDKV-1 performed better. Plants planted in pits (30X30X30 cm) at the spacing of 2X2m and 3X2m in the month of July with fertilizer dose of 20gm Urea, 120 gm SSP and 120 gm MOP have shown better growth under tropical conditions of Madhya Pradesh.

Karanj: Eighty one CPTs were selected from different agro-climatic regions of Madhya Pradesh. Progeny trial comprising of 20 progenies was established at Balaghat, Madhya Pradesh. Kusmeli Chhindwara, Sikharpur, Chhindwara and Lalpur Satna progenies were found better. Flowering and fruiting was observed in Kusmeli, Chhindwara progeny. National and zonal trial comprising of 5 and 17 accessions respectively were established at Institute campus. In national trial TNMP-14 and RAK-5 accessions were performing better. In zonal trials IGAU-1, CCSHAU-1, IGAU-5, NRCAF-2, JNKVV-29 and JNKVV-15 were performing better. In Zonal trial-I flowering and fruiting was observed in NRCAF Jhansi accession. All the trials were maintained with regular weeding and hoeing practices and irrigation as and when required.

Multilocational Trials of *Jatropha curcas:* A multi-locational 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 campus. The trials are performing well and survival is more than 85%. 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 are sent to Biotech Park, Lucknow for compilation. Minimal irrigation and maintenance was 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 without pruning (indicating no requirement for pruning). Flowering was observed in all accessions in the month of September-October 2010. Fruits were formed in all accessions: JA-9, NBRI, Lucknow (109 fruits), JA-126, NBRI, Lucknow (85 fruits), JA-139, NBRI, Lucknow (33 fruits), BTP-U, BTP, Lucknow (4 fruits), HAP 41, HNB, Garhwal (130 fruits), HAP 42, HNB Garhwal (36 fruits) and HAP 44, HNB Garhwal (74 fruits).Oil percentage in different accessions varied between 25-38%. In half sib progeny trial, flowering has been observed in September-October 2010 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, fruiting was observed only in three plants belongs to the accession JA-!8, MSSRF-10, MSSRF-51. Second pruning of multilocational trial and first pruning of half-sib progeny was done in the month of February 2011. Mulching was done in both the trials in the month of March 2011 to prevent moisture loss. The experimental trials are managed and maintained properly.

A multi-locational trial comprising of 100 superior accessions received from network partners was established in July- August 2010 at GRC farm house, Sita Pahad, Jabalpur. The experiment was established following RBD with four replications. The experimental field was divided in 400 equal sized plots and 9 plants were planted per plot at a spacing of 3m x 3m. The trial is performing well and the survival is more than 90%. 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 sent to Biotech Park, Lucknow for compilation. The experimental plantation is being maintained and managed intensively so as to raise a good crop leading to higher fruit production.

Survey selection performance trial and estimation of yield potential of *Jatropha curcas* in Rajasthan and Gujarat is being carried out. Two progeny trials, one with 5 replications at AFRI, Jodhpur and another with 15 replications at Haldughati, Udaipur having single plant per replicate in RBD of 30 CPTs were established in July 2008. At AFRI, Jodhpur site, the survival percent varied from 40 to 100. Maximum mean height, number of branches and collar diameter was observed as 247.5cm, 5.50 and 10.59cm in CSMCRI-1, while these were minimum 117.00cm, 1.80 and 3.98cm, in EL-19 AFRI-17 respectively. At Haldughati, Udaipur site, percent survival varied from 40 to 93%. Maximum plant height was 111.43cm in CSMCRI-3, whereas, number of branches and collar diameter were 2.50 and 3.89cm in EL-21 AFRI-15. Minimum plant height and collar diameter were 67.50cm and 1.81cm in 94 AFRI-8, and number of branches was 1.00 in 142-AFRI-12, respectively. The CPTs at AFRI, Jodhpur site only yielded fruit and seeds, whereas, at Haldughati, Udaipur there was no flowering/fruiting 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 sites.

To develop seed yield equations, measurements were done in the two sample plots

of *J. curcas* laid out at Motiya Research Farm, Rajpipla (Gujarat) during 2010-11. Total mean height, mean collar diameter and mean crown width varied from 2.44m to 2.92m, 12.92cm to 14.2cm and 2.15m to 2.41m, respectively. Observation on the seed yield was also taken, which varied from 103.0g to 193g. 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 gave more close value to the observed data was only considered. It is clear that CSMCRI clones were better as compared to SRT and BCR. They were having more height and seed yield as compared to SRT & BCR though their age was only 4 years, while ART and BCR, were of 6 years old.

Based on the data recorded from two plots (4-6 years) at Motiya research Farm during 2010-11, the yield equation developed as follows:

SY(1)= -165.55+120.9868*HT
SY(2)=844.0604-51.8072*CD
LNSY(1)= 7.145631-5.60393*1/HT
LNSY(2)= -0.13976+68.55505*1/CD

Multilocational Clonal Trial and Seedling Seed Orchard of *Jatropha curcas:* Two multi-locational clonal field trials have been established at Haldughati, Udaipur by AFRI, Jodhpur. 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 at Arid Forest Research Institute, Jodhpur and 15 replications at Haldughati, Udaipur were estabilished.

Trial-I revealed that percent survival varied from 15 to 56%. Highest value of mean plant height and collar diameter were observed 124.17cm and 4.62cm, respectively in TERI/DBT/Jat/04-05, whereas, mean number of branches was 1.69 in BTP-K, which was closely followed by 1.66 in TERI/DBT/Jat/04-05. While lowest value of mean plant height, number of branches and collar diameter were observed; 72.73cm, 1.03 and 1.87cm in TERI/DBT-Jat/06/10, TERI/DBT-Jat/06/05-06/12 and TERI/DBT-Jat/06/16, respectively after 40 months of growth period. Data were non-significant for all the three parameters.

In clonal trial-II, per cent survival varied from 0 to 22%. Maximum value of mean plant height and collar diameter were noticed 78.75cm and 2.94cm in NBRI-JA-126, whereas, maximum number of branches was 1.50 in J-2, Hisar. However, minimum value of plant height, number of branches and collar diameter were 47.50cm in J-2, Hisar & HS-42, 1.00 in HS-41 and 2.21cm in HS-44, respectively.

At AFRI, Jodhpur, percent survival varied from 0 (in 6 accessions) to 100% (in 6 accessions). The accession TERI/DBT/JATROPHA/01/15 showed maximum plant height and collar diameter; 260.00cm and 9.13cm, respectively. While minimum plant height and collar diameter was observed 136.70cm in accession TERI/DBT-JATROPHA/05/31 & TERI/DBT-JATROPHA/05/87 and 2.76cm in TERI/DBT-JATROPHA/05/58 accessions, respectively. Mean number of branches varied from 1.00 to 5.00. Amongst 116 CPTs, only 12 CPTs at AFRI, Jodhpur site were seeded during 2010-11 which ranged from 4.72g to 135.26g.

At Haldughati, Udaipur site, per cent survival varied from 20 to 80%. Maximum plant height, number of branches and collar diameter were observed; 140.71cm, 2.75 and 4.47 cm in accession TERI/DBT-JATROPHA/04/16, TERI/DBT-JATROPHA/05/53 and TERI/DBT-JATROPHA/07/05-06/37, respectively. Minimum plant height was shown by accession TERI/DBT-JATROPHA/04/31 (51.00cm), while accession

TERI/DBT-JATROPHA/05/26 showed minimum number of branches and collar diameter of 1.00 and 1.74cm, respectively. No fruiting was observed at Haldughati, Udaipur sites during 2010-11.

The observations showed that plantation at AFRI, Jodhpur site showed better performance than at Haldughati, Udaipur in term of growth parameters while, accessions planted at Udaipur site showed better survival than Jodhpur site. Data were non-significant for all the parameters.

Genetic Improvement of *Jatropha curcas* for Adaptability and Oil Yield: Survival of 18 selected elite accessions under arid conditions after 65 months of growth period varied from 6 to 69%. Overall mean plant height, number of branches and collar diameter varied from 135.00 to 226.67cm, 1.00 to 4.50 and 3.83 to 8.26cm, respectively. Seed yield ranged from no seed to 660.00g per plant.

Performance of 63 native accessions after 54 months of growth period under arid conditions ranged from 33 to 100%, whereas average plant height, number of branches and collar diameter varied from 155.0 to 295.0cm, 1.00 to 4.00 and 4.55 to 12.55cm, respectively. Seed production varied from 0.00 to 313.0g per plant. On the basis of across site performance, 14 accessions have been selected.

Percent survival in spacing trial after 44 months varied from 14% in 2mx2m to 39% in 3mx3m. Maximum mean plant height was observed (200.22cm) in 4mx4m spacing treatment, while number of branches and collar diameter was maximum 3.08 and 5.76cm in 3mx3m spacing. Minimum plant height, number of branches and collar diameter was observed 179.90cm, 2.00 and 5.24cm in 2mx2m spacing. Only two treatments seeded in 2010 which ranged from 225g per plant in 3mx3m to 319g per plant in 4mx4m spacing. Data were non-significant for all the parameters.

Percent survival in pollarding trial varied from 30% in T_2 to 46% in T(control). The mean plant height and collar diameter ranged from 151.81cm (T_2) to 158.58cm (T_3) and 5.42cm (T_2) to 5.59cm (T_0), respectively. Whereas, the mean number of branches ranged from 3.87 in control (T_0) to 8.96 in (T_2). No fruiting was observed during 2010-11. Analysis of variance suggested that effect of pruning is significant on number of branches, while non-significant on average plant height and collar diameter after 37 months of imposing treatments.

From the result of main plot analysis (irrigation effect), average plant height was 233.11cm in I_2 (30 days) and maximum up to 270.17cm in I_1 (15 days). Maximum number of branches and collar diameter was observed 4.45 and 9.65cm in I_2 and I_1, respectively, while these were noticed minimum 3.30 and 8.59cm respectively in control. Three irrigation treatments plant were seeded this year except control which was ranged from 31.8g per plant in I_3 (45 days) to 81.0g per plant in I_2, followed by 76.4g in I_1 treatment. Only plant height was significantly affected by irrigation treatment, whereas, number of branches and collar diameter remains unaffected by the irrigation. From sub-plot analysis for fertilizers (F_1 organic maure 2kg/pit; F_2 organic manure 5kg/pit; F_3 = Nitrogen 10g+ P, 20g, K, 10g per pit;F_4 = 2kg organic manure + Nitrogen 10g+ P, 20g, K, 10g) per pit results revealed that mean plant height ranged from 237.50cm in F_2 to 253.85cm in F_3. The mean number of branches and collar diameter were observed maximum 4.00 & 10.31cm in F_4 and minimum 3.62 & 7.69cm in F_1, respectively. All the fertilizer treatments plants were seeded which ranged from 22.5g in F_0 to 58.0g 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 the growth performance of *Jatropha* after 49 months of the planting.

Database on Tree-Borne Oilseeds: The demand and prices of petroleum products are growing by leaps and bound. The planning commission is examining the possibility of producing blended high speed diesel with 20% Jatropha and other TBO's based diesel. This project was initiated to contribute to the knowledge base of TBO's with an aim to estimate their current availability and future supply, demand analysis and estimation of their contribution to the rural economy of India. The objectives of the project is documentation of the scattered plantations of TBO's in Rajasthan and Gujarat done by Government organizations, research institutions, etc. and to develop a database for its fast retrieval.

In order to estimate state wise acreage of cultivation of seven tree borne oilseed species from Gujarat and Rajasthan, a detailed list of Government departments/Institutions viz; State Forest Department, Horticulture, Agriculture Departments, Railways and NGO was prepared by AFRI, Jodhpur. Proforma for data collection was developed and sent to the various departments. Under this study, information regarding seven TBOs viz; Jatropha (*Jatropha curcas*), Karanja (*Pongamia pinnata*), Neem (*Azadirachta indica*), Mahua (*Madhuca indica*), Mango *(Mangifera indica)* kernel as feed, Jojoba (*Simmondsia chinesis*) and piloo (*Salvadora spp*.), falling in the jurisdiction of AFRI was collected and compiled.

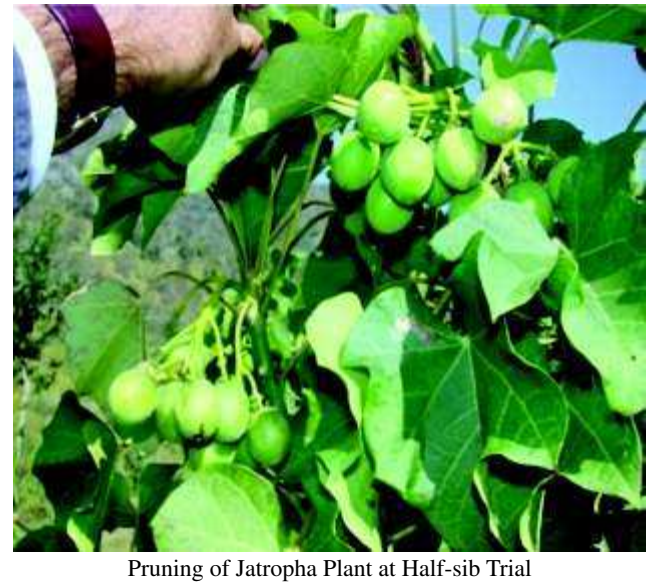
Seed Sources of *Jatropha curcas* L: Seeds from Lower and Mid Himalayan Regions of Himachal Pradesh were studied by HFRI,Shimla. Seeds were collected from the 29 seed sources and 19 individual trees in Himachal Pradesh and sent to The Tata Energy Research Institute, (TERI), New Delhi for estimation of 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 (Nalagarh), Joharji (Solan), Majhouli (Solan), Brahmpukher (Bilaspur), Bhojnagar (Solan), Samloe (Sunni), Devidhar (Sunni), Dharja (Solan) Samati (Solan), Narag (Sirmour), Sarahan (Sirmour), Nalagarh (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 recorded seed yield. The seeds from some progenies were also sent to TERI, New Delhi for oil estimation. Conducted nursery studies for raising *Jatropha curcas* in lower and mid Himalayan regions of Himachal Pradesh. 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 & aspect found to considerably affect growth & survival in *Jatropha curcas* plantations in lower & 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 *Jatropha curcas:* Multilocation experimental trial of rooted cuttings of 10 superior accessions of *Jatropha curcas* has been done in 0.5 ha area at Solag village

(N 31^{0}21.356', E 76^{0}49.737' Altitude: 938m) in Bilaspur District of Himachal Pradesh. The actual plantation in this trial was carried out during October 2008 and some accessions were planted in 2009 as per the statistical design provided by Department of Bio-technology (DBT): Jatropha National Coordinator. However, due to frost injury followed by drought like conditions and heavy mite attack, the survival of *Jatropha* plants fell abruptly at that site during 2009 & 2010. Therefore, the similar trial with same accessions has been re-established at Jawalaji area (N 31^{0}52.947', E 76^{0}18.880' Altitude: 546m) of Kangra district of Himachal Pradesh during September 2010. The trial also covered 0.5ha area and recorded very good initial survival. The growth and survival data is being recorded regularly.

Demonstration Plantation of Jatropha at Thakurdawara, Nalagarh (H.P.)

For establishing half-sib trial, seeds of *Jatropha curcas* representing 20 accessions obtained from NBPGR, New Delhi as per the instructions of the funding agency and were sown in Institute's nursery at Bir Plassi Nalagarh, District, Solan, Himachal Pradesh, during 2008-09. The germination behaviour of these seeds was recorded in the nursery. The plantation of this half-sib trial of superior accessions of *Jatropha curcas* was carried out at village Jawalaji of Kangra district of Himachal Pradesh (N 31^{0}52.947', E 76^{0}18.880', Altitude: 546m) in 1ha area during August 2009. Total 523 number of plants of Jatropha planted at Jawalaji which includes plants from superior accessions of half-sib trial and plants from local accessions. Jatropha experimental plantation at Jawalaji was being maintained intensively. Growth and survival data of experimental plantations as well as nursery stocks was recorded regularly. The survival is more than 80% till date. Plants are growing vigorously in the trial and flowering is also recorded in the second year of plantation. Pruning of plants has been done in the month of February 2011 as per the guidelines provided by Jatropha National Coordinator. After pruning, vigorous branching has been recorded in the trial which may help in increasing the seed yield during current year.



Pruning of Jatropha Plant at Half-sib Trial

2.7 Forest Protection

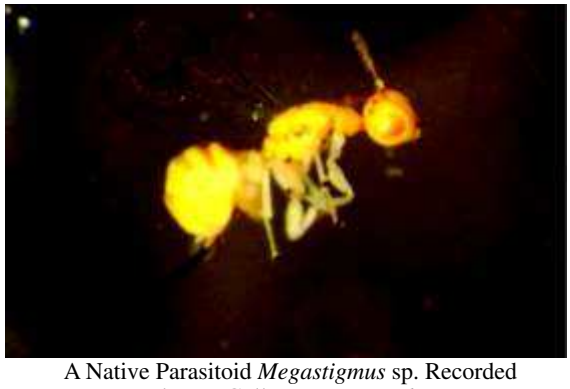
Overview

Insect pests and disease problems of forest plant species are the major deterrents of productivity on the one hand and on the other, affect the long term programme of afforestation and environment amelioration. Research in ICFRE institutes is mainly centred on biology of insect pests and pathogens, integrated pest management, host plant resistance against insect pests and pathogens, biological control and use of beneficial micro-organisms for enhancement of productivity.

Summary of the Achievements Under the Theme

Insect/Marine Pests

- Life table and behavioural mechanisms involved in oviposition by *L. invasa* was studied for 3 generations in Coimbatore. The total life cycle period from egg to adult was recorded as 125-130 days.
- Biology and parasitisation efficiency of parasitoids of the gall insect *Leptocybe invasa* viz. *Megastigmus* sp. and *Quadrasitchus mendelli* were studied.
- Infestation of *Indarbela quadrinotata,* a pest of *Casuarina equisetifolia,* was the highest in the North-eastern agro-climatic zone of Tamil Nadu. There was no significant reduction in growth of the trees due to the pest attack during the period of one year. Pungam (*Pongamia pinnata*) oil and Jatropha (*Jatropha curcas*) oil were promising.



A Native Parasitoid *Megastigmus* sp. Recorded on Eucalyptus Gall Wasp *Leptocybe invasa*

- The potential biopesticidal fractions were extracted, characterized and identified from *Aegle marmelos* seed oil and tested against teak insect pest *Hyblaea puera* at Nilambur and Kulathupuzha nurseries in Kerala.
- A total 197 clones of *Eucalyptus* were assessed for their susceptibility and resistance/ tolerance against gall insect in a field trial at Satyavedu.
- *Pongamia pinnata* seeds during post harvest storage were attacked by unidentified lepidopteran species which caused higher damage than that of an unidentified bruchid beetle. Methyl parathion protected seeds for a longer period and pest mortality was higher than the plant based extract treated seed lots.
- Bio-efficacy of chemical pesticides (Quinalphos, Imidacloprid and Dimethoate) and botanicals (neem oil, jatropha oil and pongamia oil) and a commercial neem product (Neemazal 1%) were tested on the targetted pests of *Ailanthus excelsa* and *Gmelina arborea* and their effective doses for control of the pests were determined.
- A new sandal seed borer *Araecerus fasciculatus* Linn.(Anthribidae: Coleoptera) was found to cause serious damage to sandal seeds. The overall percentage of damage stood at 20%. Two new weevils viz, *Peltotrachelus cognatus* Faust and *Myllocerus delicatulus* Boheman were found as defoliators of sandal.
- Mangrove plants *Excoecaria agallocha, Avicennia officianalis* and *A. marina* in Godavari, Krishna and Sarada-Varaha deltas were found to be infested by several marine wood boring pests including certain rare pholadids, namely, *Lignopholas chengi, L. rivicola* and *L. fluminalis.*
- Test timbers of *Bombax ceiba* and *Paraserianthes falcataria* treated with

TBTM-MMA compound were found to have curtailed fouling growth and wood borer attack to a great extent even after 30 months of marine exposure trials at Vishakhapatnam and Kochi harbours but for sphaeromatid borer invasion of a few panels at Kochi.

- Bio-deterioration studies at Machilipatnam and Nizampatnam ports in Andhra Pradesh on marine materials, including wood showed that the two environs are relatively safe from biofouling point of view, but are potentially hazardous from the view point of marine wood borer activity that exercises a great bearing on fishing operations in these regions.
- Integrated management package for white grubs in teak nursery at Kanchangaon, Mohagaon Project Division, Mandla (Madhya Pradesh Forest Development Corporation Ltd.) was developed.
- Insecticidal properties of some plant extracts (*Azadirachta indica, Melia azedarach, Acorus calamus, Adhatoda vesica* and *Clerodendron viscosum*) were evaluated against *Hertia vitessoides* Moore (Lep: Pyralidae), a major pest of *Aquilaria malaccensis* Lamk.
- Potential insect pests of selected Bamboo species in Assam were recorded.
- Sixteen species of insects and 2 species of mites have been documented on *Acacia nilotica.*
- Major biotic factors responsible for khejri mortality were found to be *Ganoderma lucidum* and *Acanthophorus serraticornis.* The khejri mortality percentage varied from 18 to 23%. Maximum mortality was noted in Nagaur and minimum in Jhunjhunu district.
- Pheromone traps were used to manage *Ips longifolia* Steb. in Chir pine Forests in Himachal Pradesh. Doses of pheromone were standardized.
- Time-mortality bioassay using 7 doses of Baculovirus were applied on 3rd instar larvae of *Lymantria obfuscata*. LT_{50} for the doses, were calculated.
- Ten spots colony of the spider were recorded and geo referenced in Himachal Pradesh. Ten complete mature colony of the spider were collected and reared in the laboratory. Seventeen prey species belonging to 6 families under 4 orders were recorded.
- *Cateremna tuberculosa* has been reported to be as a pest of stored seeds of Chilgoza pine.
- Biology of *Phloeobius crassicollis* was studied. Insect was reported as new pest of ten bamboo species on which average attack percentage was recorded from 2 to 51% with maximum attack of 51% in *Bambusa wamin*.
- Biology of *Aphrodisium hardwickianum* white was studied. *Quercus dilatata* was also found to be attacked by this beetle. Para-dichlorobenzene in kerosene oil @ 10 ml / emergence hole was found to be most effective measure. Mechanical control by hammering stone into the exit hole for adult was also effective.
- Bioassay of various extracts of aerial plant parts of *Calotropis procera* and *Plumbago zeylanica* were tested against larvae of shisham defoliator, *Plecoptera reflexa* and poplar defoliator, *Clostera cupreata*. 2% methanol and acetone extracts gave about 60-70% mortality after 72 hrs.
- A new biopesticidal product "Vilvekam-*Aegle marmelos* seed oil based biopesticide" was developed, and released.

Diseases, Pathogens and Beneficial Microbes

- A total of 222 fungal isolates of 40 genera were isolated from the fruits and seeds of *Elaeocarpus munronii, Dysoxylum malabaricum, Dipterocarpus indicus, Vateria*

indica, Garcinia gummigatta, Poeciloneuron indicum, Syzygium malabaricum, Myristica malabarica, Knema attenuata, Madhuca longifolia, Hopea ponga, Kingiodendron pinnatum and *Cinnamomum sulphuratum*.

- Natural fungal flora of seeds of *D. malabaricum, E. munronii, M. malabarica*, *P. indicum* and *V. indica,* being pathogenic on seeds and seedlings was proved.
- A new fungal species viz., *Penicilloipsis indcus* was identified from the seeds of *D. malabaricum*. New host records of fungi i.e., *Beltrania rhombica* on seeds of *P. indicum* and *Bartalinia lateripes* on seeds of *G. gummigatta* were also reported.
- Control of forest seed pathogenic fungi has been achieved by using the leaf and bark extracts of *Prosopis juliflora* and Cleistanthus.
- The cause of culm rot and bamboo blight disease in Assam was identified as *Fusarium udum*. The most effective fungicides found *in-vitro* are being tried for its management.
- Seven species of fungi belonging to different genera were isolated from canker disease of rohida (*Tecomella undulate*) and established cultures in laboratory for pathogencity test.
- Major biotic factor responsible for khejri mortality was found to be *Ganoderma lucidum* and *Acanthophorus serraticornis.* The khejri mortality percentage varied from 18.08 to 22.67 %. Maximum mortality was noted in Nagaur and minimum in Jhunjhunu district.
- *Cylindrocladium quinqueseptatum* was isolated from 28 samples out of 68 samples collected from Uttar Pradesh. The artificial inoculation and disease development protocols have also been developed.
- Cultures of fungal pathogens of poplar are regularly maintained, viz., *Alternaria, Botryodiplodia, Curvularia, Drechslera*, *Phoma /Phyllosticta* and Sclerotium.
- Diversity of nine isolates of *Curvularia* sp., causing leaf spot disease in poplars and their management using four different media such as PDA, CDA, MEA and SA was studied .
- Clones of *Casuarina equisetifolia* (250 no.) screened for infection of *Subramanianospora vesiculosa* (blister bark disease) under controlled condition revealed that 36 clones were resistant and having higher pehnolic content.
- Morphological variations were studied for the four virulent isolates of *Fusarium solani* f. sp. *dalbergiae,* the causal organism of wilt disease of *Dalbergia sissoo.* Their mass cultures were prepared in broth for artificial inoculation on promising germplasm.
- Seventeen clones procured from G&TP Division, FRI were artificially injected with conidial suspension of the 4 strains and observations for disease expression and extent are being made.
- Effective antagonistic species of *Trichoderma* against the four pathogen strains of *Fusarium solani* f. sp. *dalbergiae* were tested and found to cause mycoparasitism by hyphal lysis and coiling.
- *Trichoderma viride* formulation was found significantly superior to all the treatments and control in increasing the number and biomass of leaves of *Stevia rebaudiana*. In *Asparagus racemosus*, *Trichoderma piluliferum* and *T. viride* were significantly superior to other treatments and control in increasing the root biomass.
- Natural decay resistance of imported woods was tested against *Trametes versicolor*, a white rot fungus suggested that teak wood from Ghana was resistant to decay.
- DNA finger printing using RFLP-PCR was done for twenty promising clones of *D. sissoo.*

- RAPD-PCR was conducted with isolates of *Cordyceps sinensis,* collected from different locations in Uttarakhand for studying the variability among the isolates. Nine population lines were identified.
- Internal transctibed region of nrDNA (ITS regions) were amplified and sequenced for the authentic identification of the isolates of *Cordyceps sinensis*. Blast search results affirmed their identity as *Cordyceps sinensis* (the new name is *Ophiocordyceps sinensis*).
- For the first time, beta tublin gene region of *Cordyceps sinensis* has been sequenced, studied and deposited in gene bank.
- Cordycepin, ergosterol and adenosine was detected in some of the *Cordyceps sinensis* isolates, collected from different geographical locations in Uttarakhand. Some of the bioactive principles were found to be in a higher quantity in the cultivated *Cordyceps sinensis* in comparison to the wild.
- A new protocol for artificial cultivation of fruiting bodies of *G. lucidum* was developed using used tea leaves-wheat straw spawn, poplar branch billets and by creating a low-cost mist chamber. The fruiting bodies were harvested within 90 days which is the shortest reported time in its artificial production.
- For extending the results to the user groups, a one-day training programme on cultivation of *Ganoderma lucidum* was conducted on 11th March 2011. Local mushroom growers and farmers (21 No.) were given demonstration and hands-on training in glasshouse of Forest Pathology Division, FRI, Dehradun.
- Ten strains of *Frankia* were isolated and identified from the rhizospheres of casuarinas in Tamil Nadu.
- Suitable and effective forms of ectomycorrhizal (ECM) fungal inoculum for growth improvement of seedlings of commercially important plantation tree species like *Acacia auriculiformis, Acacia mangium, Casuarina equisetifolia, C. junghuhniana, Eucalyptus camaldulensis* and *E. tereticornis* were identified.
- Standardized suitable culture medium and ideal pH and temperature conditions for mass production of different isolates of ECM fungi (*Laccaria fraterna* and *Pisolithus albus)* under *in-vitro* conditions.
- Diversity of mycorrhizal associations with *Dipterocarpus* and *Shorea* species in Assam were assessed.
- The effect of Arbuscular Mycorrhizal was studied on the growth performance of *Mesua ferrea* L. and *Aquilaria agallocha* Roxb.
- Antifungal properties against *Rhizoctonia bataticola* and *Fusarium solani* was found in *Citrullus colocynthis* and against *Alternaria alternata* in *Datura stramonium*.
- Qualitative and Quantitative phosphate solubilizing, siderophore and HCN production characteristics of 68 isolates of fluorescent pseudomonads from rhizosphere soil of G-48 clone of *Populus deltoides* were studied.
- As an alternate to the application of chemical hormones (IBA), for induction of rooting and nutrient enhancement in *Eucalyptus* clones beneficial microbial inoculants like *Azospirillum, Pseudomonas, Bacillus* and *Azotobacter* were applied and effective rooting and nutrient enhancement achieved.
- Isolates of 216 Plant Growth Promoting Rhizobacteria (PGPR) and 26 different AM fungi were isolated and identified from the rhizosphere samples of 6 different fast growing native tree species of Tamil Nadu and Kerala.

- Nucleotide Sequences were constructed for different isolates of PGPR isolated from the rhizosphere of fast growing native tree species and the same have been submitted to European Molecular Biology Laboratory (EMBL) and NCBI Database.
- Efficacy of PGPRs for production of IAA and Phosphate solubilization was determined.
- Molecular characterization of Phosphate Solubilizing Bacteria (PSB), isolated from the *Ailanthus excelsa* rhizosphere samples was done and identified as *Bacillus megaterium.*
- One-day interactive meeting for developing a network on shisham mortality was organized on Sep. 2011, which was attended by scientists from HAU, Hissar; Dr. Y S Parmar University of For. & Hort., Nauni, Solan; G. B. Pant Univ. of Agr. & Tech., Pantnagar; ICFRE Institutes (Jodhpur, Jorhat, Jabalpur, Ranchi and Allahabad); Forest Officers from Haryana, Punjab, Uttarakhand and Uttar Pradesh forest departments and Scientists of concerned Divisions of FRI.

Projects under the Theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	12	22	23
Externally Aided	7	5	1
Total	19	27	24

2.7.2 Insect Pests, Diseases and Control

Insect Pests

Insect Pest Surveys, Incidence and Biology

Insect Pests of Bamboo

Phloeobius crassicollis was reported as new pest on the following ten bamboo species in and around Dehradun: *Bambusa bamboos, B. nutuns, B. polymorpha*, *B. tulda, B. vulgaris, B. wamin*, *Dendrocalamus giganteus, D. strictus, D. calostachyus* and *Gigantochloa atroviolacea*. Average attack percentage on these species was recorded from 2 to 51% with maximum attack of 51 % in *Bambusa wamin*.

From Assam, 23 insect pests belonging to the various orders of Lepidoptera, Orthoptera, Coleoptera were recorded infesting following bamboo species: *Bambusa tulda, B. balcooa, B. pallida* and *B. nutans*. Based on the incidence and intensity of insect pest attack, *Antonina* sp., *Psara licarsisalis, Crocidophora* sp., *Hexacentrus unicolor* (Tettigoniidae) and *Oxya nitidula* (Walk) (Acrididae) were categorized as major pests, causing serious damage. During the survey, the natural enemies like entomopathogenic fungus, *Beauveria bassiana,* was collected from *Crocidophora* sp.*;* two different predatory spiders (*Oxyopes* sp.,) on the larvae of *Crocidophora* sp., and *Psara licarsisalis* were also recorded. Paint brush swift *Baoris farri* (Moore) was also recorded as new host on *Bambusa tulda.*

Field Manual of Insect Pests

Insect pests of *Dalbergia sissoo* and *Populus deltoides* were collected and photographed for preparation of the field manuals.

Biology of *Leptocybe invasa*

Life table and behavioural mechanisms involved in oviposition by *L. invasa* was studied for 3 generations in Coimbatore. The total life cycle period from egg to adult was recorded as 125-130 days. Trial with 2 coloured sticky traps deployed in 3 nurseries for 2 seasons showed that adult wasps preferred yellow colour.

Insect Pests of Sandal

Five silvi-horticultural models of sandal situated in Bevananahalli, Muddennahalli, Gottipura, Yelwala (Mysore) and Jarackbandae were continuously surveyed for insect pests. It was observed that insect pests problems were

more and diseases were less on sandal. Coccids (sap-suckers) were economically more important pest as was than any other insect pest. Three new stem borers were recorded during the study viz *Purpuricenus sanguinolentus* Olivier and *Exocentus* sp. and *Derolus volvulus*. The stem borer *Purpuricenus sanguinolentus* was found to cause extensive damage to sandal plants. A new sandal seed borer *Araecerus fasciculatus* Linn.(Anthribidae: Coleoptera) was found to cause serious damage to sandal seeds whose overall damage stood at 20 %. Two new weevils defoliators were also recorded viz. *Peltotrachelus cognatus* Faust and *Myllocerus delicatulus* Boheman. Three new lepidopterous defoliators recorded were *Amata passalis* (Artiidae), *Micronia aculeate* (Uraniidae) and *Parallelia* sp. (Noctuidae). One grasshopper species, *Crotogonus* sp., was observed on all the silvi- horti models of sandal. Pollen feeders collected from sandal plants were identified as *Oxycetonia versicolor* and *O. juncunda.* Nine new parasites collected on coccids of sandal have been identified and documented. Check-list on the entomofauna of sandal was also updated.

Insect pests of *Emblica officinalis, Pongamia pinnata, Garcinia* sp. and *Dysoxylum* sp.

Nearly 35% gall infestation and 100% defoliation was observed in *Pongamia pinnata* seedlings along with scale insect. *Emblica officinalis* seedlings were found to be completely defoliated by *Meconellicoccus hirsutus* in Sulikere nursery and Lakkunda nursery. At the latter site 20% infestation was seen in *Garcinia,* and 15% in *Dysoxylum* seedlings.

Fouling Organisms

Thais blanfordi (Melvill), a gastropod, was found to be associated with fouling assemblages for the first time in the country at Machilipatnam port. Recruitment of fouling organisms on rubber, asbestos, cement, asphalt, FRP, PVC and brass showed that different forms preferred different substrata for settlement.

Marine Borers in the Mangrove Habitats of Northern Andhra Pradesh

Rare pholadids, namely, *Lignopholas chengi, L. rivicola* and *L. fluminalis* were recorded from the mangroves in the Godavari delta. Mangrove habitats in Srikakulam, Visakhapatnam, East Godavari and Krishna districts were surveyed and damage caused to vegetation was assessed. Mangrove plants such as *Excoecaria agallocha, Avicennia officianalis*, *A. marina* were found to be infested by several species of marine wood boring organisms. Important pest species were recognized to be *Sphaeroma terebrans* (Pillbugs), *Martesia striata* (Piddocks), *Lyrodus pedicellatus, Nototeredo knoxi, Nausitora hedleyi, Bankia campanellata, B. destructa* and *B. philippinensis.*

Control

Chemical

Eucalyptus Gall Wasp, *Leptocybe invasa*

Screening of 2 plant based extracts (Citronella oil, Neem oil), and some pesticides (Acetamiprid, Imidacloprid and Methyl parathion) through foliar and soil application showed that incidence of galls was reduced with the application of pesticides. In order to standardize preventive methods of management of gall wasps, comparison of gall resistance with and without susceptible clones were attempted and found that some resistant clones showed gall incidence from 10- 30%.

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 and 81% 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 per emergence hole) were found to be the most effective measure. Mechanical control by hammering stone into the exit hole for adult was also effective.

Insect Pests of *Ailanthus excelsa (Atteva fabriciella* and *Eligma narcissus*) and *Gmelina arborea (Tingis beesoni*)

Quinalphos, Imidacloprid, Dimethoate at 0.025 to 0.05% were effective in controlling these pests.

Integrated Management Package

Package on white grubs in teak nursery was developed for Madhya Pradesh Forest Development Corporation Ltd. In this package different activities like installation of light trap unit, different dates of sowing of teak seeds, pruning of host trees around the nurseries, application of biopesticides cakes (neem and jatropha) and prophylactic / curative treatment of phorate 100 gm per bed (size 10x1m), synthetic pyrethroids i.e. deltamethrin 0.005% followed by alphamethrin 0.01% was recommended against these key insect pests.

Efficacy of TBTM-MMA Preservative Against Fouling Organisms

In continuously exposure trials of TBTM-MMA treated test panels of *Bombax ceiba* and *Paraserianthes falcataria* for the last 30 months at Visakhapatnam and Kochi harbours, it was found that monthly recruitment of fouling organisms was negligible in treated panels, whereas, untreated panels (controls) showed higher biomass loads. All treated panels at Visakhapatnam remained free from any wood borer attack throughout the period but a few treated panels at Kochi were attacked by sphaeromatid wood borers.

Biocontrol

Eucalyptus Gall Wasp, *Leptocybe invasa*

Culture of Eucalyptus gall wasp population and the parasites *Megastigmus* sp. and *Quadrastichus mendelli* in nursery plant were raised on Eucalyptus clones in breeding chamber. Studies on the biology and parasitisation efficiency of *Megastigmus* sp. and *Quadrasitchus mendelli* showed that *Megastigmus* sp. took approximately 40-45 days and *Quadrastichus mendelli* took 28-32 days to complete the life cycle. The parasitisation efficiency of *Quadrastichus mendelli* was found higher than that of *Megastigmus* sp.

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 Yellownape and *Picus flavinucha*.

New Biocontrol Opportunities for Prickly Acacia and A*cacia nilotica*

Anamolococcus indicus (sap.-sucker) *Physcita* sp. (leaf weber) and *Deoderus* sp. (beetle) were found to be the potential candidates for biological control of *A. nilotica.* Based on the elaborate host specificity studies under lab and nursery conditions, involving 9 species of Acacias, these insects were screened.

Microsporidia as Biocontrol Agents

A total of 94 lepidopterans were tested and microsporidian parasites were isolated from 29 species. Morphometry of 29 species of microsporidia were studied. Bio-assay study using microsporidian parasites was carried out on larvae of *Hyblaea puera*, *Catopsilia* sp., *Papilio demoleus* and *P. polytes* by inoculating different concentrations of spores isolated from their respective hosts.

Braconid Parasitoids (Hymenoptera: Braconidae) from Central India

Extensive survey for the collection of Braconid parasitoids and their host insects was carried out in Chhattisgarh (185 localities of 16 districts) and Maharashtra (385 localities of 34 districts). Twelve new species (*Apanteles lakhaensis; Apanteles neocajani*; *Apanteles neohyblaeae; Apanteles neotaeniaticornis* and *Rogas jalnaensis, Anisocyrta gilvicorpa* sp. nov.*; Bracon jalgaonensis* sp. nov.; *Chelonus* (*Chelonus*) *wardhaensis* sp. nov.; *Chelonus* (*Microchelonus*) *hingoliensis* sp. nov.; *Doryctes indicus* sp. nov.; *Parahormius longicorpus* sp. nov. and *Parahormius longiflagellatus* sp. nov.) have been described as new to the science. Five genera and 14 species have been recorded for the first time from India. Twelve generas and 39 species have been recorded for the first time from Chhattisgarh and Maharashtra. Consolidated host-record of Indian Braconid species has also been prepared.

Studies on Larval Parasitoids of Major Defoliators of Teak and Sal Forests of Orissa

Surveys in ten districts of Orissa were carried out and 202 samples of larvae and pupae of insect pests of teak and sal defoliators collected. Rearing of field collected samples yielded 180 specimens of *Apanteles* out of which following fifteen species were identified: *A. antipoda, A. belippa, A. bambusae, A. caniae, A. creatonoti, A. detrectans, A. effrenus, A. expulsus, A. lamprosemae, A. leptothecus, A. machaeralis, A. neocajani, A. neotaeniaticornis, A. tachardiae* and *A. fuseinervis*. Natural field parasitisation of all these 15 species was calculated. All these *Apanteles* spp. are indigenous and were recorded for the first time from Orissa.

Entomopathogenic Nematode for the Management of Termites and White Grubs

The laboratory culture of one exotic and six unidentified (native) populations of EPNs native to central India, was maintained *in vivo*. One of the EPN isolate (*Steinernema dharnaii* sp. nov.) has been identified (at molecular level) as new-to-science by CABI, Kew, UK. Process for the identification of other unidentified native EPN populations is in progress in collaboration with the Zoological Survey of India, Dehradun.

Insect Pests of Medicinal Plants-*Abelmoschus moschatus, Gloriosa superba* and *Withania somnifera*

On muskdana, *Abelmoschus moschatus,* three insect pests viz. *Anomis flava and Sylepta derogata (*defoliators) and red bug *Dysdercus cingulatus* (sap sucker); on kalihari, *Gloriosa, superba,* two defoliators viz. *Polytela gloriosa* and *Amsacta lacieneus* and on Ashwagandha, *Withania somnifera,* two insect pests viz. sap suckers, *Plautia crossota* and aphids were recorded. *Ichneumon* sp. and *Stermia* sp. were recorded as parasites on the insect pests of *A. moschatus* and *G. superba*. Seasonal history of the key insect pests *A. flava, S. derogata, P. gloriosae* and *D. cingulatus* was also studied.

Management of Indian Gypsy Moth (*Lymantria obfuscata*) in Himachal Pradesh

The final Time-Mortality Bioassay using 7 doses of Baculovirus, viz. 1.70E+09, 8.50E+08, 4.25E+08, 2.13E+08, 1.06E+08, 5.31E+07 and 2.66E+07 were applied on fifty 3rd instar larvae for each dose. Time-Mortality-Bioassay data were subjected to Probit Analysis using SPSS software. The results indicated that LT_{50} for the doses, were 0.372, 20.582, 8.223, 12.492, 12.403, 10.556 and 10.810 days, respectively, meant the days required to kill the larvae after administering the viral dose.

As the laboratory trials were successful for sex-pheromone, a experimental field trial of sex-pheromone was conducted in some selected spots of Shamshi. Fifty pheromone-traps were mounted on the ground and pheromone ampule was filled with 1 microliter of the extracted pheromone. The site was revisited after 15 days

Male IGM Killed in Pheromone

and the catch of male moths from all traps were counted. Altogether 650 adult male were killed.

Assessment of impact of first field trial of baculoviral experiment was done at the selected sites of Oak forest in Charwag village of Sarahan District. The effect of baculovirus was assessed by counting the number of egg-mass recorded during July-August and comparing the numeric strength with the record of egg-mass during last two years. It was found that there was a reduction of production in egg-mass measuring 92%.

Predatory Efficiency of *Stegodyphus sarasinorum* Karsch (Arachnida: Araneae: Eresidae) against Insect Pests

Five field surveys were conducted in areas like Nogli, Gesipul, (Rampur), Sunni, Basantpur, Arki, Gablog, Bangora, Dadhau, Renuka and Kunj-Kayer falling in the lower hill and mid-hill regions of Himachal Pradesh. Twenty three different spots were screened in search of social spider nest and only in 10 spots, colony of the spider was recorded and geo-referenced. Ten mature colonies of the spider were collected and reared in the laboratory. Following 15 trees and shrubs were recorded as the host tree where the spider constructed the web viz. *Mallotus philippensis, Artemesia* sp., *Lagerstroemia* sp., *Curessus* sp., *Platycladus orientalis, Kigelia pinnata, Prunus dulcis, P. domestica, Dalbergia sissoo, Eucalyptus* sp., *Zyzyphus jujuba, Phyllostachys* sp., *Callistemon viminalis, Acacia catechu, Punica granatum* and one unidentified. Following 17 prey insect species belonging to 6 families under 4 orders were recorded: *Granida albosporsa, Holotrichia longipennis, Anomala* sp., *Apogonia* sp., *Melolontha* sp., *Brachytrypes portontosus, Anlanches milaris, Chrotogonus* sp., *Apriona cinerea, Deudoris epijarbus, Closstera cupreata, Plectora reflexa, Agrotis epsilon, Heterotermes indicola, Pieris brassicae* and *Pieris rapae.*

Social Spider Nest Reared in Lab

Management of Insect Borer Complex in Chir Pine Forests

It was observed that *Polygraphus longifolia* Steb.(Coleoptera: Scolytidae) passes through three to four generations during a year. For management, pheromone traps were used. Pheromone, Ipsdienol ($C_{10}H_{16}O$) at 1 mg, 2 mg , 4 mg and 8 mg loading/ concentration in four types of pheromones traps viz. Fero-T™, Del-Ta™, Wot- T™ and Fligh-T™ by following factorial RBD design were evaluated at Plateau chir pine forest in Barsar Forest Range under Hamirpur Forest Division.

Botanicals

Bioassay Against Major Defoliators of Poplar and Shisham

Laboratory reared 3rd instar larvae of Shisham defoliator, *Plecoptera reflexa* and poplar defoliator, *Clostera cupreata* were tested using Acetone (A) and methanol (M) extraction of aerial parts of *Calotropis procera* (CP) and

Plumbago zeylanica (PZ). It was found that 2% concentrations of PZA and PZM gave 63 and 73%, whereas, CPM and CPA gave 67 and 63% larval mortality after 72 hrs respectively.

Atteva fabriciella, *Eligma narcissus* (*Ailanthus excelsa*) and *Tingis beesoni* (*Gmelina arborea*)

Pongamia, Jatropha and Neem oil at 5 different concentrations (2-3%) were found effective in controlling these insect pests. The commercial product, Neem azal (1%) tested at 10 different concentrations exhibited that the product at 10 and 20 ppm was effective for managing *E. narcissus* and *T. beesoni*, respectively.

Vilvekam-*Aegle marmelos* Seed Oil Based Biopesticide

Eight suitable preformulations from aqueous and organic extracts from the processed tissues (half fruit, pulp and seeds) of *A.marmelos* were developed and tested at the doses of 2000, 5000 and 10,000 ppm in comparison with neem formulation and synthetic pesticide against the target insect pests, *Hyblaea puera* and *Spodoptera litura*. Based on the promising results obtained from the laboratory and field trials a new product "Vilvekam-*Aegle marmelos* seed oil based biopesticide" was developed, and released.

Field Level Biopesticidal Applications

Insect Resistant Germplasms

Screening for Eucalyptus Gall Resistant Clones

A trial with 179 high yielding clones of *Eucalyptus* located at Satyavedu, Andhra Pradesh was screened for the attack of the gall insect, *Leptocybe invasa*. Data so far collected showed that about 19 clones were showing resistance/ tolerance to the gall insect. Consistency of the resistant nature of these clones needs to be watched further.

Others

Integrated management of Khejri mortality

Field surveys were made in 4 districts viz., Nagaur, Sikar, Churu and Jhunjhunu to assess the

extent of mortality. The percentage khejri mortality ranged between 18.08 to 22.67 % with an average mortality of 20.93 % in all the surveyed districts. Eggs and larvae of different instars of *Acanthophorus serraticornis* have been collected for rearing in the lab condition. The treatments were given as recommended by CAZRI, AFRI & ARS. Before treatments, observations were recorded on DBH, root infection with borer/fungus defoliation percentage, and weight of loong production by visual and actual record. The bio-ecology of *Acanthophorus serraticornis* was studied in the laboratory as well as in the insectary conditions. The eggs have been laid by female beetles in the month of September-October in the moist soil around the collar region of trees. The eggs are oval in the shape, white and measured 4.76 mm in length and 2.38 mm in width. Incubation period varied from 9-11 days. The maximum length of newly hatched Ist instar larvae was 25 mm, creamish-white with blackish brown head. The Ist instar larvae life was of 45-50 days. Life generations of *Acanthophorus serraticornis* overlap considerably and different instars larvae have been collected from fields during January to March. A workshop was organized to review the work done by AFRI and suggestions and future line of action have been finalized.

Influence of Climate on Bionomics of *Pityogenes scitus* Blanford (Coleoptera: Scolytidae) in Himachal Pradesh

Five Forests 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. Emergence of beetle and climatological data for five localities were collected.

Different Pheromones Traps Evaluated in Chir Pine Forests

Diseases and their Control

Seed Borne Diseases

A total of 222 fungal isolates of 40 generas were isolated from the fruits and seeds of *Elaeocarpus munronii, Dysoxylum malabaricum, Dipterocarpus indicus, Vateria indica, Garcinia gummi-gatta, Poeciloneuron indicum, Syzygium malabaricum, Myristica malabarica, Knema attenuata, Madhuca longifolia, Hopea ponga, Kingiodendron pinnatum* and *Cinnamomum sulphuratum*. Natural fungal flora of seeds of *D. malabaricum, E. munronii, M. malabarica*, *P. indicum* and *V. indica* were found to be pathogenic on seeds and seedlings. A new fungal species viz., *Penicilloipsis indcus* was identified from the seeds of *D. malabaricum*. New host records of fungi i.e., *Beltrania rhombica* on seeds of *P. indicum* and *Bartalinia lateripes* on seeds of *G. gummigatta* were reported. Control of forest seed pathogenic fungi has been achieved by using the leaf and bark extracts of *Prosopis juliflora* and *Cleistanthus* sp.

Ten fungal species i.e. *Alternaria alternata, Aspergillus niger, Cephalosporium* sp., *Chaetomium globosum, Cladosporium* sp., *Fusarium equiseti, Fusarium oxysporum, Penicillium citrinum, Rhizopus stolonifer* and *Trichothecium roseum* were isolated and identified from *Pinus gerardiana* (chilgoza) seeds. *Penicillium citrinum* was the most predominant fungus affecting Chilgoza seeds in storage. It was observed that 40.07% of seed rot was found at 25^{0}C and even 8.27% seed rot was observed at 0^{0}C due to *Penicillium citrinum*.

Diseases of Sandal Wood

Five silvi-horticultural models of sandal situated in Bevananahalli, Muddennahalli, Gottipura, Yelwala (Mysore) and Jarackbandae were continuously surveyed for insect pests and diseases. The diseases of sandal plants were very predominant during the seedling stages only. Some of the common diseases observed in all the five models are damping-off (*Fusarium* sp.), root disease (*Phytophthora* sp. and *Pythium* sp.), foliar blight (*Botrytis s*p.), root decay (*Cylindrocarpon* sp.) and tip blight (*Phoma* sp.). The symptoms of root decay and tip blight were found in the 2-3 years old plants also. The management strategies were adopted to reduce the inoculum level at the field by following cultural and biological methods.

Bacterial Wilt in Teak

The impact of bacterial wilt diseases in hi-tech teak plantations on length of lamina and intermodal length of apical region of the Teak stem was found to be less in Ridomil (0.3 % and 0.2%) followed by Streptocyclin (0.1%) as compared to control. Powdery mildew occurs in moist conditions and is usually seen in the wetter spring and fall seasons. Spraying of sulphur (0.2%) is recommended but it may injure tender foliage, especially in hot weather so it must be used carefully under strict scientific supervision. Biological agents include *Cladosporium cladosporoides*, *C. oxysporum* and *Trichoderma virens* which are eco-friendly and give quite fruitful results.

Management of Diseases of Aonla, Neem and Khamer

Varieties viz. Kanchan, Anand-2 and NA-7 showed more susceptible reaction to *Fusarium oxysporum.* On the basis of laboratory evaluation, Ridomil 0.2% was found the most effective against the growth of *F. oxysporum* followed by Ridomil 0.1%, Bavistin 0.2% and Dithane M 45 0.2%. Comparative efficacy of six fungicides recorded at 3 intervals (15, 25 & 35 days) confirmed that Bavistin, Dithane M 45 and Ridomil at both concentrations and Fytolan at 0.2% were effective to control the disease in nurseries while Thiram and Foltaf were less effective.

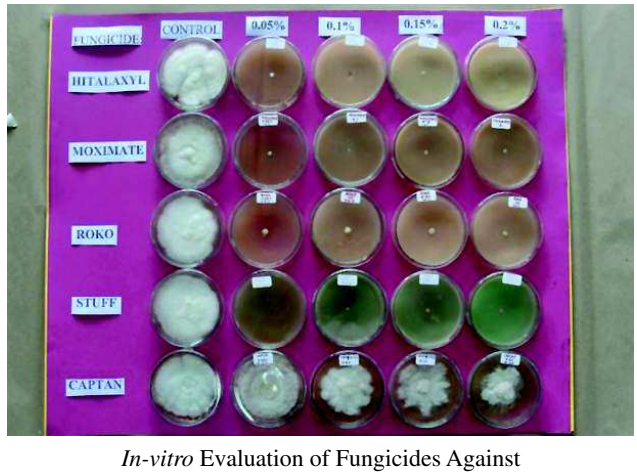
Sites prone to wilt infection have been selected from Madhya Pradesh and Maharashtra. Three pathogens viz. *Fusarium solani, Verticilium nigrescens* and *Rhizoctonia solani* causing wilt in Aonla, Neem, and Khamer have been identified. Susceptibility of the pathogen to different fungicides and biological agents has been determined under controlled laboratory condition.

Culm Rot and Bamboo Blight Disease in Assam

Pathogenicity tests carried out in the lab as well as potted seedlings revealed *Fusarium udum* as the causal organism of the disease. Two biocontrol agents (viz. *Trichorderma viride* and *T. harzianum*), 8 fungicides and 1 antibiotic were tested *in vitro* against the fungal pathogen. The most effective fungicides as well as biocontrol agents were selected for *in-vitro* tests. Four fungicides viz., Mass, Bavistin, Moximate and Indophil M 45 were found effective under *in-vitro* condition were tried in the potted bamboo seedlings against culm rot and bamboo blight disease.

Pathogenicity Test in the Lab

Pathogenicity Test in Potted Seedlings



In-vitro Evaluation of Fungicides Against *Fusarium udum*

Host Specificity of Rust Fungus in *Acacia* Species

Host specificity test on 14 species of *Acacia* was conducted for rust fungus , *Ravenelia evansii* in polyhouse at Jodhpur, only eight species performed well in the climatic conditions of temperature and relative humidity at Jodhpur. The cross-infectivity and host specificity test were designed using the seven species of Acacias including *A. nilotica indica* against rust infection.

Stem canker disease in rohida

Survey was carried out to select experimental site and collection of diseased samples, isolation and identification of pathogens responsible for stem canker of rohida (*Tecomella undulata)* in Barmer. Seven fungi have been isolated from different sites from infected rohida trees. The fungi have been identified as *Lasiodiploidia theobrome*, *Stemphylum* sp., *Alternaria* sp. and rest of the fungi were unidentified. Individual fungus species and in combination were inoculated on healthy branches of Rohida for pathogenicity testing.

Khejri Mortality

Field surveys were made in 4 districts of Rajasthan viz., Nagaur, Sikar, Churu and Jhunjhunu to assess the extent of mortality. The mortality of khejri ranged between 18 to 23 %. Based on the actual data of tree mortality in the randomly selected pockets at different localities, in addition to *Ganoderma lucidum* and *Macrophomina phaseolina* was isolated from infected khejri roots. Eggs and larvae of different instars of *Acanthophorus serraticornis* have been collected for rearing in the lab condition. Six sites were selected in five districts viz; Surani (Balesar Road, Jodhpur), Raghunatpura (Didwana, Nagaur), Jhareli (Jayal, Nagaur), Goshala (Fatehpur, Sikar), Churu (Churu) and Sultana (Jhunjhnu) for the laying out of experiment. The treatments were given as recommended by CAZRI, AFRI and ARS. Before treatments, observations were recorded on DBH, root infection with borer/fungus defoliation percentage, and weight of loong production by visual and actual record.

Fruiting bodies of *Ganoderma lucidum* were collected from infected khjeri trees. The fungus was isolated and multiplied on sorghum seeds. Freshly prepared culture of *Rhizoctonia bataticola* causing charcoal root rot in khejri trees was inoculated on the young seedling for pathogenecity test. Till now, three different strains of *Trichoderma* spp. have been isolated from the soil collected from different sites.

Diseases of Medicinal Plants and Their Bio-control

Diseases of *Rauvolfia serpentina, Withania somnifera* and *Chlorophytum borivillianum* were recorded from Madhya Pradesh and Chhattisgarh. A new damping-off disease of *W. somnifera* caused by *Sclerotium rolfsii* was reported for the first time from India. Antagonistic organisms viz. *Streptomyces* sp. and *Bacillus amylolequifaciens* were isolated from the soil. The effect of antagonistic organisms and biopesticides (1 litre cow urine + 100 g each leaves of *Azadirachta indica, Ailanthus excelsa* and *Calotropis procera*) was tested on the major pathogens of *R. serpentina* and *C. borivillianum* in the laboratory. The experiment on the effect of *Trichoderma harzianum, Bacillus firmus, B. amyloliquefacien* and, *Streptomyces* sp, Bavistin and biopesticides were conducted on the leaf spot and inflorescence disease of *R. serpentina* in the field. Among the above treatments bavistin 0.5% + *Streptomyces* sp. showed best results for disease control as well as seed production. In another experiment, the effect of systemic fungicide, biopesticide and bio-controlling agents on the foliar diseases of *C. borivillianum* were noticed. In this experiment, two fortnightly spray of the culture of *Streptomyces* sp. shows significant disease control as well as better rhizome production. One experiment on the selection of

potting mixture for the root development of *W. somnifera* was conducted by using different combination of potting mixtures. Neem cake 50%+ soil mix 50% proved best potting mixture for the over all growth of the *W. somnifera* as well as reduction in root-knot caused by *Meloidogyne incognita.*

Screening for Resistance Against Diseases

The studies on blister bark disease resistance in 250 clones of *Casuarina equisetifolia* were carried out in a nursery experiment by artificially inoculating the pathogen, *Subramanianospora vesiculosa* which exhibited that 36 clone were resistant to the pathogen. The rest of the clones were found expressing the resistance and susceptibility to the pathogen at varying degrees. Analysis of total phenols was also carried out and correlated with the level of resistance expressed by different clones.

Resistance against *Fusarium solani* wilt disease of *Dalbergia sissoo* was tested in seventeen clones by using direct inoculation (injection) with four virulent strains. Only one clone No. 103 showed resistance while clone no. 49 and 1003 were the most susceptible ones.

Antifungal Properties of Plants

Antifungal properties of seven selected plant parts (leaves, roots and seeds of *Datura strumonium*, fruits of *Balanites aegyptiaca*, roots and fruits of *Citrulus colocynthis* and flowers of *Tephrosia purpurea*) were evaluated against fungal pathogens. For antifungal assay, pure cultures of fungi were procured from National Type Culture Collection, Forest Pathology Division of FRI, Dehradun. Total fourteen extracts were tested against five fungi for their antifungal properties: (1) Aqueous extract of *Citrulus colicynthis* roots showed good antifungal activity against *Rizoctonia bataticola*, (2) Alcohalic extract of *Citrulus colicynthis* roots showed antifungal activity against *Fusarium solani,* (3) Aqueous and ethanolic extract of *Citrulus colycinthis* leaves showed mild to moderate antifungal activity against selected fungi, (4) Aqueous extract of *Datura strumonium* seeds showed good antifungal activity against *Alternaria alternata* and (5) Alcohalic extract of *Datura strumonium* seeds showed moderate to mild antifungal activity against all five fungi.

Inhibition zone by Aqueous Extract of *Citrulus colycinthis* Roots Against *F. solani*

Inhibition zone by Aqueous Extract of *Citrulus colycinthis* Fruit Against *F. solani*

Dynamics of Litter Decomposition in Sal Forest

Natural sal sites were selected from Madhya Pradesh, Chhattishgarh, and Orissa. Litter samples have been collected and analyzed for carbon flux and NPK. Microbial flora and fauna associated with litter decomposition have been

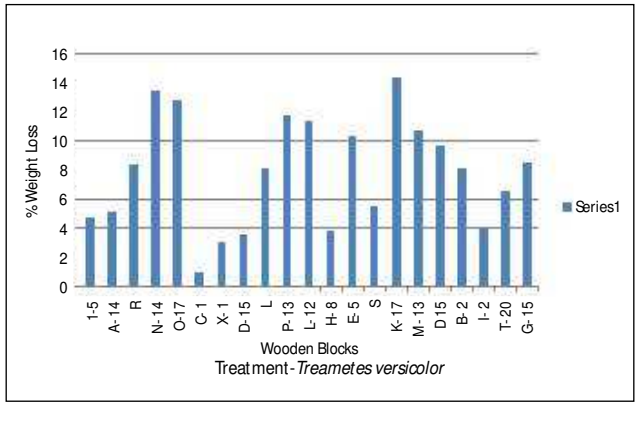
studied. Fungi forming ectotrophic mycorrhizae (Russula and Pulveroboletus among basidiomycetes and *Geastrum, Astraeus* and *Scleroderma* among gasteromycetes) with sal trees have been collected and identified. Other beneficial supporting microbes including *Trichoderma, Cladosporium* and PSB have been cultured and preserved for further use under field condition.

Fungal Degradation in Catamarans

Fungal infested timber from catamarans from the third field station, Pudimadaka was collected. The fungal samples were cultured and maintained. Timber test coupons were treated to a gradient of CCA absorptions. CCA treated coupons were subjected to experimentation with pure cultures of individual fungi. In general, lower loadings of CCA along with control were infested, whereas, higher loadings resisted infestation.

Natural Decay Resistance in Imported Woods

Natural decay resistance tested through accelerated laboratory tests with white rot fungus *Trametes versicolor,* revealed that beech wood (*Fagus grandifolia*) from France gave highest percentage weight loss (14.36), followed by ash wood (*Fraxinus americana*) (13.48) and beech wood from Belgium (12.84), whereas, minimum weight loss was observed in teak wood from Ghana (1.06) blocks.



Molecular Variability

RAPD-PCR was conducted with isolates of *Cordyceps sinensis* collected from different locations in Uttarakhand for studying the variability among the isolates which identified nine population lines. Internal transcribed region of nrDNA (ITS regions) were amplified and sequenced for the authentic identification of the isolates of *Cordyceps sinensis*. BLAST search results affirmed their identity as *Cordyceps sinensis* (the new name is *Ophiocordyceps sinensis*). For the first time beta tublin gene region of *Cordyceps sinensis* has been sequenced, studied and deposited in gene bank.

Active Principal in Medicinally Important Fungus

Cordycepin, ergosterol and adenosine were detected in some of the *Cordyceps sinensis* isolates collected from different geographical locations in Uttarakhand. Some of the bioactive principals have been found to be in a higher quantity in the cultivated *Cordyceps sinensis* in comparison to the wild. Comparison of the cordycepin content, determined in the sporophores of *Cordyceps sinensis* and literature reported with those determined in the cultured samples, revealed that the cordycepin yield was high in eleven cultured samples of which seven isolates ISO 3 (0.024%), ISO 6 (0.029%), ISO 10 (0.013%), ISO 21 (0.026%), ISO 22 (0.013%), ISO26 (0.016%) and ISO 33 (0.02%) showed significantly high cordycepin content. The results of study demonstrated that *Cordyceps sinensis* could be cultivated on Jhangora grains where the cordycepin production was found to be much higher than that of naturally occurring sporophores. This study is the first report regarding the cordycepin production in the cultured Indian isolates of *Cordyceps sinensis*.

Cultivated Fruiting Body of *G. lucidum*

Cultivation of *Ganoderma lucidum*

An economical cultivation protocol of a medicinally important fungus *Ganoderma lucidum* was successfully developed using poplar billets for the first time and has been passed on successfully to the Mushroom growers in Dehradun and nearby areas.

Wood Decay Fungi and their Management

Specimens of 102 wood decay fungi were collected from 22 hosts. One new species, *Nitschkia tectonae* and three new records of fungi were reported from India viz. *Australohydnum dregeanum, Hjorstamia fresii* and *Schizopora flavipora.*

Nine hyper parasitic fungi colonizing decaying wood have been isolated. Out of them, *Trichoderma viride* and *Aspergillus flavus* were selected and tested *in-vitro* for biological control of 10 wood decaying fungi (*Trametes cingulata*, *Stereum hirsutum*, *Pycnoporus sanguineus*, *Trametes feei*, *Phellinus badius*, *Lenzites elegans*, *Phellinus pachyphloeus*, *Lenzites acuta*, *Earliella scabrosa*, *Gleophyllum striatum* and *Flavodon flavus*). Different concentration of Ammonium tetraborate, Potassium tetraborate, Manganese sulphate, Magnesium sulphate, Zinc sulphate, Copper sulphate, Borax boric acid and Urea, were tested to evaluate the efficacy of these chemicals against *Flavodon flavus* and *Trametes cingulata*.

Root Rot and Stem Decay in *Acacia catechu* and their Control

Fungi causing root rot and stem decay diseases in *Acacia catechu* were collected from Khandwa (6 samples) and Yavatmal (27 samples). Wood decay and disease causing fungi (Auricularia, *Daldinia concentrica, Flavodon flavus, Ganoderma lucidum, Lenzites palisoti* Monodictys, *Phellinus badius, P. gilvus*, Stachylidium, *Schizophyllum commune* and Torula) were isolated from fruit bodies and diseased samples. During survey, over 60% mortality in *Acacia catechu* plantation (compartment 282 & 310, 22 ha) at Hivari Range in Yavatmal was recorded due to root rot disease caused by *Ganoderma lucidum.* The site was poor in murrum soil. Young plantation (one year old) at Mukutbandh and Ghosa range of Pandharkawda division was surveyed and up to 5% seedlings were found dead due to root rot disease. Ten years old plantation (mixed with sissoo and neem) was surveyed at Isapur (Digras), Pusad Division and found almost healthy (only 4% plants were found dead due to *Ganoderma lucidum).*

2.7.3 Mycorrhizae, Rhizobia and other useful Microbes

Mycorrhizae

Different types of ectomycorrhizal (ECM) fungal inocula (Basidiospores, Vermiculite based vegetative mycelial and alginate bead inocula) of *Laccaria fraterna* (1 Isolate) and *Pisolithus albus* (4 Isolates) inoculated singly to *Acacia auriculiformis, A. mangium, Casuarina equisetifolia, C. junghuhniana, Eucalyptus camaldulensis* and *E. tereticornis* seedlings grown in sterilized and unsterilized potting media under nursery condition. It was found that the vegetative mycelial inoculum of *P. albus* (Isolate 3) for *A. auriculiformis, C. equisetifolia* and *C. junghuhniana;* Isolates 2 and 4 for *A. mangium*

and basidiospore inoculum (Isolate 3) for *E. camaldulensis* and *E. tereticornis* were suitable for growth improvement of the seedlings in nursery. Nodule population was found higher in seedlings grown in sterilized potting medium inoculated with vegetative mycelial inoculum of *P. albus* isolate 3, followed by isolates 1 and 2 in Casuarinas. All the ECM inoculated plants had more number of ECM colonized roots (myco-tips) especially the basidiospore inoculum of *P. albus* (Isolate 3) showed significantly more myco-tips in all the tree species.

Plant Growth Promoting Rhizobacteria (PGPR)

In all, 216 PGPR isolates and 26 different AM fungi were isolated and identified from the rhizosphere samples of 6 different fast growing native tree species in Tamil Nadu and Kerala. Germplasm of all these PGPR isolates are maintained in the laboratory. Population density of PGPRs and AM fungi was determined and the maximum population was recorded in *Melia dubia* rhizosphere followed by *Gmelina arborea.* Maximum percent of root colonization and soil spore population of AM fungi was observed in *G. arborea* followed by *M. dubia* and *Dalbergia latifolia.* Season and soil type influenced the population density of PGPRs and AM fungi.

Bacterium, *Azospirillum amazonense* Isolated from Rhizosphere of *Neolamrckia cadamba*

Bacterium, *Bacillus megaterium* Isolated from Rhizosphere of *Ailanthus excelsa*

PGPR isolates were screened for production of IAA and phosphate solubilization efficiency and the best isolates were selected for nursery experiments. Salt tolerance capacity of PGPR isolates to various concentrations of sodium was also studied under *in-vitro* conditions and some of the isolates were found tolerant.

Nucleotide Sequences of different isolates of PGPR (Plant Growth Promoting Rhizobacteria) isolated from the rhizosphere of six different fast growing native tree species in Tamil Nadu and Kerala have been submitted to European Molecular Biology laboratory (EMBL) and NCBI Database.

Molecular characterization of Phosphate Solubilizing Bacteria (PSB) isolated from the *A. excelsa* rhizosphere samples was done and identified as *Bacillus megaterium.* Nursery experiments revealed significant growth increments in bio-inoculants applied seedlings of *A. excelsa, A. triphysa* and *N. cadamba* over control in 90 and 180 DAI.

A nursery experiment organized to study the effect of selected PGPR isolates on seedlings of shola species such as *Mappia foetida, Symplocos cochinsinensis, Syzygium cuminii, Syzygium arnottianum, Michelia nilagirica* and *Michelia champaca* revealed that bio-inoculants inoculated seedlings had better seedling health and growth parameters over uninoculated control seedlings.

Microbial inoculants (Azospirillum, Pseudomonas, Bacillus and Azotobacter) tested on 30 Eucalyptus clones for effective rooting and nutrient enhancement in comparison with IBA revealed that PGPRs inoculated Eucalyptus stem cuttings responded better for rooting than IBA treated cuttings under controlled conditions (37º C & 65 % RH). The PGPR, *B. megaterium* inoculated clone no. 14 showed vigorous rooting after 14 days and found better than IBA treated cuttings with percentage of rooting was 81.00. Similarily, *P. fluorsecens* showed better root initiation in clone No. 111 after 14 to 15 days of inoculation. Clone No. 17 showed 70% of root initiation after 15 days of inoculation. However, the clones 1, 196, 19, 31, 16, 7, 9, 188,186, 16 and 63 showed late response to PGPRs inoculation collected from Sathyavedu and Karunya. These clones produced rooting only after 20 days of inoculation with percentage of rooting was 45.00 – 58.00.

The AM fungi and PGPRs inoculated clones (C111, C14, C19, C53) also showed higher content of P than control clones. Out of 30 clones, clone nos 111, 191, 116,76,101,154,186,14,69 and 123 showed better performance in root initiation, number of lateral roots, root length and shoot length. The nutrient status (P) was also studied in the microbial inoculants, inoculated *Eucalyptus* clones and it was found that content of P was higher in the microbial inoculants applied *Eucalyptus* clones.

Diversity of Mycorrhizal Associations with *Dipterocarpus* and *Shorea* Species in Assam

The survey and collection work was carried out in two study sites: Site-I includes Amsoi, Kulsi, Dhupdhara for *S. robusta* and site -II includes Jeypore, Digboi and Margerita for *D. retusus* and Jeypore for *S. assamica*). Composite samples (24 nos.) of rhizosphere soil, composite samples of ectomycorrhizal roots (24 nos.) and ECM fruit bodies (12 nos.) were collected from the selected sites. Morphological and anatomical details of ECM roots and ECM fruit bodies were worked out for their proper identification and taxonomic details. Russula species was reported to be associated with all selected tree species, therefore, it was selected for nursery trials. Mass inoculum of Russula species was raised on wheat grains in polypropylene bags.

Rhizosphere soil was analyzed for the isolation, quantification and colonisation of AM with roots of selected plant species. *Glomus* sp. was most dominant strain reported but percent colonisation was fewer (2-4%). Mother inoculum of AM fungi was raised with living host (wheat) in small earthen pots (10 Nos., 650 g capacity). Mass inoculum of AM fungi for nursery trials was raised in bigger earthen pots (4 Kg capacity, 25 nos.) with living host (wheat). Seeds (500 nos.) of *Dipterocarpus retusus* and *Shorea robusta* were collected and sown in nursery bags (20x21 cm) filled with sterilized soil. To observe the efficacy of mycorrhizae with selected host species, four sets of experiments were laid: (i) Control (not inoculated), (ii) Inoculated with Ectomycorrhizal fungi, (iii) Inoculated with Endomycorrhizal fungi and (iv) Inoculated with Ecto + Endomycorrhizal fungi.

Mass Inoculum of *Russula* sp.

Mass Inoculum of *Glomus* sp.

Nursery Trials

Seed of *S. robusta*

Soil Sterilization

Seeds of *D. retusus*

Arbuscular Mycorrhizal Diversity in Meghalaya

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* L. and *Aquilaria agallocha* Roxb.) are being raised by inoculation experiment with VAM fungi.

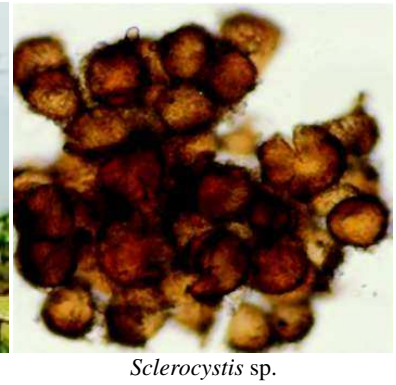
Collection of Rhizospheric Soil Samples

AM Fungi and Rhizobium for *Acacia nilotica* and *Ailanthus excelsa* in Western Rajasthan

Rhizosphere soil and root samples of *Acacia nilotica* and *Ailanthus excelsa* were collected from various forest nurseries viz; AFRI model nursery, Bhuteshwer nursery, Jodhpur; Navalgarh forest nursery, Jhunjhunu and high tech nursery of Forest Department. Sojat Road (Pali). In plantations, rhizospheric soil samples of *Acacia nilotica* var. *indica* were collected from various sites viz., Nagaur (4), Bikaner (2), Barmer (3), Pali (5) and Sirohi (5 sites) districts. For *Acacia nilotica* var. *cupressiformis,* samples were collected from Nagaur (1), Pali (5 sites) and Sirohi district (5) and samples of *Ailanthus excelsa* from Nagaur (1), Bikaner (1) and Barmer (3) district. Soil samples were analyzed for pH, EC, (%) organic carbon (% OC), phosphorous (P) and isolation of AM fungi carried out. The important genera identified were *Acaulospora, Gigaspora, Glomus* and *Sclerocystis*. Among these four genera, *Glomus* occurred most frequently. The different species of *Glomus* were recorded as *G. aggregatum, G. fasciculatum, G. mosseae, G. macrocarpum G. microcarpum*, *G. constrictum* and *Glomus* sp. Out of which, *G. fasciculatum* was dominant species in all the sites of nurseries as well as in plantations. The spore population varied from site to site and ranged between 163 to 480 propagules per 100 g soil.

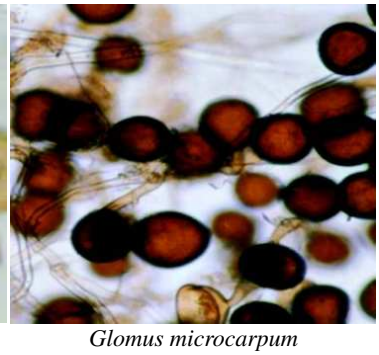
Acacia nilotica var. *indica* at Sirohi

Acacia nilotica var. *cupressiformis* at Pali

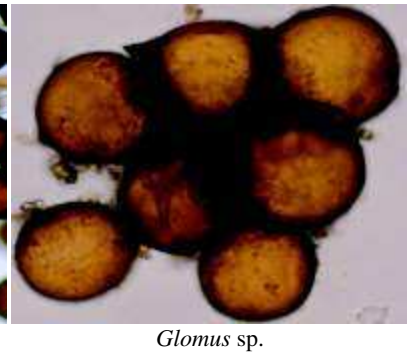


Sclerocystis sp.

Glomus aggregatum



Glomus microcarpum



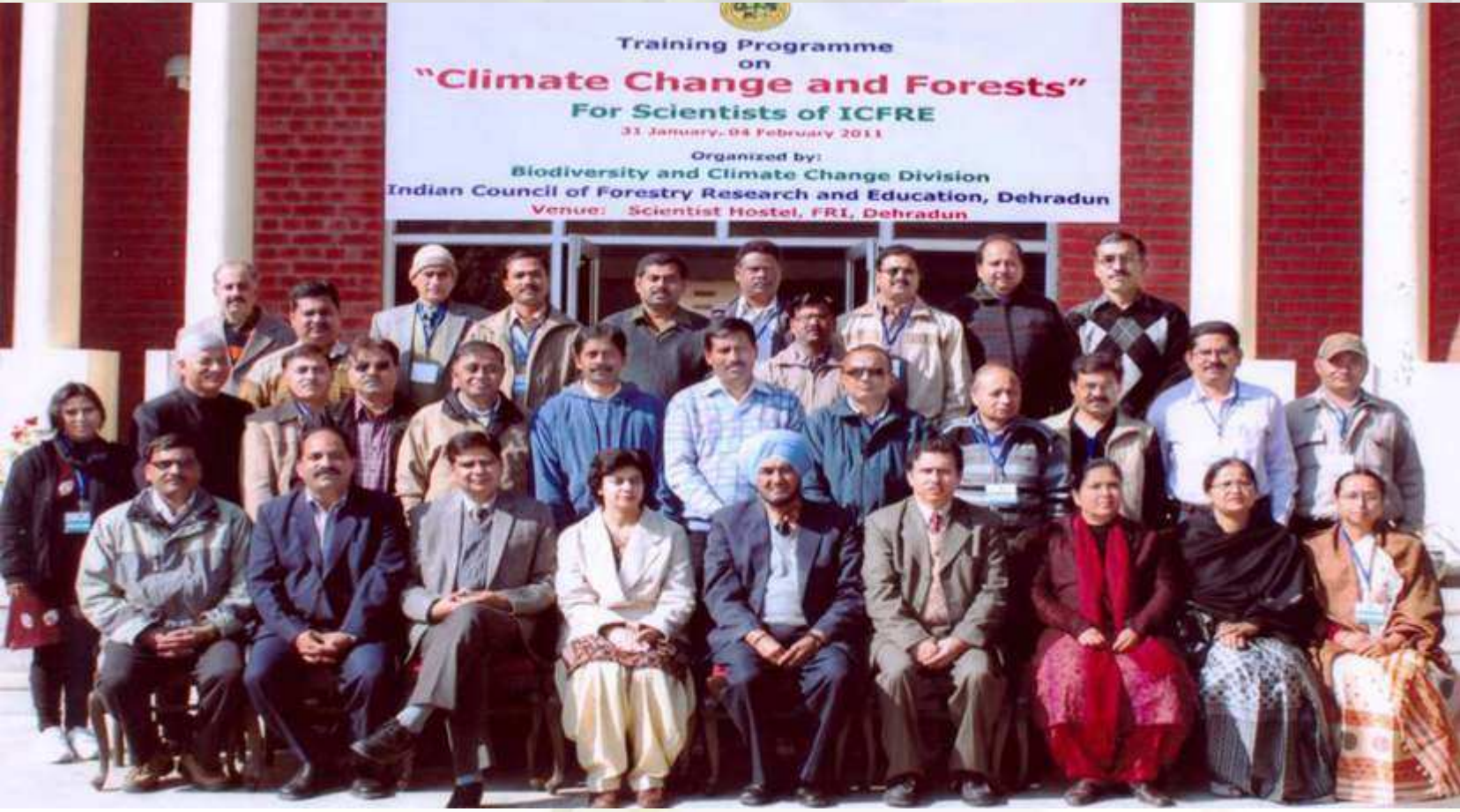
Glomus sp.

Frankia

The technique developed to inoculate and establish the association of *Frankia* successfully with the rooted cuttings of casuarina was tested in a nursery trial using 10 strains of Frankia isolated from *C. equisetifolia* and *C. junghuhniana*. In the trial, 93 clones of *C. equisetifolia* and seedlings of *C. junghuhniana* were used. Nodulation occurred both in the rooted stem cuttings of *C. equisetifolia* and seedlings of *C. junghuhniana* after 30 days. Further, the data collected on growth parameters showed increased shoot length, root length, collar diameter and biomass with the Frankia inoculated seedlings. Analysis of nitrogenase activity of 10 strains of *Frankia* showed that the strains collected from the coastal and stressed sites had higher nitrogenase activity (137.57 to 256.18 nmol of C2 H4 mg protein/hr). Similarly, estimation of nitrogen content of the *Frankia* inoculated seedlings showed an average of 0.159 mg/g of Nitrogen content. A field trial has been established at Karaikal with *Frankia* inoculated seedlings of *C. equisetifolia* and *C. junghuhniana.*

Frankia Nodule Formation in Rooted Stem Cutting of Casuarina

Frankia Structure



EDUCATION VISTAS

EDUCATION VISTAS

Introduction

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 programmes. Initially, the universities imparting forestry education were supported by the grants released by ICAR. However, after grant of autonomy to the ICFRE, pursuant to its mission objective the Directorate of Education, ICFR has been been mandated to galvanize forestry education in the country through State and Central Universities in order to develop technical capabilities and strengthen infrastructure for forestry faculties in the universities imparting forestry education at the graduate and postgraduate levels. The Directorate of Education being an important part of the ICFRE also nurtures Forest Research Institute (D) University into an institute of excellence in higher learning in forestry. It provides financial support in the form of Grant-in–aid to improve gap-filling infrastructure to different universities. Other activities of Directorate of Education, ICFRE are to enhance quality of forestry education by continuously striving for improvements in curriculum, to provide a frame work 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 main streaming of forestry across sectors, to attract talent into forestry as a profession, to provide avenues for capacity building to the scientific and technical cadre of the council and of the sector in general and to provide policy research support to the ministry.

Processes in Forestry Education

For achievement of the mandate, the Directorate has a processes of creating infrastructure for universities for giving impetus to Forestry Education, matching international standards for forestry education and providing access to international level teaching and learning resources, including books and journals through e-consortium and information system. In addition to these, other processes include :

- 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.
- 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.
- 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.
- Design Development and Execution of Mid Career Training of Indian Forest Service phase-III as Lead Training Organization.

Forestry Education

- The Directorate of Education is providing Grant-in-aid to the Universities for promoting Forestry Education in the Country. Towards this end, ICFRE released Grant-in-aid to the tune of Rs. 204.088 lakhs to 10 Universities in the financial year 2010-11. Also obtained Utilization certificates from 10 universities and Revalidations were issued for14 universities for the balances available with them for utilization in the current financial year.
- Encouraged Universities to get accreditation with ICFRE, as a new initiative of quality control in forestry education for the first time through Accreditation Board of ICFRE. The accreditation process completed for 9 Universities and certificates issued. The proposals for accreditation of 9 more Universities have been received.

HRD Initiatives

- As part of the HRD initiatives for capacity building of scientific personnel, 11 training programme (including 1 training of MCT Phase-III) were organized in a number of training organizations of repute, in which 207 participants (including 60 participants of MCT) were trained in 8 Institutions.
- In order to provide wide national exposure to the scientists, a total of 71 permissions were accorded at Council level for participation of scientists in national level seminars, workshops and symposia etc.
- Facilitated 44 cases of foreign visits, which were finally approved by the Government of India with funding from a number of sources providing a much needed international exposure to the scientific cadre.

Mid Career Training of IFS

- ICFRE has been entrusted with Mid Career Training Project for IFS officers for phase III, by providing best institutional arrangement and partnership with Institutions like WII, Dehradun, FSI Dehradun, IIM-Ahmedabad, Colorado State University (US) and Swedish University of Agricultural Sciences (SLU) Sweden.
- ICFRE has the distinction of organizing second such programme as Lead training provider from 31st January 2011 to 4th March 2011.

Policy Research

- Organized two Evaluation Committee meetings at ICFRE on 29th September 2011, 25th November 2011 and 4th Policy Research Committee meetings at Van Vigyan Bhawan, New Delhi on 30th March 2011respectively.
- ICFRE hosted the National Forest Rights committee, jointly constituted by MoEF & MoTA. After detailed deliberations, consultations, meetings across 17 States, the committee submitted its report "MANTHAN" to the Hon'ble Minister of Environment & Forests, Govt. of India in January 2011 (details of meetings enclosed).

H.R.D.

As part of the HRD Initiatives, the ICFRE Organized Following Specialized Training Programme for Scientists and Forest Officers from 1.4.2010 to 31.03.2011 as follows ;

S. No	Training	Dates	Institution	No of participants
1	Training on maintaining roaster for SC/ST/OBC	30 and 31 August 2010	SC/ST Commission Lkw at ICFRE, D.Dun	21
2	Climate Change & Carbon Mitigation (CCCM)	06 to 10 September 2010	BCC Divn ICFRE D.Dun	5
3	Training of staff RAI, RAII & TAI on Laboratory Management	13 to 17 September 2010	FRI, D.Dun.	25
4	Climate Change & Carbon Mitigation (CCCM) for Women Scientists & Technologists	06 to 10 September 2010	BCC Divn ICFRE D.Dun	7
5	Training of staff RAI, RAII & TAI on Laboratory Management	06 to 10 December 2010	TFRI, Jabalpur	25
6	Training on 'Wood Property Characterization'	03 to 07 January 2011	IWST, Bangalore	5
7	Training on 'Nanotechnology'	18 to 20 January 2011	IWST, Bangalore	7
8	Training on 'Climate Change & Forests'	31 January 2011 to 04 February 2011	BCC Divn, ICFRE D.Dun	20
9	Training on 'Remote Sensing & GIS Application'	31 January 2011 to 11 February 2011	Indian Institute of Remote Sensing, D.Dun	7
10	Induction Training for Scientists & Research Officers of ICFRE	21 March2011 to 27 March 2011	FRI (Deemed) University, D.Dun.	
11	Mid Carrier Training for IFS Officers	31 January 2011 to 04 February 2011	Dte of Edu, ICFRE at IGNFA, D.Dun	60
			Total	207

Grant-in-Aid

ICFRE has been giving Grant-in-aid to various forestry research universities/ institutions under Agricultural Universities offering Undergraduate and Postgraduate Courses to strengthen the infrastructure for giving impetus to Forestry Education in the country. During the period April 2010 to March, 2011 Rs. 204.088 lakh have been released to 10 Universities as Grant-in-aid. Unutilized grant revalidated to 14 universities and permission for diversion of grant from one head of account to another has been issued to 04 Universities.

ICFRE Accreditation Board

The Directorate of Education has also undertaken the work of evaluation of the Forestry Courses being run in the Universities under the programme "Accreditation of course programme" by constituting as follows:

S.No	Name of College/University	Team	Date of visit
1.	CCS Haryana Agricultural University, Hisar (Haryana)	1. Sh. Omkar Singh, DDG(Edu) ICFRE & Chairman 2. Dr. T.C. Pokhriyal, Former Scientist-F, FRI, D.Dun	08 – 11 February 2011
2.	Orissa University of Agriculture & Technology, Bhuvneshwar (Orissa)	1. Sh. Omkar Singh, DDG(Edu) ICFRE & Chairman 2. Dr. J.K. Rawat, IFS (Retd.), Former Director, FRI, D.Dun	19 to 21 May 2010
3.	Kumaun University, Nainital (Uttarakhand)	1. Sh. R.K. Dogra, ADG(Edu) ICFRE & Member Secretary 2. Dr. A.N. Shukla, Former HoD, Path. Divn., FRI, D.Dun	23-24 April 2010
4.	Central Agricultural University, College of Horticulture & Forestry, Pasighat (Arunachal Pradesh)	1. Sh. R.K. Dogra, ADG(Edu) ICFRE & Member Secretary 2. Sh. R.P.S. Katwal, Former D.G., ICFRE, D.Dun	27 October 2010 to onwards
5.	Punjab Agricultural University, Ludhiana (Punjab)	1. Sh. Omkar Singh, DDG(Edu) ICFRE & Chairman 2. Dr. J.D.S. Negi, Former Scientist-F, FRI, D.Dun	21 to 24 September 2010
6.	College of Forestry, Dr. BSS Konkan Krishi Vidyapeeth, Dapoli (MS)	1. Sh. R.K. Dogra, ADG(Edu) ICFRE & Member Secretary 2. Sh. R.P.S. Katwal, Former D.G., ICFRE, D.Dun	24 to 26 August 2010
7.	College of Horticulture & Forestry, Navsari Agricultural University, Navsari (Gujrat)	1. Sh. Omkar Singh, DDG(Edu) ICFRE & Chairman 2. Dr. S.D. Bhardwaj, Former Dean, Dr. YSP U.H.F., Solan (HP)	09 November 2010 to onwards

Policy Research Study

- First presentation on the outcome of preliminary study, desk review and response of the field study of Policy Research Study 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" by the consultant of Environ Legal Defence Firm Noida, before the Evaluation Committee of ICFRE under the Chairmanship of DDG(Edu) was organized on 29th September 2010 in the Committee Room of ICFRE.

- Second presentation on the outcome of preliminary study, desk review and response of the field study of Policy Research Study 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" by the consultant of Environ Legal Defence Firm, Noida, before the Evaluation Committee of ICFRE under the Chairmanship of DDG(Edu) was organized on 25th November 2010 in the Committee Room of ICFRE.
- Fourth Policy Research Committee meeting on 30th March 2011 at Van Vigyan Bhawan, New Delhi, under the Chairmanship of the Additional Director General (FC), MoEF, New Delhi was organized.
- The 1st meeting of National FRA Committee was organized on 3rd May 2010 in the Conference Room No. 403, Paryavaran Bhawan, New Delhi under the chairmanship of Dr. N.C. Saxena, Retd. Secretary, Planning Commission.
- Second National FRA Committee Meeting (joint Committee of Ministry of Environment & Forest and Ministry of Tribal Affairs) was organized on 7th June 2010 at Van Vigyan Bhawan, NewDelhi.
- Third National FRA Committee meeting (joint Committee of Ministry of Environment & Forest and Ministry of Tribal Affairs) was organized on 9th August 2010 at Van Vigyan Bhawan, New Delhi.
- Fourth National FRA Committee meeting (joint Committee of Ministry of environment & Forest and Ministry of Tribal Affairs) was organized on 14th September 2010 at Van Vigyan Bhawan, New Delhi.
- Fifth National FRA Committee meeting (joint Committee of Ministry of Environment & Forest and Ministry of Tribal Affairs) was organized on 13th October 2010 at Van Vigyan Bhawan, New Delhi.
- Sixth National FRA Committee Meeting (joint Committee of Ministry of Environment & Forest and Ministry of Tribal Affairs) was organized on 16th November 2010 at Van Vigyan Bhawan, New Delhi.
- Meeting of sub-group for drafting the report of National FRA Committee (joint Committee of Ministry of Environment & Forest and Ministry of Tribal Affairs) was organized on 3rd December 2010 at Van Vigyan Bhawan, New Delhi.
- Meeting for report discussion and final report preparation of National FRA Committee (joint Committee of Ministry of Environment & Forest and Ministry of Tribal Affairs) was organized from 12th to 15th December 2010.

3.1 FRI (Deemed) University

Forest Research Institute, Dehradun was conferred the status of University by the Ministry of Human Resource Development, Government of India, New Delhi vide Notification No. F.9.25/89 U-3 dated 06-12-1991. After the conferment of Deemed University status, academic activities of the Institute have increased tremendously and it has been fostering research and education in forestry, environment and other allied disciplines in a more meaningful and productive way. The University has been fostering pioneering research in specialized areas under Ph. D. Programme.

Academic Courses 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 one year courses in Post Masters Diploma in Natural Resource

Management, and Post Graduate diploma in Aroma Technology.

Admissions to M.Sc. Courses are made on the basis of all India Competitive Entrance Test During the year 2010-2011, 165 students were admitted in all the above six courses for the academic session 2010-2012. The course wise strength is as follows:

1. M.Sc. Wood Science & Technology - 35
2. M.Sc. Environment Management - 35
3. M.Sc. Forestry - 35
4. PMD in Natural Resource Management - 20
5. PGD in Pulp & Paper Technology - 20
6. PMD in Aroma Technology - 20

Course Plan: Course plan of all the courses were prepared accordingly to syllabus. Internal and External faculties were invited for taking classes. Theory and practical classes were arranged from July to December 2010 for the students of Ist and 3rd Semester and from January to May 2011 for the students of 2nd and 4th Semesters.

Special Lectures: Special lectures arranged on the following specific topic for all courses.

- "WST challenges and opportunities" delivered by Dr. S. C. Joshi, IFS, Director, IWST, Bangalore for the students of WST courses on 12th May 2010.
- "Management of Forests in USA" delivered by Prof. Rene Germaine on 7th June 2010. It was attended by the Research Officers and Scientists of FRI along with the students of FRI (Deemed) University.
- "Clean Development Management" lecture delivered by Mr. Vijay Anand on 19th August 2010.
- "Personality Development" lecture delivered by Dr. K. L. Aryan, Director Institute of Communication & Management, for the students of M.Sc. Forestry and M.Sc. Environment Management.
- "Definition of Forests" lecture delivered by Dr. K.S. Sethi, DIG, Forest Policy, MoEF, New Delhi to the all students of FRI University on 22nd October 2010.
- "Tiger Conservation Programme in India" delivered by Dr. Gardon M. Hickey on 13th October 2010.
- Special talk delivered by Dr. S. Chandola, IFS, PCCF and Chief Wildlife Warden, Govt. of Uttarakhand on 4th October 2010 on the eve of Wildlife Week 2010.
- Personality Development" delivered by Dr. K. L. Aryan, Director, ICM to all the M.Sc. students in January and February 2011.
- "Conservation Oriented Research in the field of Human Wild Life Conflict, Herpetology, ornithology and lepidopteron entomology" delivered by Mr. Sanjay Sondhi, Teetle Trust Organization, Dehradun to all the students of on 12th February 2011.
- "First Aid and Industrial Disasters" delivered by Dr. Atul Aalok, CMO, New Forest Hospital, FRI, Dehradun to the students of M.Sc. WST from 01st to 4th March 2011
- "Orchid Conservation in India" delivered by Dr. K. S. Shashidhar, IFS, Chief Wildlife Warden Nagaland, to the students of M.Sc. Forestry on 1st March 2011.
- "Vocational Studies" delivered by Dr. Ernest Kruistan, Incharge Officer of Vocational Studies in Germany on 11th March 2011
- "Near Infrared Spectroscopy" delivered by Dr. Laurence R. Schimleck, Associate professor, University of Georgia on 8th March 2011.

Study Tours / Excursions

One day study tour /excursion were arranged to the following places during the period 1st April 2010 to 31st March 2011 for the University students.

1. Wadia Institute of Himalayan Geology on 18th and 19th August 2010.
2. Watershed Works at Sahastradhara on 26th July 2010.
3. Jodhpur, Ahmedabad, Mysore and Bangalore from 22nd August to 10th September 2010.
4. Valley of Flowers from 6th to 9th September 2010 and 29th August to 3rd September.
5. Paper & Plywood Industries in Yamuna nagar on 20th August 2010.
6. Delhi from 29th and 30th September 2010.
7. Song Valley (Raipur – Kumalda) on 9th October 2010.
8. Dhanolti on 14th October 2010.
9. Sahanshahi Ashram, Dehradun on 14th October 2010.
10. Rajaji National Park, Dehradun on 17th November 2010.
11. Northern Uttar Pradesh in third week of November 2010.
12. Tehri Dam in November 2010.
13. Yumuna Nagar and Saharanpur from 11th to 13th February 2011.
14. Rajaji National Park, Dehradun on 11th February 2011.
15. Faridabad, Jaipur and Jodhpur from 12th to 19th March 2011.
16. Rishikesh on 4th March 2011.
17. Baddi, Himachal Pradesh from 9th to 12th March 2011.

Foreign Visits

Ms. Anisha Biswarya student of M.Sc. EM, 4th Semester (2009-11) visited Canada for dissertation work from February to May 2011.

Term Papers

1. M.Sc. students completed their term papers and submitted them in June 2010.
2. Post Master Diploma course students completed term papers in December 2010 and submitted the same.

Sports Meet

Sports meet was organized by University from 17th to 27th March.

- Indoor games conducted from 19th to 22nd March 2011 and outdoor games from 23rd to 27th March 2011.
- Cricket Matches organized from 17th to 21st March 2011 on the University cricket Ground.
- Closing Ceremony of Sports meet was organized on 27th March 2011.

Seminars

- M. Sc. Environment Management students participated in National Seminar on the topic "Landscape restoration process – challenges and opportunities" at FRI, Dehradun on 22nd and 23rd February 2011.
- M. Sc. WST students participated in National Seminar on the topic "Advances in Wood Science & Technology Research: Recent Trends, Future Challenges and opportunities" at FRI, Dehradun on 09th and 10th March 2011.

Industrial Attachment/Institutional Attachment/ Mill Visit

- Industrial attachment for M.Sc. WST 3rd Semester arranged in December 2010.
- Institutional attachment for M.Sc. Forestry & M.Sc. Environment Management 3rd Semester arranged in December 2010.
- Paper Mill visit arranged for PGD in Pulp & Paper Technology in December 2010.
- Industrial training and project work for Post Masters Diploma in Aroma Technology course, 2nd Semester arranged from January to June 2011.

Dissertations/Project Works

- Dissertation and Project work carried out by the final semester students of all M.Sc., PMD and PGD courses from 1st March to 31st May 2010.

- Project work Seminars of all courses conducted in the month of June 2010.

Induction Training

Forest Research Institute (Deemed) University Organized 10 weeks Induction Training of Scientists and Research Officers of ICFRE from 21st March to 27th May 2011: During the training, lectures delivered on many important topics related to Forestry, Genetics, Remote Sensing, Forest Policy & Law, Forest Survey, Wildlife, Biodiversity and Soil Science. Subject experts were invited for special lectures from different institutions like Forest Survey of India, Wildlife Institute of India, Indian Institute of Remote Sensing, Indira Gandhi National Forest Academy, CASFOS and Central Soil and Water Conservation Training and Research Institute.

Tours

- Trainees of Induction Training visited different division of FRI i.e. Non Wood Forest Product Division, Genetics and Tree Propagation Division, Botany Division, Forest Entomology Division, Forest Soil & Land Reclamation Division, RSM Division, Silviculture Division, Chemistry Division, Forest Pathology Division, Forest Ecology & Environment Division, Botany Division, Bio-Informatics Centre & GIS Cell and Cellulose & Paper Division etc.
- Long educational tour was conducted to South India for visits to IFGTB, Coimbatore, IWST, IPIRITI and IISc., Bangalore.
- Trainees of Induction Training visited Field Research Station (ICAR). With Dr. Madhu Agronomist ICAR and Shri. M.C. Pandey (Retd. CCF) Uttar Pradesh.

Other Activities

Introductory meeting was called by Dean (Academic) along with the course coordinators for the newly admitted students of FRI University in July 2010 and for students of PGD in Aroma Technology and Pulp & Paper Technology on 23rd August 2010 to welcome them and also make them aware regarding university & hostel rules and regulations.

Extra Curricular Activities

- FRI (Deemed) University celebrated Wildlife week from 2nd to 8th October 2010.
- Students of "Wildlife Club" of University attended a Voluntary Camp at Sahastradhara, Dehradun for treatment of injured animals.
- FRI (Deemed) University celebrated the "World Forestry Day" on 21st March 2011 and organized Quiz and poster presentation for the students.

Compulsory Course for Ph.D and Research Scholars:

Compulsory course for Ph.D. and Research Scholars in Forestry, Statistics and Computer Application was conducted from 15th September to 31st December 2010.

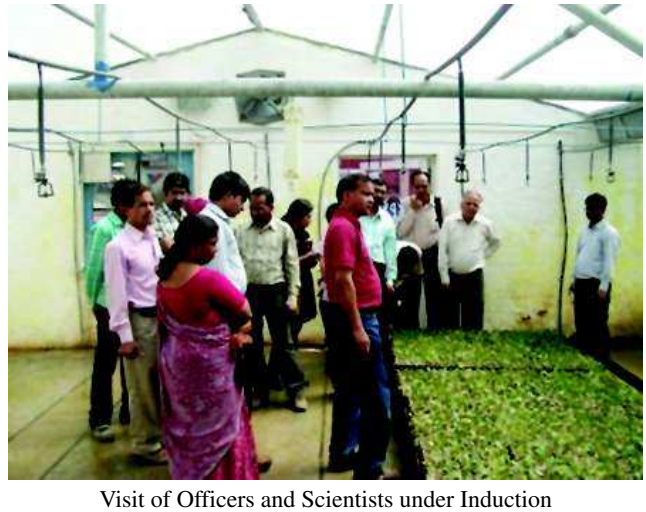
Placements

- Placement brochure prepared for all M.Sc. and Diploma courses.
- Placement brochure with student's profile was sent to different Organizations/ Industries/ Companies/ NGO's and contact them through phone/ fax/e-mail to conduct Campus Interview was maintained.
- Campus Interview was conducted with different Organizations/ Industries/ Companies/ NGO's and placement of students for academic year 2010-2011 carried out.

Placements 2011

S. No.	Institution	Selected Students	Course
1.	M/s Sudima International, Singapore	A. Raghupthi Amey Kale Amol Rangrari Mukesh Rawat	M.Sc. WST
2.	M/s CHEP International, Bombay	Vinoth V.	M.Sc. WST
3.	M/s Century Plywood, Kolkata	Arnab Chatopadhyaya Arun Kumar Vidya Sagar Surbhi Shravan	M.Sc. WST
4.	M/s Sharda Plywood, Kolkata	Kazhi Shahabuddin Prem Kumar * one name awaited	M.Sc. WST
5.	M/s C.L. Gupta, Moradabad	Bijendra Narayan Tyagi	M.Sc. WST
6.	M/s Aggarwala Timbers, Gandhi Dham	Nitesh Nandana Kumar	M.Sc. WST
7	M/s Paharpur Ltd, Kolkata	Result awaited	
8	ACF, Sikkim	Arti Basneth	M.Sc. Forestry
9.	M/s ABC Paper Mills Ltd., (Hoshyarpur)	Result awaited	M.Sc. WST
10.	Dy. Commandant CRPF	Anisha Siddhik	M.Sc. Forestry

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

3.2 Trainings Organized

FRI, Dehradun

- The second Distance Learning Programme on Remote Sensing, Geographical Information System and Global Positioning System was conducted from 4th October to 9th December 2010 for the students of FRI University. Twenty seven students participated in this programme which consisted of 4 modules, viz., Remote Sensing & Digital Image Processing, Global Positioning System, Geographical Information System and RS & GIS Application.
- Remote Sensing & GIS training for the scientists and officers of the Institute.
- Computer application for the employees of the Institute.
- Training on Afforestation Techniques for Ecotask Force personnel of Territorial Army from 20th to 23rd April 2010.
- Training on Tree Seed Technology from 17th to 21st May 2010.
- Training on Seed and Nursery Technology for IGWDP-NABARD officials from Rajasthan from 6th to 10th September 2010.
- Training on Nursery and Plantation Technology for SSB personnal from 27th September to 1st October 2010.
- Training on Afforestation techniques for Ecotask Force personnel of Territorial Army from 26th to 29th October 2010.
- Organized training on "Forest Fire Management." Sponsored by National Institute of Disaster Management, New Delhi for Officers from different States on 6th to 10th December 2010.
- One-day interactive meeting for developing a network on Shisham mortality was organized on September 21, 2011, which was attended by scientists from HAU, Hissar; Dr. Y S Parmar University of For. & Hort., Nauni, Solan; G. B. Pant Univ. of Agr. & Tech., Pantnagar; ICFRE Institutes (Jodhpur, Jorhat, Jabalpur, Ranchi and Allahabad); Forest Officers from Haryana, Punjab, Uttarakhand and Uttar Pradesh forest departments and Scientists of concerned Divisions of FRI.
- One-day training programme on cultivation of *Ganoderma lucidum* was conducted on 11th March 2011 for local mushroom growers and farmers (21 No.)
- Five days training from 3rd to 7th May 2010 on "Bamboo Resources and Propagation" was organized to the forest officers of Haryana Forest Department.

- Five days training from 10th to 14th May 2010 on "Bamboo Resources and Propagation" was organized for Punjab Forest Department at Forest Research Institute.
- Short term training was organized on ` Low cost clonal propagation technologies for NDMC, New Delhi.
- A short term training programme on "Management of Herbarium and Arboreta" between 10th to 14th May 2010.
- A short term training programme on "Development of Green Belt" between 16 to 20 August 2010.
- A DST funded training programme on "Capacity Building in Plant taxonomy" between 27th September to 8th October 2010.
- Tissue Culture of Important Forest Trees, Bamboos and Medicinal plants" was organized between December 13 to 17, 2010.
- Organized 5 days training programme on handmade paper from Lantana camara from 7th to 11th June 2010 sponsored by Department of Science and Technology (DST), New Delhi.
- Training organized by NWFP Division on "Value addition, cultivation and Marketing of Medicinal plants" during 7th to 11th December 2010.
- The NWFP Division organized Training for Farmers on cultivation, value addition and utilization of *Thymus serphyllum.* 22nd March 2011.

Training on Cultivation of *Thymus serphyllum*

- A five days Training-cum-Workshop on "Essential oil, Perfumery and Aromatherapy" jointly organized by Chemistry Division, FRI in collaboration with FFDC, Kannauj on 31st May 4th June 2010 at FRI, Dehradun.
- Hands-on Training to Prepare Handmade Paper and its conversion to various products for NGO's.
- Display of Technology of Natural Dyes and Compost to Honuorable Union Minister of Environment and Forest Govt. of India during All India Meet of National Biodiversity Authority MoEF, GOI and States Biodiversity Boards on 6th September 2010 at Chandigarh.
- Demonstration of Natural Dye and Herbal Gulal Technology to ETV which was broadcasted on 22nd September 2010.
- Training-cum-Workshop on "Applications and Benefits of SAMRIDDHI- A Silk Productivity Enhancer" at Bhudwala and Bhud villages of Vikas Nagar for Silkworm farmers on 27th March 2011.
- A five days short term training course on "Wood Seasoning" was organized by the Division during 25th to 29th October 2010 in which 12 participants from Naval Dockyard, Mumbai and Naval Ship Repairing Centre, Kochi participated. Apart from seasoning other related topics like Wood Preservation, mechanics, finishing and composites were also introduced to the trainees by the faculty of the Forest Products Division.
- A five days Short term training course on "Classification and grading of timbers" was organized by Timber Mechanics Discipline, Forest Products Division, FRI from 6th to 10th December 2010. In this training, 23 personnal from Naval Dockyard, Mumbai, Naval Ship Repair Yard, Naval Base, Kochi, Himachal Pradesh State Forest Corporation Ltd.,

Shimla, Garden Reach Shipbuilders & Engineers Ltd., Kolkata participated.

- Training on "Ecorestoration of Wastelands"
- Training on "Bioremediation and Environment Amelioration"
- Organized technical meeting cum workshop on "Remediation of the waterlogged site through Biodrainage" with farmers at selected water logged site (Dated 16th March 2011).

IFGTB, Coimbatore

- A training on "PCR Based Gene Isolation Techniques" on 29th and 30th July 2010.
- A five days "Training Workshop on Conservation and Management of Forest Genetic Resources" from 5th to 9th July. The Training Workshop was cosponsored by the ICFRE, Forest Research Institute, Malaysia (FRIM), APAFRI, Bioversity International and International Timber Trade Organization (ITTO). 21 researchers/officers from 7 countries participated in the Workshop. The details of participation is as follows, India – 6, Cambodia - 3 , Indonesia – 3, Malaysia – 3, Myanmar – 2, Philippines -1, Thailand -3.
- Two training workshops to the officials of forest department, wood-based industries and farmers on production of genetically improved seeds and seedlings at IFGTB on 12th and 13th August 2010 under the AusAID-funded project. Mr.K. Pinyopusarerk from CSIRO, Australia functioned as a Resource Person for the two training programmes.
- A training programme on "Clonal Forestry" to the officials of Tamil Nadu Forest department on 21st December 2010. About 37 officials attended the training.
- A training programme on "Importance of Biodiversity, its Conservation and Sustainable Utilization" for students and teachers of Govt. Schools and Govt. aided Schools in Tamil Nadu was conducted on the following dates, by utilizing the amount made available by the Directorate of Environment, Chennai.

  4th and 5th August 2010 - 36 Participants
  11th and 12th August 2010 - 40 Participants
  18th and 19th August 2010 - 33 Participants
  25th and 26th August 2010 - 29 Participants
- An Environmental Awareness Programme was conducted to the Students of Panchayat Union Elementary School, Kandiyoor on 30th March 2011.
- A two days training works shops on "Management of Forest Resources for Indian Forest Service Officers sponsored by the Ministry of Environment and Forest was conducted on 18th and 19th October 2010.
- An "Introductory ArcGIS Training Program from 11th and12th January 2011 for scientists of IFGTB, Coimbatore.
- One day orientation programme for the faculty and students of the Dept. of Zoology, Govt. Arts College, Coimbatore, on 6th August 2010.

Training Programme on "Instrumentation Methods and Chemical Analysis"

- Two days Intensive Hands on Training Program on "Instrumentation methods and chemical analysis" on 27th and 28th September 2010 at IFGTB. About twenty participants including students, and research scholars from different colleges and universities had participated and benefited.
- As part of the training, Dr. Annadurai, CEO, Prescient Biosciences, Bangalore, delivered special lecture on "Emerging Opportunities in Biosciences" to the training participants, JRFs, Officers and scientist of IFGTB on 28th September 2010.
- A two weeks Training on "Ectomycorrhizal Fungi – Isolation, Identification, Pure culture and Mass production and Application methods in tissue culture, nursery and field" was organized to a Women Young Scientist, FRI, Dehradun at IFGTB, Coimbatore on 14th to 26th March 2011.

IWST, Bangalore

- Short term training on "Instrumentation Techniques for Phytochemical Analysis" from 14th to 16th December 2010 at the Institute. Seven participants attended the training from different colleges affiliated to Bangalore University and Kuvempu University.
- A specialized training on "Wood Property Characterization" for Five ICFRE Scientists from 3rd to 7th January 2011.
- A specialized training on "Wood Finishing" was conducted during 27th and 28th January 2011. Participants from High Build Coating Private limited (7 no.) attended the training programme.
- Short term training on "Sandal Seed and Nursery Technologies" at the Institute from 21st to 25th February 2011. Thirty participants participated.
- Conducted Course Coordinator for the compulsory training of Ph.D. scholars working under FRI University at IWST Bangalore
- Training to farmers and tree growers from different regions of the country on Chemistry and utilization of sandal was imparted on 22nd November 2010 and 21st February 2011.
- Dr. R. Sundararaj delivered lectures on "Management of Pests in Sandal nursery" to the trainees of "Modern Seed and Nursery Technologies" on 22nd February 2011
- Compulsory training course on "Computer Applications" for Research Scholars of FRI University in 15th September to 24th December 2010.
- One day training programmes on "IFRIS (Research Information System Module) Implementation" for Scientist on 22nd April 2010 and 13th July 2010 at IWST, New Computer Lab Bangalore.
- One day training programme on "IFRIS (Research Information System Module) new Project updating" for Scientist on 8th December 2010 and February 2011 at IWST, New Computer Lab Bangalore.
- Six months compulsory training programme for research scholars of FRI Deemed Univeristy.
- Two training programmes on 'Impact of Bauxite Mining on Environment and Management Measures, and Socio-economics and Ecological Aspects on the Exploitation of the Bauxite in the Traibal Areas' for the Andhra Pradesh Mining Development Corporation tribal trainees from Araku Valley on 1st October 2010

TFRI, Jabalpur

- Training on vermicompost/ biofertilizers at Bhaisajhar Nursery, Bilashpur on 17th and 18th May 2010 to the trainees of CGRVVN Ltd.

- Training on "Recent Advances in Nursery Techniques" for Staff of TFRI at TFRI, Jabalpur from 27th to 29th May 2010.
- Training on "Non-destructive Harvesting, Processing and Value Addition of NTFPs Including Medicinal and Aromatic plants" for Orissa Forestry Sector Development Project Officials at Rourkela and Talchar, Orissa on 16th to 18th and 20th to 22th September 2010 respectively.
- Training on "Bamboo Based Silvi-agri System and Medicinal Plant Based Silvi-medicinal System" to the farmers of Majhauli under the NABARD training programme at the institute on 21st December 2010.
- Training on "Agroforestry research Experiments" to the Forest Guards Trainees of Balaghat district, M.P. on 2nd February 2011 at the Institute.
- Training on "Environment and Afforestation" for NTPC officials during 22nd to 24th March 2011 at the Institute.
- Training on "Integrated Development of Jatropha and Karanja" for trainers and farmers at Gwalior and Guna, M.P. respectively.
- Training on "Sustainable Harvesting of Gums and Oleoresin of Salai, Dhawara and other Gums" on 27th and 28th, and 29th and 30th March 2011 at Sheopur-Kala (M.P.).
- Training on "Environmental Issues & Green Solutions and Cultivation of Medicinal Plants & Processing" on 05th June 2010 at the Centre, Chindwara.
- Training on "Soil Conservation & Watershed Management" on 26th July 2010 at the Centre.
- Training on "Naturalists & Guides of Bhariya Tribes of Patalkot, Chhindwara (M.P.)" from 26th July to 4th August, 2010 at the Centre.
- Training on "Agroforestry with Reference to Medicinal Plants" by the Centre on 20th and 21st January 2011.
- Training on "Cultivation of Medicinal and Aromatic Plants" at the centre on 28th January2011.
- Training on "Biofertilizers and Biopesticides" at the Centre on 24th February2011.
- Training on "NWFP value Addition, Processing and Marketing" at the Centre on 4th March 2011.

RFRI, Jorhat

- Training on 'Fundamentals of GPS and its application in Forest Resource Mapping to Scientists, Research Officer, Research Fellows as In-house Capacity Building on 24th March 2011 at, RFRI. Twenty numbers of trainees participated at the event.
- Training on "Diversity of Rattan in Northeast India" on 25th to 29th November 2010 to Foresters Trainees had come from Andaman and Nicobar and Arunachal Pradesh.

Forester Trainees from Arunachal Pradesh Visiting Rattan Demonstration Garden

AFRI, Jodhpur

- Training on increasing productivity of wastelands, for 35 farmers and officials of Agriculture Department, Sri Ganganagar district, on 2nd July 2010.
- A traning cum field visit in coloabration with Jal Bhagirathi Foundation, Jodhpur for farmers and field functionaries on 13th August 2010.
- One week refresher course training for IFS officers from 27th to 31st December 2010 on

integrated approach for sustainable development of fragile desert ecosystem.

- Summer training on plant tissue culture and biotechnology from 1st to 14th June 2010.
- Training programme"Van Ayum Krishi Utthan" was jointly organized by AFRI with Vichar Munch Abu Road for around 100 nos. of farmers on 5th May 2011.
- A workshop-cum-training on GPS, population assessment, identification of medicinal plants and methodology for sample collection of selected medicinal plants etc. was organized under NMPB sponsored network project for all the officers and staffs involved in execution of the project on 3rd May 2010.
- A training programme on "Collection, Preservation and Studying Coleopteran Insects Infesting Coniferous Forests" on 14th and 15th October 2010 at HFRI, Shimla for the frontline staff of the State Forest Department, Himachal Pradesh. In total, 20 field officials, participated in the above training. The training included lectures on Nursery pests, entomo-pathogens, methods of collection of beetles, preservation methods and nature of damage and potential of beetles as pest in the conifer forests.

Training on "Collection, Preservation and Studying Coleopteran Insects Infesting Coniferous Forests"

- A one-day training programme on "Enhancement of Forest Productivity" in Kathua Forest Division, on 17th January 2011 for field functionaries working in the State Forest Department, Jammu & Kashmir. About 32 officials were present during the training programme.

Training on "Enhancement of Forest Productivity"

- One-day training on "Eco-restoration of Degraded Area Through forestry Intervention" on 14th February 2011 at Krishi Vigyan Kendra, Saru, Chamba. About 45 officials of state forest department comprising of Forest guards and Deputy Rangers of Chamba, Churah and Dalhousie Forest Divisions including 15 local farmers participated in the training.

Training on "Eco-restoration of Degraded Area Through Forestry Intervention"

- A one-day training-cum-interaction programme on "Production of Tall Plants in Nursery: Issues and Concerns" at Forest Training Institute, Chail on 15th February 2011. It was attended by 30 nos. of field functionaries of State Forest Department of Himachal Pradesh.

Training on "Production of Tall Plants in Nursery: Issues and Concerns"

- A one-day training on "Cultivation of Medicinal Plants; an Option for Diversification and augmentation of rural income" on 19th February 2011 at Sai Ropa, Banjar, Kullu (Himachal Pradesh). About 48 participants from State Forest Department, Himachal Pradesh, NGO's, Mahila Mandals and members of VFDC's took active part in the programme.

Training on "Cultivation of Medicinal Plants; an Option for Diversification and Augmentation of Rural Income"

- Training on "Identification, Sustainable Utilization and Conservation of Medicinal Plants of Himachal Pradesh" at Forest Training Institute, Chail on 25th February 2011 for the field staff of State Forest Department, Himachal Pradesh. A total of 64 field staff participated in the training.

Training on "Identification, Sustainable Utilization and Conservation of Medicinal Plants of Himachal Pradesh"

- Training on "Prospects of Wild edible plants of Kinnaur District: Their Utilization and Conservation" at Forest Rest House, Nichar on 17th March 2011 for the farmers, Forest field staffs, Mahila mandals etc. About 60 people participated in the training.
- A training on, "Soil Fertility and Nutrient Management Through Agroforestry Species" was organized at Town Bharari (Bhota), District Hamirpur (H.P.) on 28th February 2011. Forty farmers, SFD field functionaries and members of Mahila Mandals participated in the training programme.

IFP, Ranchi

- Two days farmers training on "Vermi-Composting" under the NAIP funded at Forest Research Centre, Mandar on 22nd and 23rd February 2010 where 27 nos. of farmers of Godda District participated.

Sh. Chandi Pratihar, Vermicompost Consultant, West Bengal Delivering Lectures and Giving Field Training to the Farmers During Training on Vermicomposting under NAIP (ICAR) Project

- Two days training programme on "Lac Cultivation through Scientific Method" in Ranka Block, Garhwa District of Jharkhand on 16th and 17th June 2010 in which 185 nos. of farmers and cultivators attended.
- A training on "Medicinal & Aromatic Plants Cultivation" on 10th to12th March 2011 at IFP, Ranchi in which 25 nos. of farmers participated.
- A Training Programme on "Bamboo Propagation, Cultivation and Management for Sustainable Livelihood" on 24th to 26th March 2011 at IFP, Ranchi in which 25 nos. of farmers participated.

3.3 Visits Abroad

- Dr. Vimal Kothiyal, Head, FP Division, FRI, Dehradun visited China & Malaysia as a member of Expert Team of Commonwealth games for approval of furniture and its quality from July 2010 up to 15th July.
- Dr. Sudhanshu Gupta, Secretary, ICFRE, Dehradun visited Sweden for participation in the ITP (Intensive Training Programme) for Forest Certification from 12th to 28th May 2010.
- Dr. A. Vijayaraghavan, Scientist-C; Dr. Maheshwar Hegde, Scientist-C, IFGTB, Coimbatore and Dr. R.K. Kalita, Scientist-C, RFRI, Jorhat visited Taiwan to attend "National Programme for Training of Scientists and Technologists Working in Govt. Sector" organizes and funded by DST, GoI, New Delhi from 29th May to 06th June 2010.
- Dr. G.S. Rawat, DG and Shri V.R.S. Rawat, Scientist-D, BCC ICFRE, Dehradun visited Germany to participate in the "Next United Nations Climate Change Negotiations from 31st May to 11th June 2010.
- Dr. S.S. Negi, Director and Dr. N.S.K. Harsh, Scientist-F, FRI, Dehradun visited Cambodia for demonstration of preservation and treatment works to the selected trees and to participate in the "19th Technical Session of International Coordination Committee for Safeguarding Angkor" and make presentation in ICC from 5th to 13th June 2010.
- Mohd. Yousuf, Scientist-F, TFRI, Jabalpur visited Hungary to participate in the "7th International Congress of Hymenopterists" from 20th to 26th June 2010.
- Dr. S.S. Negi, Director, FRI, Dehradun visited China to attend Forestry College Dean Meeting in "Asia-Pacific Region – Forestry Education towards Sustainable Forest Management" from 21st to 23rd July 2010.
- Dr. S.A. Ansari, Scientist-F, TFRI, Jabalpur visited London, UK to attend "WGGW and Expo 10" from 23rd to 27th July 2010.
- Dr. G.S. Rawat, DG, ICFRE, Dehradun; Dr. N.K. Vasu, Director, RFRI, Jorhat; Dr. O.K. Remadevi, Scientist-F; Dr. V.P. Tiwari, Scientist-F; Dr. Syam Vishwanath, Scientist-E, IWST, Bangalore; Dr. R. Yashodha, Scientist-E; Dr. Modhoumita Dasgupta, Scientist-D, IFGTB, Coimbatore; Dr Ombir Singh, Scientist-C, FRI, Dehradun; Dr. B. Divakara, Scientist-C, IFP, Ranchi; Ms. Parveen, Scientist-C; Ms. Nazhat-Ul-Qayoom Quazi, SRF; Ms. Preeti Chauhan, SRF; Ms. Shivani Dhobhal, Research Scholar, FRI, Dehradun and Ms. Dhanya Bhasker, SRF, IWST, Bangalore visited S. Korea to participate in the "XXIII World IUFRO Congress" from 23rd to 28th August 2010.
- Shri V.R.S. Rawat, Scientist-E, ICFRE, Dehradun visited Germany to attend "UN Climate Change Negotiations" from 02nd to 06th August 2010.
- Dr. Geeta Joshi, Scientist-D, IWST, Bangalore and Km. Poonam Dubey, Research Scholar, TFRI, Jabalpur visited Taiwan to attend "IUFRO Tree Seed Symposium" from 15th to 21st August 2010.

- Dr. N. Senthilkumar, Scientist-C, IFGTB visited Hungary to attend "IX European Congress" from 22nd to 27th August 2010.
- Shri V.R.S. Rawat, Scientist-E, BCC, ICFRE, Dehradun visited China to attend "United Nations Climate Change Talks from 02nd to 09th October, 2010
- Dr. Girish Chandra, Scientist-C, TFRI, Jabalpur visited Slovenia to attend International on "Applied Statistics 2010 from 19th to 22nd September 2010.
- Dr. B.N. Divakara, Scientist-C, IFP, Ranchi visited Benin to attend "International Symposium DADOBAT 2010" from 25th to 27th October 2010.
- Dr. G.S. Rawat, DG, ICFRE, Dehradun visited Bhutan to attend "IV Meeting of the Governing Board of the SAARC Forestry Centre (SFC)" from 20th and 21st October 2010.
- Dr. Sangeeta Gupta, Scientist-E, FRI, Dehradun visited China to attend "International Conference on Wood Culture (ICWC) form 23rd to 26th October 2010.
- Dr. Sudhanshu Gupta, Secretary, ICFRE, Dehradun visited Mozambique to attend "2nd Part of the SIDA financed International Training Programme on Forest Certification" from 03rd to 13th November 2010.
- Dr. S.S. Negi, Director, FRI, Dehradun visited Germany to participate in the DAAD Autumn School on "International School Networking, Economic Approaches, Policies, Education and Future Strategies" from 08th to 18th November 2010.
- Dr. Rajiv Pandey, Scientist-E, ICFRE, Dehraun visited Philippines to participate in the International Conference on "Forestry Education & Research for the Asia Pacific Region" from 23rd to 25th November 2010.
- Shri V.R.S. Rawat, Scientist-E, BCC, ICFRE, Dehradun visited Mexico to attend meeting of "COP-16 to NFCC" from 29th November to 10th December 2010.
- Dr. Maheshwar Hegde, Scientist-D, IFGTB, Coimbatore visited Nepal to attend meeting of Cites on "Convention International for Adventure Species of Flora & Fauna" from 9th to 11th January 2011.
- Sh. Sandeep Tripathi, Director (Research), ICFRE visited Nepal to participate in the "Eastern Himalayas Regional Workshop on Forests and Climate Change" from 24th to 28th January 2011.
- Dr. S.S. Negi, Director; Dr. N.S.K. Harsh, Scientist-F and Dr. Subhash Nautiyal, Scientist-F, FRI, Dehradun visited Cambodia for project related studies and works under the consultancy project "Preservation and Conservation Treatment of Trees with Active Participation of local Stakeholders" at Ta Prohm Temple (4th Enclosures) for fourth phase of Archeological Survey of India Project on the Conservation and Restoration of Ta Prohm Temple (Cambodia) under ITEC Programme of MoEA, GoI from Cambodia 10th to 20th February 2011.
- Dr. Sangeeta Gupta, Scientist-E invited as guest speaker in "2010 International Wood Culture Symposium, Shaanxi, China" 22nd to 26th October 2010 at Yangling, Shaanxi. One of her student presented papers at Germany and Las Vegas.
- Ms. Shivani Dobhal, Scientist WoS-B attended 23rd IUFRO World Congress, Seoul, Korea 23rd to 28th August 2010.
- Ms. Preeti Chauhan, SRF, attended 23rd IUFRO World Congress, Seoul, Korea 23rd to 28th August 2010.
- By Dr. N. S. K. Harsh- 05th to13th June 2010 to attend 19th Technical Session of International

Coordination Committee (ICC) Meeting of UNESCO at Siem Reap, Cambodia and make presentation of the activities, preceded by field visit of AD-HOC Experts and project related activities after the ICC Meeting.

- By Dr. N. S. K. Harsh-February 09th to 16th 2011 visit to Siem Reap, Cambodia for project related studies and works under the consultancy project "Preservation and Conservation Treatments of Trees with Active Participation of Local Stakeholders at Ta Prohm Temple (4th Enclosure), Siem Reap, Cambodia" (Archeological Survey of India Project on the Conservation and Restoration of Ta Prohm Temple (Cambodia) under ITEC Programme of Ministry of External Affairs, Govt. of India)
- Shri S.K.Shanmughasundaram, HOD,Visited U.S.A as part of Mid Career Training Phase 4 from 19th June to 04th July 2010.
- Dr. Maheshwar Hegde attended International Training Workshop on Non-detriment Findings and the Review of Significant Trade for Plant Species during 9th to 11th January 2011 at Hotel Everest, Kathmandu, Nepal. This International regional (Asian countries) workshop was organized in Nepal at Kathmandu by CITES management authorities in collaboration and cooperation with CITIES secretariat Geneva, Switzerland.
- Sri M. Lokeswara Rao, IFS visited USA for in-service mid career training programme.
- Dr. N. Rama Rao, Scientist F, visited Bhutan for EIA and EMP studies on Bhunakha and Sankosh Hydro-electric Projects.
- Dr. Geeta Joshi attended IUFRO Tree Seed Symposium: Recent advances in seed research and *ex-situ* conservation, at Taipei Taiwan during 16th to18th August 2010.
- Dr. Sanjay Singh, Scientist-D participated in International Seminar, 2010 on "Climate Change and Environmental Challenges of 21st Century" at Rajshahi, Bangladesh during 7th to 9th December 2010 and presented his research paper entitled "Carbon Sequestration Potential of Bamboos vis-à-vis Fast Growing Tropical Trees".
- Dr. Sanjay Singh, Scientist-D and Sri Satya Prakash Mishra, SRF attended the 1st Asia International Conference on "Environmental Supporting in Food & Energy Security : Crisis & opportunities" on 22nd to 25th March 2011 at Bankok, Thailand.

3.4 Participation in Seminars/Symposia/ Workshops/Trainings

- Scientists/Officers/ Researcheres of ICFRE (H.Q. and Institutes) participated in the following Seminars/ Symposia/ Workshops/ Trainings
- Water Technology Seminar on "Solution for Current Analytical Changes" organized by Waters, Bangalore on 1st February 2010 at Coimbatore.
- Second Rashtriya Yuva Vaigyanik Sammelan-2010 on 6th and 7th February 2010 at Doon University, Dehradun.
- Sixth National Conference on Advancement of Technologies- Focus 2010. Theme "Information Technology & Energy Management", GLA group of Institutions, Mathura, UP on 20th and 21st February 2010.
- National Conference on "Conservation, Improvement and Sustainable Use of Medicinal Plants & Non Wood Forest Products" held on 9th and 10th March 2010 at Ranchi.
- "FGRMN National Workshop" conducted at IFGTB, Coimbatore on 9th and 10th March 2010.
- National Conference on "Sustainable production and Utilization of Medicinal and Aromatic Plants : Current Trends and Future

Prospects" held at Bhubaneswar organized by Regional Plant Resource Centre, Govt. of Orissa with the collaboration of State Medicinal Plant Boar, Govt. of Orissa, Bhuvaneswar on 8th and 9th April 2010.

- Workshop on Joint Forest Management held on 13th April 2010 at MoEF, New Delhi.
- Sensitization training programme on Modalities and Procedure of CDM afforestation and reforestation projects on 16th and 17th April 2010.
- National Workshop:Global Plan of Action (GPA) for Conservation and Sustainable utilization of Plant Genetic Resources for Food and Agriculture (PGFRA) at NBPGR, New Delhi on 17th April 2010.
- Training programme on "Creativity and innovation", conducted by ASCI, Hyderabad from 1st to 7th May 2010.
- Training workshop on Biodiversity Data Discovery and Publication, Organized by Wildlife Institute of India from 4th to 7th May 2010.
- Edusat Coordinator Workshop organized by ICFRE on 7th May 2010.
- International conference on "Wildlife and Biodiversity Conservation viz-a-viz Climate Change" held at Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, Srinagar, J & K, India from 3rd to 5th June 2010.
- Second Environment Summit 2010 on 5th June 2010 organized by CII at Dehradun.
- National conference on forest people interaction held in Pokhara, Nepal on 6th and 7th June 2010.
- Training on "Tendering & Contracting" from 14th to 18th June 2010 at the National Institute of Financial Management, Faridabad.
- Training on Management and Leadership development at LBSNAA, Mussoorie from 14th to 18th June 2010.
- Workshop on Developing an EIA Biodiversity Data Pubishing Framework: India Pilot Project from 23rd to 25th June 2010 at Wildlife Institute of India, Dehradun.
- Seventh International Congress of Hymenopterists at Koszeg, Hungary from 20th to 26th June 2010.
- International Training Workshop on Conservation and Management of Forest Genetic Resources during 5th to 9th July 2010 co-organized by ICFRE, FRIM, APAFRI, Biodiversity International and supported by ITTO and conducted at the Institute of Forest Genetics and Tree Breeding, Coimbatore.
- Third National Congress on "Plant Breeding and Genomics" held from 7th to 9th July 2010 at Tamil Nadu Agricultural University, Coimbatore.
- National seminar on Impact of climate change on biodiversity and challenges in thar desert on 9th July 2010 organised by Desert Regional Centre, Zoological Survey of India, Jodhpur.
- International conference of Image Processing Computer Vision and Pattern recognition IPCV 2010 from 12th to 15th July 2010 at LasVegas, USA.
- "National Workshop on the Archaeological Science" on 17th and 18th July 2010 at New Delhi.
- National seminar on combating environmental degradation on 26th and 27th July 2010 organized by Gujarat Ecology Commission, at Gandhinagar.
- International conference on computer Graphics-Visualization computer vision and Image Processing from 27th to 29th July 2010 at Freiburg, Germany.

- National Seminar on "Recent Trends in Pharmaceutical Research" held at MM University, Mulana on 7th and 8th August 2010.
- Workshop to review the conduct of DUS test for the period 2007-2010 at National Academy of Agricultural Research Management, Hyderabad on 11th and 12th August 2010.
- Training programme on "Importance of Biodiversity, its Conservation and Sustainable Utilization" Funded by the Directorate of Environment, Govt. of Tamil Nadu for the 3rd Batch–Pollachi Educational District school students and School teachers on 18th August 2010 at IFGTB, Coimbatore.
- National Conference on "Biodiversity for Sustainable Development: Threats, Indicators, Climate Change, Poverty Alleviation and Targets for Safeguarding Biodiversity" on 25th and 26th August 2010 organized by Department of Plant Science, Centre for Biodiversity and Forest Studies, Madurai Kamaraj University, Madurai.
- XXIII IUFRO World Congress on "Forest for the Future: Sustaining Society and the Environment" held at Seoul, South Korea from 23rd and 28th August 2010.
- Meeting-cum-workshop on "Research needs and the Financial, Technological and Capacity Needs and Constraints to Address Climate Change Concerns vis-a-vis Forests and Forest Products in India" on 1st September 2010 at TFRI, Jabalpur.
- National Seminar on Conservation and Sustainable Utilization of Red-listed Medicinal Plants on 2nd and 3rd September 2010 at Newman's college, Thodupuzha, Kerala.
- National Conference on Herbal medicine on 8th and 9th September 2010 by Department of Botany, Bharathiar University, Coimbatore.
- Workshop Strengthening of Sceince & Technology at KFRI, Peechi, Kerala on 13th and 14th September 2010.
- National Seminar on Managing Fragile Ecosystems: Research Needs and Priorities in the Peninsular Indian Region at the MES ASMABI College, P. Vemballur, Kodungallur, Thrissur district, Kerala on 15th and 16th September 2010.
- 'Physiological and Molecular Interventions for yield and quality improvement in Crop Plants' held at SVBP, Meerut on 17th and 18th September 2010.
- Workshop on "Shisham Mortality Finding Solutions for Future Plantation" held at Dehradun on 20th September 2010.
- Fourth International Conference: INDIAS 2010 organized by Allahabad University from 19th to 21st September 2010 at University of Allahabad.
- International Conference Applied Statistics-2010 from 19th to 22th September 2010 at Ribno, Slovenia.
- Training workshop on "Earthquake Resistant Design & Construction Practices" from 21st to 24th September 2010 at CBRI, Roorkee.
- Workshop on Validation and verification being organized by UNESCO and UNDP (India), New Delhi from 28th September to 1st October 2010.
- National Seminar on "Biotechnology for Human and Social Welfare" organized by Yash Krishi Takaniki Evam Vigyan Kentdra , Allahabad on 3rd and 4th October 2010.
- International conference on Bioresource Technology, organized by Nirmala college for women, Coimbatore on 7th and 8th October 2010.
- DBT sponsored training on "Biological data analysis"conducted by Bioinformatics centre, CPCRI, Kasarcode, Kerala from 10th to 12th October 2010.
- "Desert biodiversity workshop: Priority Conservation of Grasses, Trees and Fauna,"

organized by WWF-India, Mehrangarh Museum Trust, INTACH, AFRI, Tiger Watch, Bishnoi Tigers Vanya and Paryavaran Sanstha, and TWSI at AFRI, Jodhpur on 11th and 12th October 2010.

- Workshop on management of Forest Genetic Resources for IFS officers on 19th October 2010 sponsored by the MOEF, GOI.
- Workshop on "Sustainable Participatory Management of Natural Resources to Control Land Degradation in the Thar Desert Ecosystem" at Jal Bhagirathi Foundation, Bijolia, Jodhpur (Rajasthan) on 20th October 2010.
- Training programme in the area of biotechnology in 2010 organized at FRI from 27th September to 8th October 2010 under State Biotechnology Programme.
- Conference, Biopesticide: Emerging Trends (BET 2010). Biospesticides in Food and Environment Security from 20th to 22nd October 2010 Hisar (Haryana).
- "2010 International Wood Culture Symposium, Shaanxi, China" from 22nd to 26th October 2010 at Yangling, Shaanxi.
- Training workshop on Role of Scientist in Biodiverstiy Conservation from 25th to 29th October 2010 organized by Wildlife Institute of India, Dehradun.
- International Conference on Environment and Management (ICEM 10), held at Hyderabad from 25th to 28th October 2010.
- "International Conference on Nano Sensor and Technology (ICNST)" from 28th to 30th October 2010 at CSIO, Chandigarh.
- Regional Workshop on Biodiversity Conservation" conducted by Panchmarhi Bioreserve at Samvad Sadan Chhindwara on 7th November 2010.
- Fifth Uttarakhand State Science and Technology Congress (USSTC) held at Doon Univ., Dehradun from10th to 12th November 2010.
- XXV Carbohydrate Conference from 11th to 13th November 2010 at H.P. University, Shimla.
- Regional workshop on "लघुवनोपज के सतत वन प्रबन्धन में महिला वन समिति सदस्यों की सहभागिता" on 16th November 2010 at State Forest Research Institute, Jabalpur.
- International Conference on "Cooling the EarthTactics for Restoring Climate Order and Saving the Living Planet" organized by the Department of Environmental Science, G. B. Pant University of Agriculture and Technology at Pantnagar from 15th to 17th November 2010.
- Conference on "Fertilizer" at Birsa Agricultural University, Kanke, Ranchi on 16th November 2010.
- Biodiversity and Biotechnology: Biodiversity Resource Management and Sustainable Development conference at Department of Botany and Biotechnology, Govt. new Science College, Rewa, M.P. on 16th and 17th November 2010
- Dr. Girish Chandra attended and presented the paper Ranked Set Sampling Theory for Large Set Size with probability proportional to Rank Size Matrix in conference on Interface beween Statistics, Mathematics and allied Science from 20th to 22nd November 2010 at Kumoun University, campus Almora, Uttarakhand.
- Second Biennial International Conference on New Developments in Drug discovery from natural products and traditional medicines from 20th to 24th November 2010 at National Institute of Pharmaceutical Education and Research (NIPER), Chandigarh.
- National Seminar on "Current Advances in Biosciences:Application in Health, Environment and Agriculture" at Department of Botany, Hitkarni, Mahila Mahavidyalaya, Jabalpur on 23rd and 24th November 2010.

- Compulsory training programme for Indian Forest Services officers from 22nd to 26th November 2010 on "Water Conservation and Rain Harvesting" at Forestry Training Institute, Jaipur (Rajasthan).
- International Conference on Folk and Herbal Medicine, Udaipur, Rajasthan from 25th to 27th November 2010.
- Conference of Plant physiology held at BHU, Varanasi from 25th to 27th November 2010.
- International Symposium on "Taxonomy, Plant Diversity and Conservation" from 26th to 28th November 2010. Organized by Department of Botany, Bhatathiar University, Coimbatore, Tamil Nadu.
- National Symposium on Sustainable rice production system under changed climate held from 27th to 29th November 2010 organized by Central Rice Research Institute, Cuttack.
- Workshop for IFS officers on the subject 'Personal & Employees job satisfaction at IMTR, Goa held on 2nd and 3rd December 2010.
- National Seminar on "Global Perspective of Biological Researches in the Present Scenario" Organized by Department of Botany Dayanand Girls (P.G.) College, Kanpur, on 7th and 8th December 2010.
- International conference on "Energy, Environment and Development (ICEED) 2010)" at Sambalpur, Orissa from 10th to 12th December 2010.
- "Fourth International Conference on Plants & Environmental Pollution, 2010" from 8th to 11th December 2010 organized by International Society of Environmental Botanists and National Botanical Reseach Institute, Lucknow.
- International Seminar on Conservation, Sustainable Collection, Processing and Marketing of Medicinal Plants with focus on RET species at Bangalore on 11th and 12th December 2010.
- "Biodiversity: Challenges and Issues" organized by ICFRE at Dehradun on 16th December 2010.
- International symposium on "Recent Advancement in Cross Disciplinary Microbiology: Avenues & Challenges AMI 2010-CMAC.BIT Mesra from 14th to 17th December 2010.
- Madhya Pradesh Mahila Vigyan Sammelan held at Mata Gujri Girl's College, Jabalpur on 18th and 19th December 2010.
- National Training Workshop on 'Strengthening CITES implementation capacity to ensure sustainable wildlife management and non-detrimental trade in India' on 20th and 21st December 2010 at Wildlife Institute of India, Dehradun.
- Seventh symposium on Phytochemistry and Ayurveda: Poential and Prospectus at Dehradun on 25th December 2010.
- National Seminar on "Tropical ecosystems: Structure, Function and Services" held on 28th and 29th December 2010 at IFGTB, Coimbatore.
- Workshop on "कृषि वानिकी विस्तार- समस्या एवं महत्व" on 29th December 2010 organized by Extension and Research Circle, Jabalpur.
- "Specialized Training on DNA Fingerprinting of Plants following RAPD and Microsatelite Techniques" at Rajiv Gandhi Centre for Biotechnology, Thiruananthapuram from 27th December 2010 to 14th January 2011.
- "Indian Science Congress 2010" at Chennai from 3rd to 7th January 2011.
- Third Herbal International Exhibition-cum-Summit on Medicinal and Aromatics Products, Species and Finished Products (HI- MAPS) organized by the Associated Chambers of Commerce and Industry of India on 15th and 16th January 2011 at New Delhi-110020.

- Workshop on "Jatropha: A Biofuel Plant"on 18th January 2011 organized by S.N. Tripathi Memorial Foundation at Chaundauli District, U.P.
- Workshop on "New Frontiers and future of Wood Science & Technology in India" held at Institute of Wood Science and Technology, Bangalore on 20th January 2011.
- Training on "Nano Technology" organized by Indian Institute of Science, Bangalore from 18th to 20th January 2011.
- Seminar on "Climate Change and Adaption" organized by St. Francis College for Woman, 20th January 2011.
- International conference on "Recent trends in Renewable Energy Resources", organized by IICT, Hyderabad from 28th to 30th January 2011.
- Training on Remote Sensing and GIS Application in Forestry & Ecology held at IIRS, Dehradun from 31st January to 11th February 2011.
- A two-week training course in"Basic Remote sensing and GIS Applications in Forestry" at Forestry and Ecology Division (FED), IIRS, ISRO, Dehradun from 31st January to 11th February 2011.
- Seminar on Bamboo under National Bamboo mission organized by Agriculture Department at Abu Road, Sirohi, Rajasthan on 3rd February 2011.
- Training programme on Climate Change and Forest conducted by BCC Division, ICFRE from 31st January to 4th February 2011.
- "Delhi Sustainable Development Summit-2011" at New Delhi Sponsored by The Energy Research Institute, New Delhi from 3rd to 5th February 2011.
- National Symposiym on "Recent advances in Plant Tissue Culture and Biotechnological Researches in India & XXXII Annual meet of Plant tissue culture association (INDIA) from 4th to 6th February 2011.
- National Seminar on "Progress in Life Science for Human Welfare" on 5th and 6th February 2011 at Govt. Model Science College, Jabalpur.
- IUFRO Symposium on Short Rotation Forestry : Synergies for Wood Production and Environmental Amelioration from 10th to 12th February 2011 at PAU Ludhiana.
- Eight All India People's Technology Congress on 11th and 12th February 2011 at Science City & Energy Park, Kolkata.
- National Conference on Conservation of Sacred Groves to Protect Local Biodiversity from 12th to 14th February 2011 at CPR Environmental Education Centre, Chennai.
- National Seminar on Climate Change, Biodiversity and Conservation held at St. Andrews PG College, Gorakhpur on 16th and 17th February 2011.
- National Seminar on "Recent Advances in Bamboo Propagation, Management and Utilization" on 17th and 18th February 2011 at IWST, Bangalore.
- Seminar on "Krishi Prodyogiki Dwara Khaddann, Poshan Ebam Paryavaran Suraksha" at Agriculture Research Station, Keshwana, Jalore on 18th February 2011.
- National workshop on "Non Timber Forest Products Marketing: Issues and Strategies" held on 19th February 2011 organized by NTFP Division, TFRI sponsored by MP Trading and Development Cooperative Federation, Bhopal.
- "Thirteen Indian Agricultural Scientists & Farmer's Congress" on 19th and 20th February 2011 organized by Bioved Research Institute of Agriculture & Technology Allahabad.
- National Conference on Landscape Restoration Processes-Challenges and opportunities at FRI, Dehradun on 22nd and 23rd February 2011.

- Symposium on Insect Pest Management, held at the Entomology Research Institute, St. Xavier College, Palayamkottai from 23rd to 25th February 2011.
- Workshop on "Science-based Policy Options for Climate Change Adaptation in Rajasthan" organized by Rajasthan Pollution Control Board, Jaipur on 24th and 25th February 2011.
- Ninth CYSC-2011 from 28th Febraury to 1st March 2011 at Jagdalpur (Chhatisgarh).
- National Seminar on Casuarinas on 3rd and 4th March 2011 at IFGTB Coimbatore.
- Second National Workshop on Forest Genetic Resources held at IFGTB on 8th and 9th March 2011.
- National Seminar on Advances in Wood Science and Technology Research: Recent Trends, Future Challenges and opportunities at FRI, Dehradun on 9th and 10th March 2011.
- Consultative workshop on strategies for formulation of Forest Genetic Resources Management Network (FGRMN), organized by the Institute of Forest Genetics and Tree Breeding, Coimbatore on 9th and 10th March 2011.
- राजभाषा वैज्ञानिक संगोष्ठी, रक्षा प्रयोगशाला, जोधपुर 10 से 11 मार्च 2011, पृष्ठ सं. 32&36 A।
- "National Seminar-cum-Workshop on Computational Biology and applications" on 11th March 2011 at Bharathiyar University, Coimbatore.
- State level workshop as a delegate on UK India collaboration forest landuse restoration project organized by Forest department, Uttarakhand at Manthan Hall, Rajpur Road, Dehradun on 13th March 2011.
- Conference on 'Green Chemistry Education: Necessity for sustainable development' on 22nd and 23rd March 2011 at HNB Garhwal University, Srinagar (Garhwal).
- National workshop on *Prosopis juliflora*: Past Present & Future at Central Arid Zone Research Institute, Jodhpur on 23rd and 24th March 2011.
- National conference on "Plants and People" held at the Kakatiya University, Warangal on 29th and 30th March 2011, and presented a paper titled "Ethnobotany – an essential tool for human welfare and biodiversity conservation".
- One day workshop on "Bio-remediation of Contaminated Soil" conducted by The Research Wing of Tamil Nadu Forest Department on 25th March 2011.
- Water management training on 29th March 2011 organized by Central Ground Water Board (WZ), Jaipur at CAZRI, Jodhpur.
- Third Insect Science Congress on "Pest Management for Food Security and Environment Health" as organized by Indian Society for the Advancement of Insect Science and Department of Entomology, Punjab Agricultural University at Ludhiana from 18th to 20th April 2011.
- "Experience Sharing Workshop" at Attappady Hills Area Development Society (AHADS), Agali, Kerala on 21st May 2011.
- Training-cum-Workshop on Essential oils, Perfumery and Aromatherapy' organized jointly with FFDC, Kannauj from 31st May to 4th June 2011 at FRI.

EXTENSION PANORAMA

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, Statistics and Environment Management divisions 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 Publication Division looks into the extension activities and strategies being adopted by the Institutes of ICFRE for the 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 and the ICFRE Brochure. The reports of ICFRE and its institutes are collected, complied, edited and published as the Annual Report of ICFRE, which is tabled in Parliament. 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 five VVKs have been established in different states. Eight Demo Villages have been established 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. Division conducts trainings and workshops on the implementation of Rajbhasha Hindi.

Statistics Division is mandated to collect process and disseminate information pertaining the forestry sector of India. To fulfil the mandate, the follwoing tasks were carried out during the year 2010-11.

1. The work on Forestry Sector Report India 2010 sponsored by Ministry of Environment and Forests, Government of India has been undertaken by the Division.
2. A "Monitoring Mission" from International Tropical Timber Organization (ITTO) visited ICFRE from 10th to 12th March 2011 to review the ITTO sponsored project "A sample survey of pulp, paper and hardboard industry of India".
3. Two half-yearly issues of Timber Bamboo Trade Bulletin were published during the year.
4. Data for "Forestry Statistics India 2009" were collected and collated, which is under preparation.

Shri A.K. Bansal, DG, ICFRE and
Dr. Steven E. Johnson, Editor and Communications Manager, ITTO during the Monitoring Mission of ICFRE-ITTO Project

5. The NOVOD Board sponsored ongoing project entitled 'Development of a database on tree-borne oilseeds in India' was in progress.
6. Statistical inputs were given to the research scholars of FRI Deemed University through individual consultations and meetings of the Research Advisory Committees. Lectures on Statistical Methodologies were given to the students and research scholars of FRI Deemed University.

Environment Management (EM) Division: undertakes consultancies in the area of environment and forest for sectors like hydropower, mining, infrastructure, highways etc. Also, it coordinates with the EIA Cells in the institutes of ICFRE for undertaking region based consultancies. Till March, 2011, the Division has completed 30 EIA/ EMP studies worth ` 1193.02 lakh and 10 projects worth ` 295.81 lakh are underway.

Sustainable Land and Ecosystem Management-Country Partnership Programme (SLEM-CPP)

The GEF funded and World Bank supported medium size project on "Policy and Institutional Reform for Mainstreaming and Up-scaling Sustainable land and Ecosystem Management in India" anchored at the Ministry of Environment and Forests, Government of India, and implemented by the ICFRE, Dehradun started functioning since August 2009. The overall objective of the project is to enhance the institutional and policy framework for harmonisation, coordination and monitoring of interventions in agricultural and natural resource management strategies that promote sustainable land management and enhance agricultural productivity while minimizing environmental impacts. In order to achieve the objectives, the project has three components, namely *Institutional and Policy Mainstreaming*, *Outreach and Knowledge Management* for scaling-up of sustainable land management solutions, and *Partnership Programme Management and Monitoring and Evaluation*.

Technical Coordination

Technical coordination has been provided through the Technical Facilitation Organisation (TFO) anchored at the Indian Council of Forestry Research and Education (ICFRE). Various divisions of the ICFRE headquarters and its research institutes provided the requisite technical support as and when required to SLEM projects located in different parts of the country.

National Steering Committee Meeting

As a part of the requirement of the SLEM-CPP, a National Steering Committee (NSC) had been constituted under the guidance of the Ministry of Environment and Forests. The composition of the National Steering Committee is as follows:

Chairperson – Spl. Secretary, Min. of Envt. & Forests

Members -

- Director General, ICFRE.
- IGF, Desertification Cell, MoEF, GoI.
- Joint Secretary and GEF Operational Focal Point India , MoEF, GoI.
- Joint Secretary and UNFCCC Focal Point, India MoEF, GoI.
- Joint Secretary and CBD Focal Point, India MoEF, GoI.
- Joint Secretary, Ministry of Rural Development, GoI.
- Joint Secretary, Ministry of Water Resources, GoI.
- Joint Secretary, Ministry of Agriculture, GoI.
- Director and GEF Political Focal Point India, DEA, GoI.

1st National Steering Committee Meeting

The first meeting of the NSC was held on 26th May 2010, at the Ministry of Environment and Forests, New Delhi. The meeting was chaired by Shri R. H. Khwaja, Special Secretary, MoEF. Also present at the meeting were Dr. G. S. Rawat, Director General, Indian Council of Forestry Research and Education (ICFRE) and the Member Secretary of the NSC, Dr. Rabindra Kumar, DDG (Extn), ICFRE. The NSC was also attended by the various stakeholders, including representatives from the Ministry of Rural Development, Ministry of Agriculture and Cooperation and the Project Directors of seven projects under SLEM-CPP.

Brainstorming Workshop in Progress

Brainstorming Workshop on the Baseline Study

A two day brainstorming workshop (29th and 30th September 2010) on the Baseline Study for the Sustainable Land and Ecosystem Management was held at the Indian Council of Forestry Research and Education, Dehradun. The workshop was a part of the consultative process under the World Bank led medium size project (MSP), Policy and Institutional Reform for Mainstreaming and Up-scaling Sustainable land and Ecosystem Management in India, anchored at the ICFRE. The Brainstorming Workshop was inaugurated by Dr. G. S. Rawat, Director General, ICFRE. Participants at the workshop included nodal officers for the SLEM projects, scientists and experts from the eight ICFRE institutes across the country. The inaugural session of the workshop was also attended by senior officers of the ICFRE.

Financials

The total approved cost of the project is US $ 1,985,267 of which GEF financing accounts for US $981,412 and the balance amount of US $1,003,855 is by way of co-finance by the ICFRE. The TFO has incurred an expenditure of ¡ 49,74,375.00 during the year April 2010-March 2011. The total cumulative expenditure incurred till March 2011 is ¡ 82,46,305.10 only.

The 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 database, etc. to its users. During the year, 29,761 books were loaned to the users for outside reading. Besides, 59,726 documents were consulted inside the library.

The document collection of the NFLIC was enriched by the addition of 2,731 books and other documents, out of which, 1,210 books were purchased at a cost of ¡ 18.17 lakh. The NFLIC subscribed to 79 Indian and 110 foreign periodical titles at a cost of ¡ 74.02 lakh. It also received 325 periodical titles as gratis. The NFLIC also provided online accessibility to 14 most useful journals to the regional institutes of ICFRE at a cost of ¡ 15.00 lakh.

A bibliographical database-forest science database was also subscribed for providing access to old as well as latest research articles on forestry at a cost of ¡ 2.23 lakh.

In order to track, analyze, and visualize research on different aspects of forestry and environmental 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 ¡ 8.08 lakh.

The NFLIC has been selling ICFRE publications through its Book Depot. During the year, 665 books and 23 VCDs were sold to the state forest departments, universities, etc. and a revenue of ¡ 1,38,791/- was 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 Forests in Press, Current Forestry Literature, which are accessible through the website of the Centre having URL: www.frienvis.nic.in. Besides, the contents pages of journals, forest cover of India, state-wise and then district-wise, announcements of forthcoming national and international conferences, seminars, symposia, training course, etc. were also put up on the website.

Publications: The ENVIS Centre on Forestry published two issues of ENVIS Forestry Bulletin, including a special issue on Forest Products Chemistry; and three issues of Environment and Forests News Digest.

4.1 Report on Van Vigyan Kendras (VVKs) and Demo Villages (DVs)

Van Vigyan Kendras (VVKs)

FRI, Dehradun has established six Van Vigyan Kendras (VVKs) in the states and UTs of its working jurisdiction. At present three states viz. Uttarakhand, Punjab and Haryana and two Union Territories viz. Delhi and Chandigarh have VVKs working under the supervision of FRI, Dehradun. One VVK at Kanpur is being looked after by CSFER, Allahabad.

A number of trainings were provided on various themes including 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 and Forest mensuration and tree pruning techniques.

A training and demonstration programme on "Challenges and Prospects of Forestry" was organized from 23rd to 25th January 2011 at Van Vigyan Kendra, Kanpur by CSFER, Allahabad.

Field Demonstration During Training on Forest Mensuration at VVK, Delhi

Training on Urban Forestry at VVK, Chandigarh

Participants of Agroforestry Training at VVK, Haldwani

Training on forest mensuration and tree pruning techniques at VVK, Delhi

Participants of Forest Mensuration & Tree Pruning Techniques Training at VVK, Hoshiyarpur

Training Under Demo Village

Participants at VVK, Pinjore

Training on GPS Under VVK Training Programme

IFGTB, Coimbatore has established three VVKs in the states and UTs of its jurisdiction. The institute organised training programme on seed production and nursery techniques and an interactive workshop with farmers at VVK, Coimbatore, Tamil Nadu wherein, more than 200 farmers from various Districts of Tamil Nadu participated. Planted 500 seedlings of *Azadirachta indica, Syzygium cumini, cassia fistula, Switenia macrophylla, Switenia mahogany, Spathodia, Pungam* and *Dalbergia sisoo* with involvement of students, trainees, farmers, forester on World Environment day 2010. Also organised training programmes on Clonal Forestry to the officials of Tamil Nadu Forest Department, Papaya Mealy Bug (Paracoccus marginatus) infesting Tree Crops for farmers and foresters. Distributed seedlings to farmers.

Published books on *Melia dubia* – Money Spinning Series – 2 and Tree borne oil seeds, Pamphlet and brochures on Bio remediation strategies of mine spoils: An experience of IFGTB, Vilvekam - *Aegle marmelos* seed oil based biopesticide and Nitrogen fixer a growth promoter for casuarinas were published. Also, reprinted 1000 copies of book on Quality planting stock production since there was huge demand for the same from farmers and foresters.

The clones released by the institute was provided to Andhra Pradesh Forest Department, Gujarat Forest Department and Andhra Pradesh Paper Mills

Tree Information Centre

The queries received from foresters and farmers in areas related to cultivation and management techniques, quality planting materials of various fast growing native species, pest and disease problems, farm inputs were addressed through single window system. A dedicated telephone is installed at the centre to facilitate receiving and answering queries.

Tree Information Centre

The institute conducted consultative meeting with all ACFs of Southern, central and northern regions of Social forestry wing. Kerala at Ernakulam under the chairmanship of CCF, Social Forestry, Ernakulam and discussed about the programmes and activities of VVK, Kuthiran.

The institute organised training programmes to field forest officers at South Andaman, Baratang, Middle Andaman, Mayabunder and Diglipur and foresters trainees at Forest Training School, Wimberlygunj under VVK, Port Blair, Andaman and Nicobar Islands on Quality planting stock production, Biofertilizers and biomanures, Climate change and Forestry, Reproductive and floral biology of mangroves, and plantation technologies. More than 200 field functionaries were trained.

IWST, Bangalore has established three VVKs in the states falling under its jurisdiction. The institute organized training programme at VVK, Goa on 21st and 22nd September 2010 for a batch of 30 Range Forest Officers and Deputy Range Forest Officers of Goa Forest Department. They were given training on model nursery practices for sandal, macro and micro-propagation techniques of different bamboo species. During the training, demonstrations on different wood preservation techniques i.e., sap displacement and boucherie process was organized. The importance of wood preservation and different methods of preservation were briefed and training on handling of equipments and chemicals were provided. The extraction of volatile oil from *Eucalyptus* leaves using distillation unit was demonstrated to the trainees. On 22nd September 2010, a batch of 25 no. of Forest Guards, Goa Forest Department was given training on model nursery practices for sandal and nursery pest

management. The trainees were also given training on wood processing i.e., wood properties, seasoning, preservation and protection with a especial emphasis on *Acacia auriculiformis* and other plantation grown secondary wood species and small girth timber for value addition. A demonstration on different wood preservation techniques i.e., sap displacement and boucherie process and extraction of volatile oil from *Eucalyptus* leaves using distillation unit was demonstrated to the trainees.

As part of VVK, Karnataka activity, training was provided to Range Forest Officers (RFO) of Karnataka Forest Department (FTATI, Kadugodi) at IWST, Bangalore on 22nd September 2010, under a regular training programme. A visit was also organized to tissue culture lab, nursery and different divisions of institute including AWTC. Training was provided to VFC Presidents and Executive Committee Members at FTATI, Kadugodi on 12th October 2010, under a regular training programme. During the training, lecture and demonstration on "Sandal nursery technologies" and various aspects of Wood Preservation were explained. This was followed by demonstration on Sap displacement technique and broucherie process. Training was also provided to Range Forest Officers (In charge) at FTATI, Kadugodi on 18th November 2010 under a regular training programme. During the training, lecture on "Modern Nursery and Plantation Techniques" was delivered.

The institute demonstrated the technology of extracting essential oil using portable distillation unit to the trainees of Forest Technical and Administrative Training Institute, Karnataka at VVK, Kadugodi, IWST Bangalore on 16th November 2010.

Altogether five training programmes were conducted under "Van Vigyan Kendra", FRC, Hyderabad. A total of 252 participants received training on topics covering subjects like Biodiversity conservation, Global warming and climate change, Environmental protection and Urban forestry.

RFRI, Jorhat is operating five numbers of Van Vigyan Kendras in five North-Eastern states: Assam, Arunachal Pradesh, Mizoram, Nagaland and Tripura. Different activities were planned for the financial year 2010-2011 as per ICFRE guidelines.

The institute conducted seven nos. of trainings at VVK Nagaland on Nursery & Plantation especially on Bamboos to over 300 beneficiaries including the frontline field officials, farmers, NGOs and villagers. The trainings covered Techniques of raising bamboo, nursery & plantation, management of diseases & Pests in bamboo, harvesting, utilization & preservation of bamboo, bamboo varieties of North-East region, Medicinal Plants/Herbs of Nagaland- IK on Medicinal herbals, its value addition, Use of GPS in Forest survey & mapping and Importance of Wildlife Conservation.

The institute conducted ten trainings with two days duration during 2010-11 under VVK Arunachal Pradesh for the farmers of the state and functionaries of different departments like Horticulture, Agriculture and Environment & Forests, Govt. of Arunachal Pradesh on the subjects including Propagation, Cultivation and Management of Orchids/ Floriculture for economic development of Arunachal Pradesh, Bamboo and Cane: its propagation, cultivation and management for sustainable development, Forest and Forestry of Arunachal Pradesh, and Effect of global warming and climate change. Over 200 participants were present in the training programmes.

Modern nursery was established under VVK project at Chessa. During 2010-11 received ¡ 50,000/- (¡ fifty thousand) only for maintenance of the nursery, purchased the seeds of different cane species like *Calamus tenuis, C. erectus, C. gracilis, C. flagellum, C. floribundus;* seeds of *Aquilaria agallocha,* medicinal plants and some

edible fruit plants like *Baccurea sapida, Nerium* spp., litchi, plum etc. which are required by common people. In addition to these, purchased some nursery equipments.

The institute conducted four trainings on different topics including agroforestry and other land use practices for sustainable production, Modern nursery techniques, Role of Self Help Groups and EPAs for JFMCs in NRM, Forestry extension and eco-development planning, NTFPs and their marketing, Medicinal plants-Panchakarma treatment, Agro techniques of medicinal plants, Plantation techniques and management of bamboo, Macro-proliferation technique of bamboo and Value addition techniques of bamboo for furniture, handicraft, incense sticks. Over 93 participants were benefitted by the trainings.

Field visits and practical sessions were also conducted as follows:

- Integrated farming (forestry, apiculture, pisiculture, piggery, poultry, rubber plantation crops) at Don Bosco Vocational Training Institute, Bishramganj
- Bamboo multiplication and plantation management at Ram tala
- Vermicomposting techniques at Don Bosco Vocational Training Institute
- VVK model nursery, Tripura State Forest Department Central Nursery, eco-parks, herbal gardens
- Bamboo furniture, handicraft and incense stick manufacturing units at BENU, TFDPC, TRIBAC

During the period 2010-2011 a Model Nursery which was established at Hatipara had been maintained with activities like extension of water supply connection, maintenance of vermicompost unit etc.

AFRI, Jodhpur has established two VVKs one each at Rajasthan and Gujrat and third one is under process of establishment at Silvasa, UT of Dadra & Nagar Haveli and Daman.

The institute conducted three days VVK training at Kishan Bhawan, Bikaner from 4th to 6th October 2010. Total 41 participants (31 forest staffs and 10 farmers) attended training. They learned techniques of conservation and economic benefits of agroforestry, cultivation of arid fruit tree and production, losses from rat and its control, nursery techniques for cutting, grafting and high quality seed production, use of biofertilizers in forestry and composting techniques. Training was organized by delivering both lectures and onsite demonstration way.

Maintenance works of Hi –Tech nursery Bichhwal, Bikaner have been executed; rice husk for potting medium, insecticide, seeds and PVC pipe were procured for the Hi-Tech nursery.

- Raising/ Distribution of Seedlings: - In 2010-11, 3000 quality seedlings of *Prosopis cineraria* and *Dalbergia sissoo* have been raised in Hi-Tech nursery Bichhwal, under VVK. Total 10,000 nos of khejri (*P. cinareria*) seedlings raised in 2009-10 under VVK were distributed/sold during 2010-11 to 66 farmers on subsidised rate.
- Extension activities : Display boards (6 nos) were displayed at the Hi-Tech nursery Bichhwal, Bikaner for farmers/stakeholders under VVK, Bikaner.

The institute conducted three days training programme for farmers and field functionaries under Van Vigyan Kendra, Gujarat with the help of Gujarat Forest Department from 14th to 16th December 2010 at Van Chetan Kendra, Bhuj (Gujarat). Total 59 participants (38 forest staffs and 21 farmers) attended training. Both classroom lecturers and field visit were included in this training programme. Training was given on economic benefits of agroforestry, silvipastural techniques for fodder production in Kutchh region, types of grasses & range management of Kutchh region, Tree improvement programme, soil & water conservation techniques, and afforestation techniques for saline land of Kutchh region, peoples sensitization techniques for

VVK training at Van Chetana Kendra,
Bhuj on 14th December 2010

forestry extension and organic farming and composting techniques. Training was organized by delivering lectures and onsite demonstration. During the field visit, the participants learned the advanced techniques through demonstrations of vegetative propagation of tree species, vermi-composting at Hi-tech nursery, Bhuj, guggal plantation and nursery, Vandai. VVK training participants also visited silvi-pastural model developed by the AFRI at Mocharai, Bhuj.

Demonstration of Macro Propagation Techniques at
Hi-Tech Nursery, Bhuj, on 15th December 2010

VVK Training Participants Visiting AFRI Developed Silvi-pastural Model at Mocharai, Bhuj on 15th December 2010

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.

Total 3000 high quality seedlings of *Cordia mixa, Casuarina equisetifolia* and *Eucalyptus* hybrid from seeds/cuttings and *Zizyphus mauritiana, Emblica officinalis* by grafting/budding produced, 500 seedlings of each species were raised in hi-tech nursery at Research and Development Centre, Rajkot for farmers/stakeholders under VVK during 2010-11 for distribution to stakeholders on subsidized rates.

Display boards (6 nos) displayed at the Research and Development Centre, Rajkot for farmers/stakeholders under VVK, Rajkot.

Khanwel (Dadra & Nagar Haveli and Daman) proposed VVK

Establishment and strengthening of VVK

Dr. Rabindra Kumar, DDG (Ext), ICFRE, Dehradun and Dr. Bilas Singh, Research Officer visited Silvasa, Dadra & Nagar Haveli and meetings held with DCF, Silvasa on 28th January 2011 with ICFRE officials, Shri Kamal Datta, CF (Daman) and O/C of DCF (T), Silvasa and Shri Dilip Singh Mangrola, ACF (Wild), Silvasa, Dadra & Nagar Haveli FD regarding signing of MoU and VVK activities carried regular correspondence through telephonic, fax and e-mail for signing of MoU & VVK works. The

above officers had a visit to proposed nursery and VVK display centre at Khanvel, around 19 km away from Silvasa. During visit of the nursery, it was visualized that exiting proposed VVK building will require repairing before establishing VVK display centre.

The Model MoU further handed over to Shri Kamal Datta, CF for approval. However, MOU of VVK, Khanwell, Silvasa has not been approved till date by DNH authority. Therefore, FD, DNH could not permit AFRI to take up any activities of VVK at Khanwel, Silvasa.

Mass Communication Material and Media

- Information booklet of AFRI : Information booklets of AFRI in Hindi language (4750 numbers) were published under VVK for wide circulation and distribution to farmers/stakeholders /organisaions. Training programmes of VVK of Bikaner and Rajkot and Demo village were given wide publicity in many daily local news papers (Hindi and Gujarati).

Meeting of ICFRE Team with DCF(T), Silvasa

Building and the Site for Proposed VVK, Silvasa

- AFRI Darpan: Special issues of AFRI Darpan (Quarterly Magazine in Hindi, Vol 1-2, Year 8,) on VVK and Demo and extension activities was brought to highlight AFRIs extension activities.
- AFRI Publications: Published 12,800 pamphlets (4600 in English and 8200 in Hindi) on "Khejri Mortality: Causes, severity and Remedies in Rajasthan" and ^i f'peh jkt LFkku esa[ksstM+h eR;qZk** respectively.
- Prepared 30 display Boards (15 each) on Deficiency symptoms of various nutrients in plants and ^e#LFky dh thou js[kk %[ksstM+h dYi o{kdkscpkusdkl ;dYi **
- AFRI Calendar-2010 Short Term Training Courses & Other Activities.
- Following pamphlet were published:
    - The International Day for biological diversity 2010.
    - June World Environment Day Many Species, One Planet, One Future.
    - 17 June 2010 World Day to Combat Desertification.
- Abstract entitled *Prosopis juliflora* – a tree for prosperity of arid lands "In *Prosopis juliflora*: Past, Present and Future. pg. 36. CAZRI, Jodhpur, ICAR Publication."

HFRI, Shimla has established two VVKs, one each in Himachal Pradesh and Jammu and Kashmir. Under VVK, Himachal Pradesh, the institute developed pamphlet 500 no. each of *Emblica officinalis, Plantanus orientalis, Pinus gerardiana*, *Elaeagnus angustifolia* and booklets, (200 no.) each of *Pichrorhizia karrooa* and *Cedrus deodara.*

The institute organized training programme for field functionaries of SFDs and farmers as under:

- Workshop-cum-villagers meeting was held at Nalani village, Mandi on 9th May 2010 to know the farmers preference on various forestry/ agroforestry species.
- Training was held at Krishi Vigyan Kendra, Saru, Chamba H.P. on 14th February 2011 on the Topic "Restoration of degraded areas through Forestry Intervention" attended by total 60 no.of participants from our institute, forest Guards, Dy.Rangers of Forest Division Chamba, Dalhausie,Churaha and adjoining areas.
- One day training was held at Sai-Ropa, Sainj, Kullu H.P. on dated 19th February 2011 on the topic "Cultivation of Temperate Medicinal Plants; An Option for Diversification and Augmentaion of Rural Income" attended by total 40 no. of participants from our institute, state Forest Guards, Progressive Farmers, Representative of Mahila Mandals,Yuvak Mandals and NGOs of adjoining areas.
- Five day training-cum-exposure visit on "Agroforestry and NWFP Technologies for Productivity Enhancement" from 14th to 18th February 2011 participated by 35 No. of Progressive farmers from Jammu, Manali, Shilaru, and solan areas. Farmers had various informatory interactions with the concerned scientists of HFRI,ICFRE and UHF Nauni and visited Hara Herbal Garden, Ganganagar, Dhaulakuan, FRI museum, Van Vigyan Kendra, Rishikesh, Haridwar.

Nursery at FRS Brundhar, Jagatsukh (Manali):

- Maintained the demonstration nursery at various FRS by carrying out weeding hoeing and watering etc.
- To facilitate the visits of various dignitaries and other stakeholders in the station during their visits to see and understand the forestry related activities pertaining to Cold Desert Areas at Field Research Station Tabo, a Pucca Path measuring (30 m long x 3 m width and 30mh) was constructed. For propagating the idea of intercropping of medicinal plants with forestry tree species/ horticulture trees-nursery beds in the area 15m^2 were prepared within and around the tree plots. Medicinal plants like Salam panja (*Dactylorhiza hategirea*); karroo (*Picrorhiza kurrooa*); jangli lahsoon (*Asphodelus tenufoylius*), jangli pyaz (*Urgenia indica.*) and ratanjot (*Arnebia benthami*) were collected from the wild and pricked out in the beds as an intercropping material.
- Production of vermicompost and maintained the vermicompost units to showcase the different stakeholders.

Other Extension activities, Equipment, Office Furniture, Telephone

- Conducted awareness programmes on agroforstrical species, Medicinal plants, Rainwater harvesting at kanaid,Bhangrotu and adjoing areas near Sundernagar.
- Assisisted State Forest Department in extraction of silver fir seeds.
- Raised cuttings of *Tinospora*(50 no.), *Bauhinia verigata*(50 no.) *Grewia optiva* (50no.) and *Prunus* spp. (100).
- Arranged meeting at Poongh village on the importance of organic farming and vermi-composting.

Under VVK Jammu, the institute developed pamphlet on "Chinar" 500 copies. Organised one day training on dated 17th January 2011 on the topic "Application of Technological and Research intervention for Enhancing forest Productivity" at campus of Kathua Forest Division, attended by 30 no. of participant from

the state forest division including forest guards, foresters.

Establishment of Demonstration Nursery

- Procured seeds from the villagers /market of harad (20kg), behara (20kg) and *Eucalyptus* for raising in the nursery beds.
- Planted 5000 no. cutting with different clones of Popular in nursery beds procured from ICFRE, Dehradun.
- Established Forest Research Station, Nursery site at Nagbani in 1250 sqm area.
- Carried out Line sowing of Eucalyptus seeds in an area of 70 sqm, harar seeds in an area of 20 sqm, and behara seeds in an area of 20 sqm.
- Collected and planted buch rhizome in an area of 20sqm.

Demo Villages (DVs)

FRI, Dehradun

Demo Village, Shyampur

One demo village at Shyampur at Dehradun in Uttarakhand has been established by FRI, Dehradun for the demonstration and training of the farmers NGOs associated with forestry produces, People of Small scale industries and students on various issues time to time.

A model nursery has been developed at Shyampur village near Dehradun in collaboration with Bagwan Gramodyog Samiti, Shyampur Village.

The nursery has been developed with the following structures:

- Low Cost Mist Chamber – One
- Propagation Unit – One\
- Water Tank with complete pipe fittings– One
- Motor House with 0.5 HP Motor – One
- Mounted Angle Iron Beds – Eight
- Shade House – One
- Seed Drying Plateform – One
- Vermicompost Unit – One
- Root Trainers–95 Blocks–200cc (16 cells)

Achievements :

- Yearly, more than 20,000 seedlings raised and maintained in the nursery.
- 4000 seedlings – Medicinal and forestry was supplied by FRI to Demo Village.
- Maintenance of 25,000 plants – Medicinal and forestry species.
- Distribution of 10,000 plants mostly *Aloe vera* and satavar to the farmers of Baniawala, Nayagaon, Ganeshpur, Selaquie, Ambiwala, Suklapur, Shyampur of Dehradun district for growing in their agriculture fields.

Demo Village (DV) Saidupur (established by CSFER):

- The one of the objective of establishment of Demo Village is to develop low cost model nursery for demonstration purpose. The vermicomposting 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 villager's choice as teak, bel, aonla, imli, jatropha and medicinal species as satawar, kalmegh, chitrak, ashwagandh.
- The following training programmes for farmers of Demo Village (Saidupur) were organized:
  - Preservation Techniques of Bamboos: on 15th November 2010
  - A demonstration-cum-training programme was organized on vermi-composting on 31st January 2011. About fifty farmers participated in the programme.

- Training on plantation and nursery techniques of important forestry species was organized on 29th September 2010.

IFGTB, Coimbatore

Kandiyur Demo Village

Established model plantations of *Eucalyptus, Ailanthus*, teak and cashewnut and agroforestry models with cowpea, brinjal and tomato as intercrop in 11 farmers field. Distributed 5000 seedlings to farmers of Kandiyur and nearby villages.

Organized the 3rd Tree Growers Mela on 24th February 2011 and 25th February 2011 at the institute in association with the Tamil Nadu Forest Department for farmers of Tamil Nadu and Puducherry. As part of the mela, a workshop on "Best Practices in Tree Farming and an Exhibition on Plantation Technologies" were organized. More than 700 farmers from various parts of Tamil Nadu and Puducherry besides officers and staff of Tamil Nadu Forest Department, representatives from Wood based industries, scientists and faculty from Research and academic institutions participated. Twenty organizations participated in the exhibition.

A biopesticide product "Vilvekam-*Aegle marmelos* seed oil based biopesticide" a formulation developed from the oil of *A.marmelos* and N Fixer Frankia a growth promoter for casuarinas were released for the farmers.

An awareness training programme on "Environment Protection" was organised on 30th March 2011 for the school children of Primary School, Kandiyur Demo Village. A total of 36 students participated in the training programme.

An awareness training programme on "Environment Protection" was organized for the school children of Primary School, Kandiyur Demo Village on 30th March 2011.

IWST, Bangalore

- An interactive meeting with Sri Shakthi Women Group of the demo village was organized on 17th September 2010. The meeting was attended by Extension Officer, IWST, Panchayat Development Officer, elected members of the village and 25-30 women members of Sri Shakthi Women Group of Demo Village.
- Demonstration cum interactive meeting was organized on 27th September 2010 at Yentaganahalli Panchayat. The meeting was attended by all elected members of 23 villages that come under the Yentaganahalli Panchayat. The Memorandum of Understanding between IWST and Doddekerenahalli, Demo Village was signed in the presence of all the members. During the occasion, seedlings of various tree species like sandal, *Eucalyptus*, silver oak, bamboo etc were also distributed.

TFRI, Jabalpur

TFRI, Jabalpur planted teak of Madhya Pradesh origin in Demo Village, Moiyanalah for demonstrating existence of relative resistance against teak defoliator and leaf skeletonizer.

AFRI, Jodhpur

Demo Village, Salavas (Jodhpur)

Establishment and Strengthening : MoU signed between Director, AFRI and Sarpanch, Salawas village, Jodhpur for establishment of Demo village at Tikeshwar Bhakari, Salawas, Jodhpur on 14th October 2010. Fifty seedlings of different

AFRI Scientists Visited Proposed Demo Village Site, Tikeswar Bhakari, Salawas, Jodhpur on 14th October 2010 for Technology Demonstration

Sarpanch Sh. Oma Ram Patel, Planting Sapling During Ceremonial Planting Function at Demo Village Site, Tikeswar Bhakari, Salawas, Jodhpur on 14th October 2010

Dr. T.S. Rathore, Director, AFRI, Jodhpur Inaugurating Demo Village Display Centre Building at Tikeswar Bhakari, Salawas, Jodhpur on 14th October 2010

MoU Signing Between the Director, AFRI, Jodhpur and Sarpanch, Salawas Village, Jodhpur at Tikeswar Bhakari, Salawas on 14th October 2010

tree species were planted at Tikeshwar Bhakari, Salawas by AFRI officials and Salawas villagers as ceremonial function. Demonstration Hall of Demo Village and display material were inaugurated by the Director, AFRI, Jodhpur and sarpanch, Salawas village, Jodhpur.

Demo Site: Site was selected near to SFD nursery, Salawas, Jodhpur to establish agroshed compost unit and other nursery activities for demonstration purposes as well as high quality seedling production for farmer/stakeholders. Compost chamber and agroshade net house and soil conservation works have been taken up through Silviculture and Forest Ecology Division, AFRI, Jodhpur.

The selected area (7.0 ha) of community land at Tikeswar Bhakari, Salawas surveyed, plan and map were prepared to execute the soil and water conservation measures and silvipastoral model. The MoU with Salavas (Gram Panchayat) was signed on 14th October 2010. Later on in November 2010, additional land (1.5 ha) of Salavas GP has been earmarked for Demo site adjacent to Salavas nursery. Salavas GP`s land (1800 M^2) presently under the custody of RFD at Salavas Nursery also has been allowed for Demo purpose through a MoU (with DFO/Jodhpur) on February 2011.

One day Demo village training was organized at the Arid Forest Research Institute, Jodhpur on 4th March 2011. The total 35 participants (12 forest staffs and 23 farmers) attended the training. They learned about various nursery techniques and VAM, composting manure-forming techniques. Training was organized mainly in demonstration mode.

Demo Village Training Inauguration at AFRI, Jodhpur on 4th March 2011

Demonstration of Composting Techniques to the Participants at Experimental Nursery, AFRI on 4th March 2011

Demo Training Participants Visit to Medicinal Garden at Nursery, AFRI on 4th March 2011

Demonstration of VAM Application in Nursery to Trainees at Nursery, AFRI on 4th March 2011

HFRI, Shimla

Demo Village, Lanabaka, Himachal Pradesh:

i. Meetings with People for Planning and Implementation of Agreed Activities:
   - Organized camp workshop cum villagers meeting at Demo Village to plan the activities

ii. Establishment of Technology demonstration Plots:
   - Establishment of Intercropping Model for demonstration

     Established intercropping model of *Aloe vera* and *Valeriana jatamansi* with *Dendrocalamus hamiltonii* for demonstration.
   - Establishment of Mixed Demonstration Plantation

     Established the mixed demonstration plantation of *Dendrocalamus hamiltonii*, *Paulownia fortunei*, *Grewia optiva* and *Embilca officinalis* (500) in the spacing of 3x3 M^2.

iii. Nursery development & maintenance of nursery and plantation:
   - Procured sand, cement bags, soil, FYM for nursery and polyhouse beds.
   - Established concrete road (60 m long x 3 m width) from mother beds to polyhouse.
   - Collected seeds of chharma(25 kg), Colutia (20 kg), Ribs Bhojpatra (5kg),and Ephedra (10kg), Ribes (10).
   - Collected medicinal plants kharroo, jangli piaz, rattanjot.
   - Prepared 50 sqm nursery bed.
   - Repaired water channel surrounding office ,Guest house and type 1 quarter.
   - Maintained the demonstration nursery by carrying out regular weeding, hoeing and watering etc.
   - Maintained the demonstration plantation by carrying out regular weeding, hoeing and watering etc.

IFP, Ranchi

The following demonstrations were taken up in demo village - Hapamuni :

A. Demonstration on Stress Site Reclamation

The village - Hapamuni in Gumla district of Jharkhand was selected as demo village for dissemination of technologies on stress site reclamation. The village has vast tract of stress site characterized by shallow depth, rocky surface, extensive rock fragments mixed with soil of very low water holding capacity, very low in soil organic matter with the available nutrients. Field survey was conducted during 2009 for collecting soil samples in order to assess the site quality and identify plant growth limiting factors. Plantation work was completed during June, 2009 after raising quality planting stocks of *Bambusa nutans,* clones of *Eucalyptus tereticornis* and *Tectona grandis* and pit soil treatments. A workshop-cum-demonstration on 'Stress site reclamation' was organized on 30th June 2009 and was attended by 65 participants viz., villagers, field functionaries of SFD, NGOs, villagers from Hapamuni.

Plantation description & Amelioration of soil:

Sl	Species	Area & No. of Seedlings/ BPS Planted	Pit size	Spacing	Treatments
1	*Eucalyptus* (clone)	0.40 ha; 325	60 cm x 60 cm x 60 cm = 0.216 m^3	3m x 3m	Surface Soil 2.5 ft^3 + 1.6 ft^3 pit soil + FYM 1.0 ft^3 + Rice Husk 1.25 ft^3 +100g Lime before p lantation & N 200g (as Urea + DAP)+ P_2O_5 100 g (as DAP) + K 50g (as MOP) + Zn 2.0 g + Mn 2.0 g + B 2.0 g + Cu 0.50 g + Fe 1.0 g + Mo 0.15 g of their salts + Chloropyriphos - twice in 1st & 2nd Yr
2	*Tectona grandis*	0.50 ha; 340	- do -	3m x 3m	- do -
3	*Bambusa nutans* 1 yr old (BPS)	0.26 ha; 81	75 cm x 75 cm x 75 cm = 0.422 m^3	5m x 5m	Surface soil 5.0 ft^3 + pit soil 3.0 ft^3+ FYM 2.0 ft^3 + Rice Husk 2.5ft^3 + 200g Lime before plantation & NPK+ Micronutrients (double the amount as in *Eucalyptus* & *T. grandis*)

B. Demonstration on Bamboo Propagation Techniques

An attempt was taken up to establish "Bamboo Propagation Unit" at the Demo Village - Hapamuni adopted by IFP, Ranchi solely to demonstrate the latest techniques to the villagers and other field functionaries so as to educate and produce BPS in a large number. Fourteen sand beds (size 0.50m x 1.25m x 3.5m each) were laid with loose brick wall. Culm cuttings of the following species collected from "*ex-situ* conservation garden" and "Bamboosetum" belonging to IFP have been used throughout the year for the demonstration purpose. Transfer of rooted cuttings in polybags containing organic

matter and nutrient elements, placement under shade and watering etc. have also been demonstrated. Thirty five villages participated in demonstration training at Hapamuni Nursery during 2009 and 2010. Few villagers started propagating Bamboos through advanced technique.

Species Propagated through culm cuttings

Bambusa balcooa, Bambusa bambos, Bambusa nutans, Bambusa striata, Bambusa vulgaris (green), *Bambusa vulgaris* (purple), *Dendrocalamus asper* and *Dendrocalamus strictus.*

C. Vermicomposting Unit of Demo Village

India is in the process of attaining higher levels of food production for matching the demand of the growing population. Much emphasis has been laid on intensive agriculture sustainable practices because of indiscriminate use of chemical fertilizer and pesticides have led to the deterioration of soil health and soil quality. It is an alarming issue at global level, especially among the agricultural and environmental scientists. Therefore, there is urgent need to restore soil quality, health and resilience for food security and environmental security with the help of organic manures. Organic manures such as compost, verimcompost etc., not only supply macro and micro-nutrients but also improve physical, chemical and biological properties of soil for sustainable agriculture. In Jharkhand, Gumla, Logardaga and Lathehar districts are one of main farming areas, where availability of organic materials is high. While keeping all points in mind, IFP, Ranchi established a Vermicompost Unit at Demo- village, Hapamuni, Gumla with dimension of 70' X 30' X 7.5' @ ` 1,85,929/- to impart training-cum-demonstration to the farmers and to establish demo-vermicomposting farms. The Vermi-composting unit includes vermicomposting beds, decomposting tank and vermiwash collection tank. Agricultural wastes, weeds, and farm yard manure are raw materials for vermicompost production. The production capacity of the unit varies between 3-4 tonnes/

Bamboo Propagation Practice & Demonstration

harvest depending upon type and nature of materials used. The earth worm, *Eisenia fetida* is being used for vermicompost production. Training-cum-demonstration on vermi-composting and its application is being organized to the local farmers and sample vermicompost supplied to the participants free of cost.

Internal Monitoring and Evaluation of VVKs and DVs

Evaluation of VVKs

Dr. Rabindra Kumar, DDG (Extension), ICFRE, Dehradun evaluated the work done at VVK, Chandigarh from 21st to 23rd December 2010, VVK, Pinjore on 22nd December 2010 and VVK, Dadra and Nagar Haveli on 27th January 2011 .

Shri R.P. Singh, ADG (Media and Publication), ICFRE, Dehradun evluated the progress of VVK, Delhi on 13th January 2011. He also evaluated the progress of VVK, Assam on 10th January 2011.

Shri Omkar Singh, DDG (Education) conducted visit toVVK, Himachal Pradesh on 13th and 14th December 2010 in connection with the evaluation of progress of the VVK.

Shri Sandeep Tripathi, Director (Project and International Cooperation), ICFRE, Dehradun evaluated the progress of VVK, Jabalpur on 6th March 2011.

Dr. Dharmendra Verma, ADG (Environment Management), ICFRE, Dehradun evaluated the performance of VVK, Karnataka on 21st and 22nd February 2011.

Shri S.D. Sharma, ADG (Statistics), ICFRE, Dehradun evaluated the progress of work at VVK, Tamil Nadu on 20th and 21st December 2010.

Shri Pankaj Aggarwal, ADG (Project Formulation), ICFRE, Dehradun conducted the evaluation of work done at VVK, Rajasthan from 29th November 2010 to 2nd December 2010.

Evaluation of DVs

Shri M.S. Garbyal, DDG (Administration), ICFRE, Dehradun visited DV, Shyampur and evaluated the progress of work on 20th December 2010.

Shri Omkar Singh, DDG (Education) conducted evaluation of DV, Lanabaka on 15th December 2010.

Dr. Rabindra Kumar, DDG (Extension), ICFRE, Dehradun made evaluation of progress of work at DV, Hapamuni on 8th December 2010.

Shri Sandeep Tripathi, Director (Project and International Cooperation), ICFRE, Dehradun evaluated the progress of work at DV, Moiya Nala on 6th March 2011.

Dr. Rabindra Kumar, DDG (Extension), ICFRE, Dehradun at DV, Hapamuni

Dr. Dharmendra Verma, ADG (Environment Management), ICFRE, Dehradun visited DV, Doddakerenahalli and evaluated the progress of work on 21st and 22nd February 2011.

Shri S.D. Sharma, ADG (Statistics), ICFRE, Dehradun visited DV, Kandiyur and evaluated the progress of work on 21nd December 2010.

Shri Pankaj Aggarwal, ADG (Project Formulation), ICFRE, Dehradun evaluated the progress made by the institute at DV, Salawas from 29th November to 2nd December 2010.

Shri Pankaj Agarwal, ADG (PF), ICFRE, Dehradun at DV, Salavas

Shri R.P. Singh, ADG (Media and Publication), ICFRE, Dehradun conducted evaluation of DV, Meleng Grant on 11th and 12th January 2011.

All the above Evaluation Reports were sent to the Directors of the respective institutes to implement the suggestion/ observations made thereon.

4.2 Technology Transferred

FRI, Dehradun

- Trainees of Forest Training Institute, Kanpur visited CSFER, Allahabad on 29th October 2010. The trainees were trained regarding propagation techniques of bamboos and techniques were demonstrated to the trainees in the research nursery.
- A demonstration on method of vermi-compost preparation was carried out to the farmers of Saidupur village of Allahabad on 31st January 2011.
- The technique of bamboo propagation techniques in nursery was demonstrated to the participants of Van Vigyan Kendra training on 25th January 2011 under VVK training.
- Vegetative Propagation technologies of bamboo species such as Rhizome Offset Planting: Lower part of single culm with rhizome, Juvenile Single nodal Cutting, Whole Culm Cutting, Binodal Culm Cuttings, Single Nodal Culm Cuttings, Branch Cuttings (Vertical and Horizontal), Air Layering, Macroproliferation,Tissue Culture.
- Know-how for "Reshaping the gums" was developed and demonstrated by FRI, Dehradun transferred to M/s R.S. Food Processes (I) Pvt. Ltd., Rajnandgaon, Chhattisgarh at a cost of ¡ 1,15,264/- on 12th August 2010.
- The technology was also transferred to M/s Rajput Enterprises Pvt. Ltd., Bhopal at a cost of ¡ 1,25,000/- by Dehradun on 15th December 2010.
- Application of ZiBOC in block boards is initiated at industrial level.

Honorable Union Minister of Environment and Forests, Govt. of India during All India Meet of National Biodiversity Authority, MOEF and States Biodiversity Boards at Chandigarh on 6th September 2010.

Demonstration of Compost Making from Water Hyacinth to SFD Officials, Punjab on 16th February 2010 at Chandigarh in Presence of Shri R.C. Nayyar, IAS, Financial Commissioner and Principal Secretary, Forests and Wildlife, Punjab, Shri B.C. Bala, IFS, PCCF, Punjab, Shri Jitendra Sharma, IFS, CCF (Hills).

Demonstration of Compost Making from Water Hyacinth to the Followers of Environmentalist Baba Balbir Singh Seechewal at Sultanpur Lodi (Punjab) on 15th February 2010

Essential oil, Perfumery and Aromatherapy from 23rd to 27th May 2011 at FRI, Dehradun

Demonstration of Dye Extraction and Dyeing Technology to SFD Punjab Officials and NGOs

IFGTB, Coimbatore

- Transferred seed handling techniques of forestry species to farmers and foresters through posters and trainings during various training programs and Tree Growers Mela at IFGTB, Coimbatore.
- Developed and disseminated "Regional Yield Table and Carbon Table for plantations of *Casuarina equisetifolia* in Tamil Nadu".
- A low cost and high recovery protocol for isolation of total RNA from guanidine recalcitrant tissues with high phenolic content using non toxic chemicals was developed (patent pending). Effort is under taken to commercialize the technology in collaboration with Biotech Consortium India Ltd, New Delhi. The technology assessment report of BCIL revealed high demand for this technology in the R&D market.
- Sh.V.K.W.Bachpai conducted four training for over 90 farmers from eight districts of Tamil Nadu. Clonal technology of *Eucalyptus* and *Casuarina* were demonstrated.

Training to Farmers of Tamil Nadu on "Capacity Building" on Clonal technology of *Eucalyptus* and *Casuarina*.

Supply of Improved Seeds

- About 73 Kg of improved seeds collected from seed orchards of *Eucalyptus, Casuarinas* and *Acacias* maintained by the Institute in different states in Southern India, and supplied to farmers, Forest Departments and industries in different states like Tamil Nadu, Pondicherry, Andhra Pradesh, Orissa, UP, Maharashtra and Gujarat for raising quality plantations. The plantation raised through seed orchard seeds showed outstanding growth performance is compared to the local seed source.

IWST, Bangalore

- Technical Bulletin was brought out on "Arbuscular Mycorrhizal (AM) fungi as bio-fertilizer in Forestry" (IWST Technical Bulletin No.5)

TFRI, Jabalpur

Organized one day training-cum-demonstration programme on "*D.sissoo-Zea mays* Silvi-agri system" to transfer the developed package of practice to the farmers of four villages namely Padariya, Khamariya, Neemkheda and Saliwada of Jabalpur district on 31st March 2011 at TFRI, Jabalpur.

RFRI, Jorhat

- PRA techniques and microplanning
- Bamboo Treatment
- Vermicompost
- Apiculture
- Patchouli agrotechniques
- Trichoderma production and field application
- Biopesticide production and field application
- Seed handling-grading and sowing techniques

On-farm Participatory Research on the following has also been Carried out –

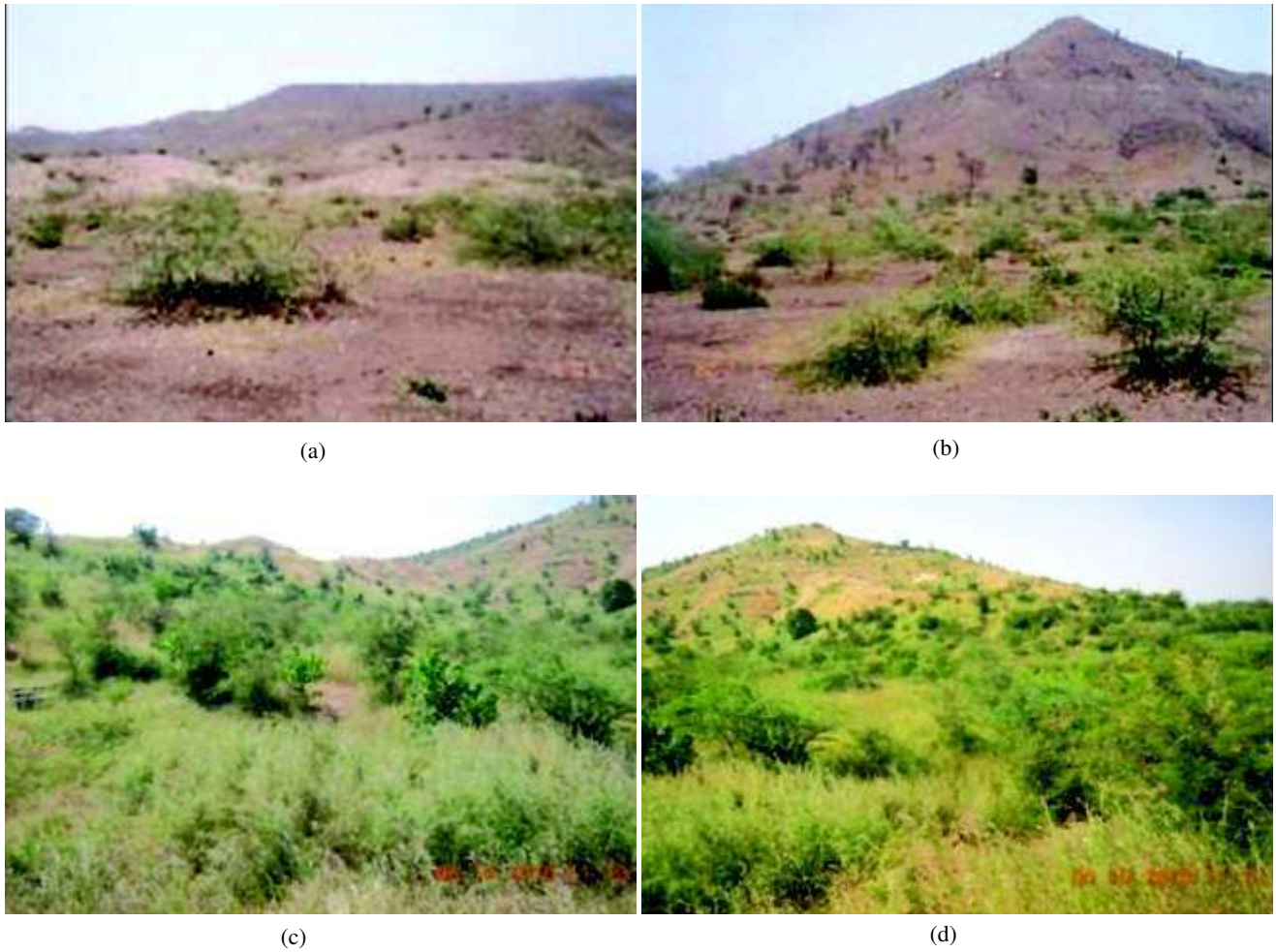
1. Agro-techniques for vegetative propagation of patchouli with reference to standard length and diameters of cuttings in nursery stage.
2. Development of patchouli based agroforestry models –
   a. Arecanut – patchouli agroforestry model
   b. Agar – patchouli agroforestry model
   c. Mangium – patchouli agroforestry model
3. Development of King Chili based agroforestry models.
   a. Arecanut – King Chili agroforestry model
   b. Mangium – King Chili agroforestry model
4. Development of Arhar–muskdana agroforestry model.
5. Development of Mangium – tea agroforestry model.
6. Development of Participatory Methodology for testing Adaptability and Sustainability of new techniques.

AFRI, Jodhpur

1. Rehabilitation of Degraded Aravlli Hills

   Disturbances to the natural habitats through overgrazing, vegetation removal and mining is a common feature in most of the hilly areas like Aravallis, which is an ancient mountain and one of the oldest geological formations in the world and the home of many tribes of India, leading to biological invasion and land degradation i.e., desertification. To restore these degraded hills, an experiment was conducted by applying rainwater harvesting (RWH) and afforestation with different tree species (*Zizyphus mauritiana*, *Acacia catechu*, *Azadirachta indica*, *Emblica officinalis*, *Dendrocalamus strictus*, *Gmelina arborea*, *Holoptelia integrifolia* and *Syzigium cumini*). RWH structures (Contour trench [CT], gradonie [GD], box trench [BT], V-ditch [VD] and a control) and slope gradient (<10%, 10-20% and >20%) of plots were two levels of treatments. Application on RWH improved soil characteristics like, reduction in soil pH and EC, and increase in soil organic carbon, NO_3-N and PO_4-P and reduced in gradients in soil water and nutrients between the plots of

<10% slope and >20% slope. This not only reduced run-off water, soil and nutrient losses and enhanced the growth of the planted seedlings, but also increased herbaceous layer productivity by 24 to 62% (average of six years) and soil carbon stock (by 3.8-fold). Contour trench and box trench were beneficial in plant growth, whereas, gradonie and V-ditch treatments were best for herbaceous growth and productivity. The impact of this practice was an increase in number of species from 39 in 2005 to 92 in 2009, increased water availability period from November to January/ March, fuelwood supply and fodder availability that resulted in enhanced socio-economic condition of the tribal people residing nearby areas. Thus, RWH and afforestation facilitates restoration process in degraded hills by improving soil nutrients, reducing resource in gradient between slopes and enhancing plant growth and herbage biomass.



(a) (b)

(c) (d)

Initial Status of the Hills (a & b) and Herbaceous Layer and Plant Growth During Restoration of Degraded Aravalli at Banswara in October 2010 (c & d)

Extension: Visits were made by the state forest department officials for replication by them for the adoption of technology and rehabilitation of degraded Aravalli hills. Results were published and presented in seminars, workshops and training programmes for wider publicity for adoption.

HFRI, Shimla

The farmers, field functionaries of the State Forest Department and other stakeholders were imparted various training programmes with respect to already standardized technologies.

4.3 Research Publications

Researchers at ICFRE have published 332 research papers in various journals including 92 aricles in foreign journals. Three hundered two research papers were presented/published in the proceedings of the conferences/symposia/ seminars, etc. A total of 57 books/ book chapters/ brochures, etc. were also published.

The National Centre for Biotechnology Information, USA assigned accession numbers to the following fungus genes isolates:

a. *Cordyceps sinensis:* 40
b. *Ganoderma lucidum*: 47
c. *Ganoderma resinaceum:* 2
d. *Ganoderma weberianum*: 2

4.4 Seminars/Symposia/Workshops Organized

Seminars

FRI, Dehradun organized the "National Seminar on Advances in Wood Science and Technology Research: Recent Trends, Future Challenges and Opportunities" at FRI, Dehradun on 9th and 10th March 2011 in which nearly 150 delegates from different Institutions/ Universities participated.

IFGTB, Coimbatore organized national Seminar on Tropical Ecosystems: Structure, Function and Services (TESFS -2010) on 28th and 29th December 2010.

IFGTB, Coimbatore organized the 2nd National Seminar on Casuarinas on 3rd and 4th March 2011.

IWST, Bangalore organized a National Seminar on "Recent Advances in Bamboo Propagation, Management and Utilization" on 17th and 18th February 2011. Dr. P.J. Dilip Kumar, Director General (Forests) and Special secretary, MoEF, Govt.of India, inaugurated the seminar. Dr. Kameshwar Ojha, DDG, National Bamboo Mission, New Delhi delivered the keynote address. Dr. Ashwatha Narayan, M.L.A., Malleshwaram, Bangalore and Sri. C.S. Vedanth, M.D., KSFDC was the guest of honour. Sri. S.C. Joshi, Director, IWST, Bangalore welcomed the delegates. Dr. Pankaj K. Aggarwal, Sc-E, IWST, Bangalore delivered vote of thanks. On this occasion a souvenir containing the abstracts of the papers was also released by the chief guest. In the two days deliberation, about 65 papers were presented orally and 18 papers were presented in the form of posters. On the 18th February 2011, a concluding session was conducted and recommendations of the seminar were finalized.

IFP, Ranchi organized a regional seminar on "Challenging and Emerging Issues in Sustainable Utilization of Medicinal Plants" on 28th January 2011.

Workshops

ICFRE, Dehradun organized two days workshop for finalization of DST training programme at ICFRE, Dehradun on 28th and 29th January 2011. Thirty two participants from different institutes participated in this workshop.

FRI, Dehradun organized National Workshop on "Landscape Restoration Process-Challenges and Opportunities" on 22nd and 23rd February 2011.

FRI, Dehradun conducted one summer school for the students, teachers and research scholars of Uttarakhand state from 26th September to 8th October 2010.

IFGTB, Coimbatore organized two days "Consultative Workshop on Strategies for Formulation of Forest Genetic Resources Management Network (FGRMN)" at IFGTB,

Coimbatore on 9th and 10th March 2011. A total of 118 participants of senior Forest officers from different states, Professors from Universities, scientists from various Research Institutes and officials from Industries attended the workshop.

IFGTB, Coimbatore organized the "Stakeholder's Workshop on Forest Research and Extension" at Thiruvananthapuram on 19th May 2010.

IFGTB, Coimbatore organized a Stakeholder workshop on Forest Research and Extension involving the officials of Tamil Nadu Forest Department at Panagal Maligai, Forest Headquarters, Tamil Nadu on 28th April 2010.

IFGTB, Coimbatore organized stakeholder's workshop on Forest Research and Extension in collaboration with the Kerala Forest Department at Forest Headquarters, Tiruvananthapuram on 19th May 2010.

IFGTB, Coimbatore organized the stakeholder's workshop on Forest Research and Extension in collaboration with the Department of Environment and Forests, Andaman and Nicobar Islands on 31st May 2010.

IFGTB, Coimbatore organized an interactive workshop with farmers on Plantation Technologies on 5th June 2010.

IFGTB, Coimbatore organized workshop on All India Multi-Locational Trials of *Eucalyptus*" on 29th and 30th July 2010.

IFGTB, Coimbatore organized workshop on organizational behaviour with the objectives of Exposing the "Live Scientists" to some fundamental concepts of behavioural science and organization behavior on 20th August 2010.

IFGTB, Coimbatore organized capacity building workshop for production of genetically improved planting stock" on 13th August 2010.

IFGTB, Coimbatore organized training workshop on "Management of Forest Genetic Resources" for Indian Forest Service officers on 18th and 19th October 2010.

IFGTB, Coimbatore organized workshop on Methodologies for QTL and Association Mapping on 23rd December 2010.

IFGTB, Coimbatore organized workshop on Papaya Mealy Bug (*Paracoccus marginatus*) infesting Tree Crops for farmers and foresters on 30th December 2010.

IFGTB, Coimbatore organized workshop on cultivation and management of tree crops for farmers of Kerala organised in association with Kerala Forest Department on 31st January 2011.

IFGTB, Coimbatore organized workshop on best practices in tree farming for farmers of Tamil Nadu in association with Tamil Nadu Forest Department on 24th and 25th February 2011.

IFGTB, Coimbatore organized workshop on "Bio-remediation of contaminated soils for sustainable productivity" with Tamil Nadu Forest Department on 25th March 2011.

IWST, Bangalore organized workshop on wood handicrafts: future strategies on 9th July 2010. The workshop was inaugurated by Mr. Lukose Vallatharai, Managing Director, KSHDC; Mr. A.K. Verma, MD, KSFIC; Mr. C.S. Vedant, MD, KSFDC; Mr. S.C. Joshi, Director, IWST were the other dignitaries. Nodal Officer was Dr. Pankaj K. Aggarwal, Scientist E.

TFRI, Jabalpur organized a workshop on 'Research needs and the financial, technological and capacity needs and constraints to address climate change concerns *vis a vis* forests and forest products in India' on 1st September 2010.

TFRI, Jabalpur organized a workshop/ Interface programme on "Conservation and

Sustainable harvesting practices of medicinal plants and other NTFPs for the Forest Protection Committee members and interested persons of village Bhundakone, Umargohan and Damgarh of Amarkantak Range on 6th January 2011 and village Karidih of East Karanjia Forest Division (MP) on 7th January 2011.

TFRI, Jabalpur organized a workshop on "Non-Timber Forest Products Marketing: Issues and Strategies" on 19th February 2011.

AFRI, Jodhpur organized one day interactive workshop on Climate Change Concerns: Needs, opportunities and gaps" on 14th June 2010 to discuss on research needs, and the financial, technological and capacity needs and constraints to address climate change concerns vis a vis forest products in the arid zone of India.

AFRI, Jodhpur organized an interactive workshop on National Mission on Green India-linking research and future scope on 2nd July 2010 to discuss the opportunities and challenges to linking research to the mission activities and goal.

AFRI, Jodhpur organized a three days workshop-cum meeting on khejri mortality from 21st to 23rd August 2010 in which scientists from different institutes of ICFRE, ICAR, NGO's, and progressive farmers participated.

AFRI, Jodhpur organized DST-Group monitoring workshop for Technology Interventions for Addressing the Societal Needs (TIASN) on 18th and 19th November 2010.

HFRI, Shimla organized a Stakeholders' Consultation titled "Setting up of Forestry Research Need Assessment: Institutionalizing the Process in the State of Jammu & Kashmir" for identifying research priorities of the state on 1st July 2010 at Van Bhawan, Jammu (Jammu & Kashmir) under the Chairmanship of Shri Jagdish Kishwan, IFS, Principal Chief Conservator of Forests, J&K. For making the consultative process more broad based across various cross-section of stakeholder of the region, participants from various specialists groups, NGOs, progressive farmers and local community based organizations such as Mahila Mandals, Yuva Mandals etc. were invited.

HFRI, Shimla organized Stakeholder's Consultations on Forestry Research Need Assessment: Institutionalizing the Process in the State of Himachal Pradesh on 6th August 2010 under the Chairmanship of Shri Vinay Tandon, IFS, Principal Chief Conservator of Forests, H.P. About 50 participants comprising of Senior Forest Officers of the State Forest Department, other stakeholders of the state and officers & scientists of the institute including research staff were present during the meeting.

HFRI, Shimla organized a workshop on Conservation, Assessment, Management and Prioritization of Medicinal Plants of Himachal Pradesh (CAMP Workshop) for strategizing conservation actions from 1st to 4th December 2010.

In order to identify the status, research needs, policy frame work and other related issues of watershed especially in the Western Himalayan context, HFRI, Shimla organized a one day's brainstorming interactive workshop on "Enhancing Water Potential of the Watershed: Issues and Concerns" on 23rd March 2011. The workshop had also been integrated with the celebration of INTERNATIONAL YEAR OF FORESTRY. About 60 participants from Himachal Pradesh Forest Department, Line Departments of Government of Himachal Pradesh, Scientists from UHF, Nauni, Solan Integrated Institute of Himalayan Studies, Representatives of non-governmental Organization including Progressive Farmers, participated in this workshop. Besides, officers,

scientists and other research support staff from the Institute were also present during this day long deliberations.

IFP, Ranchi organized national workshop on Optimizing Biodiversity and Social Security in Mining areas on 7th October 2010 in collaboration with Balipara Tract & Frontier Foundation, Assam.

Conference

IFP, Ranchi organized a national conference on "Conservation, Improvement and Sustainable use of Medicinal Plants & Non Wood Forest Products" on 8th and 9th March 2011.

4.5 Consultancies

Environment Management (EM) Division under the Directorate of Extension, ICFRE undertakes consultancies in the area of environment and forest for sectors like hydropower, mining, infrastructure, highways etc. Also, it coordinates with the EIA Cells in the institutes of ICFRE for undertaking region based consultancies. Till March 2011, the Division has completed 30 EIA/ EMP studies worth ¡ 1193.02 lakh and 10 projects worth ¡ 295.81 lakh are underway.

ICFRE is a leading identified service provider in the field of environment and forestry. The council helps clients in diverse sectors based on natural resources, such as, hydropower, mining sector, highways, oil exploration, infrastructure, forest management, landscape and restoration development by providing environmental management solutions.

During the year 2010-2011, following consultancies have been completed and awarded:

A. Completed Consultancies:

- Environmental Impact Assessment and Environment Management Plan for Kuther Hydroelectric Project (KHEP) studies for generation of 260 MW, a run-off river scheme proposed on River Ravi, Chamba districts of Himachal Pradesh of JSW Energy Ltd. Mumbai.
- Biodiversity assessment was made under various ecosystems along the proposed Ganga Express Highway from Greater Noida to Balia. A detailed report has been submitted to M/s Jaypee Ventures P. Ltd., Noida, Uttar Pradesh.

Cultivated Agriculture Land with Agri- Crops and Water Bodies

Nilgai (Females) in Agriculture Field in UP

- Biodiversity assessment was made for proposed Unnao Land parcel, Unchahar Land Parcel and Wet Land Study of Patiyali Land Parcel project". M/s Jaypee Ventures P. Ltd., Noida, Uttar Pradesh. Detailed report has been submitted.
- Biodiversity assessment in ravines and Chambal Sanctuary for Kanera lift irrigation scheme in Bhind district of Madhya Pradesh and report submitted to Water Resources Department, Gwalior, (M.P.).

B. Awarded Consultancies:

1. Comprehensive EIA and EMP study for Bhunakha hydroelectric project in Chukha Dzongkhag District in Bhutan by Tehri Hydro Development Corporation India Limited (THDC).

View of Settlement in Study Region in Bhutan

2. Comprehensive EIA studies and formulation of EMPs for Gyspa (300MW), Nakthan (141 MW) and Beri Nichli (78MW), Thana Plaun (141 MW) and Surgani Sundla (42 MW) in Himachal Pradesh by Himachal Pradesh Power Corporation Limited (HPPCL).

Gyspa Project Site, HP

Thana Plaun Project, HP

3. Catchment Area Treatment Plan for the Kutehr Hydropower Project in Himachal Pradesh by JSW Energy Limited.

During the period, the EIA team of ICFRE has also participated in Expert Appraisal Committee meetings conducted by MoEF for the following projects:

1. EIA and EMP for Kuther Hydroelectric Project (KHEP) (260 MW) Chamba districts Himachal Pradesh. JSW Energy Ltd. Mumbai.
2. EIA & EMP with Catchment Area Treatment Plan (CATP), Hydrology and Drainage Studies for Ankua Iron Ore deposits in Jharkhand.JSW Steel Ltd. Mumbai.

During the period from April 2010 to March 2011, the division has successfully completed following project:

1. Preparation of EIA & EMP with Catchment Area Treatment Plan (CATP), Hydrology and Drainage Studies for Ankua Iron Ore deposits in Jharkhand. JSW Steel Ltd. Mumbai.
2. EIA, EMP, SIA, Socio-economic Baseline Survey and R&R Plan" for Tidong – II (60 MW) HEP project in Kinnaur district, Himachal Pradesh. Himachal Pradesh State Electricity Board.
3. Biodiversity Assessment report for Ganga Expressway from Greater Noida to Balia Project'.M/s Jaypee Ventures P. Ltd., Noida.
4. Biodiversity Assessment study report for Unnao Land parcel, Unchahar Land Parcel and Wet Land Study of Patiyali Land Parcel project". M/s Jaypee Ventures P. Ltd., Noida.
5. Biodiversity Impact Assessment study for Kanera lift irrigation scheme in Bhind district of Madhya Pradesh. Water Resources Department, Gwalior, (M.P.)

Keeping in view the quality of earlier undertaken consultancy to the Royal Government of Bhutan, Tehri Hydro Development Corporation India Ltd. has awarded another hydroelectric project Bunakha HEP for comprehensive environmental impact assessment for worth ¡ 75.80 lakh.

An MoU has also been signed with Himachal Pradesh Power Corporation Limited for undertaking comprehensive EIA studies for the following projects worth ¡ 205.01 lakh:

1. Comprehensive EIA study for Gyspa Hydroelectric Project (300 MW), Himachal Pradesh.
2. Environmental Impact Assessment and Environmental Management Plan for Tosh Parvati (400 MW) HEP Project, Himachal Pradesh.
3. Comprehensive EIA study for Beri Nichli Hydroelectric Project (78 MW), Himachal Pradesh.
4. Comprehensive EIA study for Thana Plaun Hydroelectric Project (141 MW), Himachal Pradesh
5. Environmental Impact Assessment and Environmental Management Plan for Surgani Sundla (42 MW) HEP Project, Himachal Pradesh.

Moreover, JSW Energy Limited has also awarded preparation of Catchment Area treatment plan for the Kutehr HEP, Himachal Pradesh.

During the year, following projects for which EM Division, ICFRE conducted EIA studies and formulated EMP was accorded Environmental Clearance from Ministry of Environments and Forests:

1. EIA and EMP for Kuther Hydroelectric Project (KHEP) (260 MW) Chamba districts Himachal Pradesh.JSW Energy Ltd. Mumbai.
2. EIA & EMP with Catchment Area Treatment Plan (CATP), Hydrology and Drainage Studies for Ankua Iron Ore deposits in Jharkhand. JSW Steel Ltd. Mumbai.

FRI, Dehardun

- Undertaken analysis for characterization of biomass feed stock from Nagarjuna Fertilizers and Chemicals Limited, Nagarjuna Hills, Hyderabad.
- Ten numbers of steam-heated type kilns were modernized and re-installed at the premises of the U.P. Export Corporation Limited, Saharanpur under the technical supervision of scientist of the Wood Seasoning Discipline last year. One year technical service after the completion of the consultancy was done during the year. These kilns are fully being used commercially for timber seasoning by the Corporation.
- Dr.Vimal Kothiyal, Head, Forest Products Division, provided consultancy to M/s India Tourism Development Corporation Ltd and revenue earned from consultancy.
- Consultancy on, "Laboratory Testing of Bio-Pesticide Photorhabdus liminescens 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.
- Archaeological Survey of India for conservation of trees at Ta Prohm temple at Cambodia.
- Bodhgaya temple Management Committee, Bodhgaya for the maintenance of Bodhi vriksha.
- Worked in consultancy of "Renuka Dam" Project funded by Himachal Pradesh Hydro-electric Project Ltd.
- Worked in consultancy of "DEFRA project".
- Worked in consultancy on "Development of potted plants for NCT of Delhi" funded by Govt. of Delhi.

IFGTB, Coimbatore

Environmental Impact Assessment (EIA)/ Environmental Management Plan (EMP) for Bunakha Hydroelectric project of Bhutan awarded by Tehri Hydro Electric Development Corporation Ltd.

Preparation of Comprehensive Environmental Impact Assessment (EIA)/ Environmental Management Plan (EMP) for Sankosh multipurpose Hydroelectric project, Bhutan awarded by Tehri Hydro Electric Development Corporation Ltd.

Completed a consultancy project on "DNA profiling of *Eucalyptus* and *Acacia* hybrids" for the Mysore Paper Mills, Bhadravathi, Karnataka.

IWST, Bangalore

- Monitored and evaluated the work carried out by the College of Forestry, Ponnempet, University of Agricultural Sciences, Dharwad from ICFRE Grant-in-aid.
- Monitored and evaluated the work carried out by College of Forestry, Sirsi, University of Agricultural Sciences, Bangalore from ICFRE Grant-in-aid.
- Services such as wood identification, determination of moisture content, density and strength properties were rendered to various organizations (Govt/No-Govt/PSU/Private etc.)
- Provided EIA and EMP consultancy to the Bhunakha Hydro-electric project (180 MW) taken up by the Bhutanese Government.
- Provided EIA and EMP consultancy to the Sankosh Hydro-electric project (4060 MW) and Sankosh multi-purpose project, taken up by the Bhutanese Government.
- Provided EIA/EMP consultancy to Ankua Iron Ore mines of JSW Limited, Jharkhand.

TFRI, Jabalpur

1. Survey and documentation of flora and fauna in core and buffer zones of cement plant and limestone mining areas near Maihar (district– Satna, M.P.).
2. Assessment of green cover and its tangible and intangible benefits and tree cover management plan for NCPP-Dadri Project.
3. Concluded the study and submitted final report on 'Survey and documentation of flora and fauna in core and buffer zones of cement plant and limestone mines in Maihar (Dist. – Satna, M.P.) to Reliance Cementation Pvt. Ltd., Mumbai.
4. Assessment of green cover and its tangible and intangible benefits and tree cover management plan for STPP-Korba Project.
5. Conducting the study on faunal aspect of Biodiversity impact assessment study for Kanera Lift Irrigation Scheme in Bhind district of Madhya Pradesh as a consultant and submitted the survey report to ICFRE Dehradun vide letter No.Ento-3/TFRI/JBP/ 2010/1161, 29th June 2010.
6. Monitoring and Evaluation of development work in Achanakmar-Amarkantak Biosphere Reserve, Bilaspur (March 2011).

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.

HFRI, Shimla

The institute recently has been awarded a consultancy by State Forest Department Jammu and Kashmir for Assessment of Khair Trees in non-Forest Land in Five District of Jammu at a cost of ¡ 57.50 lakh.

The institute recently has been awarded a consultancy for Preparation of CAT Plan for Phinan Medium Irrigation Project in Chuwari of Dalhousie Forest Division, District Kangra at a cost of ` 15.00 lakh.

The institute has successfully completed a Consultancy titled, "Taking Up Studies on Environment Impact Assessment (EIA) and Preparation of Environment Management Plan

(EMP) for Integrated Kashang Hydroelectric Project (243 MW) in District Kinnaur of Himachal Pradesh", assigned by M/ S Himachal Pradesh Power Corporation Ltd., Shimla to the tune of ¡ 30.0 lakh. After undertaking the EIA studies, a comprehensive EMP was prepared in which all the required aspects, including Public Hearing and Public Consultation meetings with the local administration and local people were organized. The relevant suggestions put forth by the local administration and local people were incorporated in the EMP. The EIA and EMP were presented before the Specialist Committee constituted by the Government of Himachal Pradesh for the purpose, authorities of Himachal Pradesh State Pollution Control Board. The relevant suggestions of both the above authorities were incorporated in the Plan. Finally, the Plan was presented before the Expert Appraisal Committee (EAC) of Ministry of Environment & Forests, Government of India, New Delhi on 14th September 2009. The EAC has raised certain issues and suggested to take up studies on Fish Fauna. The suggestions of the EAC were incorporated in Plan and the revised Plan was presented before EAC again on 15th December 2010. Finally, the EIA and EMP prepared by HFRI was approved by the EAC and the efforts put in by the HFRI were appreciated.

A consultancy titled "Preparation of Catchment Area & Treatment Plan for Phina Singh Medium Irrigation Project, Nurpur, Distt. Kangra (HP)" to the tune of ¡ 15.00 lakh only was finalized and submitted to the consulting Organization i.e. Executive Engineer, IPH Division, Nurpur, District Kangra (HP).

Director, Himalayan Forest Research Institute Shimla organized a presentation of Phina Singh Medium Irrigation Project at the institute on 4th September 2010, where officers from State Forest Department and Irrigation & Public Health Department Himachal Pradesh were present. This consultancy is being implemented by HFRI, Shimla for preparation of CAT Plan of the project.

IFP, Ranchi

- Terms of reference for the project on "Estimate of Kendu (*Diospyros melanoxylon*) leaves production in Jharkhand" was signed on 19th January 2010 in between Jharkhand State Forest Development Corporation Limited, Ranchi (Funding Agency) and Institute of Forest Productivity, Ranchi (Implementing Agency). [Budget: ¡ 29.00 lakhs; Project Period: 6 months]
- "Preparation of Conservation Plan of the specified Faunas at Karo and Tetariakhar OCP" awarded by CCL, Ranchi was completed.

4.6 Technical Services

FRI, Dehradun

- Rendered various technical services to Indian Pulp and Paper Industries.
- One sample of derivatized starch received from M/s DAVAR Adhsive, 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, Maharasthra.
  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, Bhuvneshwar, ODISHA.
  12. M/s Melfrank Engineers, Mumbai.
  13. M/s Koolaquo Towers Private Ltd., Kolkata.
- Field Inspection of Dalbergia sissoo and *Eucalyptus* entries for release. Visited Punjab (Patiala, Ludhiana, Hoshiarpur); Haryana (Hissar); Uttarakhand (Haldwani), from 21st to 28th September 2010 for observations on insect attack on the clones.
- Investigations on oak defoliator at Nauharadhar, Himachal Pradesh.
- Surveyed Haryana, Uttarakhand and Punjab for Status of *Leptocybe invasa*, infestation on Eucalyptus.
- 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
- Medicinal plants seedling production for Delhi government
- Identification of Insect Services:
  1. Dr. M. Sawmliana Chanmari, West Aizawal, Mizoram sent insect material for identification on 31st December 2010. (Report on identification has been sent).
  2. Dr. S.P. Saxena, ASPEE College of Horticulture and Forestry, Navsari Agriculture University, Navsari Gujarat, sent insect material for identification on 6th November 2010. (Report on identification has been sent).
  3. Dr. S. I. Ahmed , Arid Forest Research Institute, Jodhpur Rajasthan sent insect material for identification on 24th January 2010 (Report on identification has been sent).

IFGTB, Coimbatore

IFGTB provided technical advice to Kerala Forest Department, 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.

The institute rendered the services for identification of about 28 species near Ecorestoration Centre at Thathengalam for Wildlife Warden, Silent Valley National Park, Kerala.

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.

Provided the information on nectar and larval host plants of butterflies suitable for Kerala condition to the Chief Conservator of Forests (Wildlife), Palakkad, Kerala. Also provided information on nectar and larval host plants of butterflies suitable for Coimbatore condition to the Park Group of institutions, Coimbatore, for developing the butterfly park.

IWST, Bangalore

Timber testing:

- Analytical services were rendered to Wild life Crime Control Bureau, Southern Region, Chennai, Commissioner (customs), Chennai, Forest Department and public. Analysis of essential oils from sandalwood samples, *Pterocarpus santalinus* samples, other wood powders etc. A number of technical inquiries on utilization of various non wood forest products from Government Departments and public were attended to and advice given.
- Five wood samples received from end users were analyzed for their preservative content and reports were sent.
- 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.
- Inspection in the zoo garden was carried out for the "Wood Decay problems" in living trees and suggestions were given.
- Tested the samples received from Reliance Industries Ltd. for the presence of fungus and test report was sent.
- Suggested control measures for the disease problem of neem tree as per a request from FRO, Bangalore.
- MoU for the project "Termite and borer resistance of shellac-based varnishes" in collaboration with IINRG was signed by Director and sent to ADG, ICFRE for approval on 8th March 2011.
- Technical advice on wood utilization under marine conditions to the Shipwright School, Indian Navy, Visakhapatnam

TFRI, Jabalpur

- Technical and advisory services to M.P. Forest Department, on insect attack in teak at Khandwa Forest Division, Khandwa, from 2nd to 4th August 2010.
- Technical and advisory services to M.P. Forest Department, on defoliator and borer attack in sal forests at Karanjia range of Dindori Forest Division, Dindori, on 12th and 13th August 2010 and also on borer attack in sal forests from 7th to 9th December 2010.

AFRI, Jodhpur

- Evaluation of plantation work on GAURAV PATH developed by Jodhpur Development Authority (JDA), Jodhpur.
- 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

The institute provided plant identification, analysis of soil (moisture contents, organic carbon) for Forest Survey of India, Northern Zone, Shimla.

4.7 Activities of Rajbhasha

ICFRE and its institutes are continuously working in the direction of implementation of Rajbhasha rules and regulations in its day to day functioning with a view to promoting the use of Rajbhasha to the maximum. ICFRE, Dehradun organized a training workshop on Hindi Software "Saransh" on 23rd November 2010. Over 250 officers, scientists and staff of ICFRE and FRI attended the training workshop. The workshop was addressed by Shri J.P. Singh and Shri Gagan Sharma, Aryan E-Soft, Pvt. Ltd., New Delhi.

ICFRE, Dehradun also organized a training workshop on Quarterly Progress Report on 27th January 2011. Over 50 personnel of ICFRE and FRI attended the training workshop. The workshop was addressed by Shri M.R. Saklani, Deputy Director Rajbhasha and Secretary NARAKAS, Dehradun.

The Council is conducting Rajbhasha Karyanvayan Meetings on regular interval at the institutes and the headquarters. Quarterly Progress Report is being compiled and sent to the Official Language Department of the MoEF. We are also observing Hindi Divas on 14th September and regularly organizing Hindi Week/Fortnight. ICFRE, Dehradun also participating in the NARKAS Meetings at the regular basis.

With a view to promoting the implementation of Rajbhasha Hindi, ICFRE is regularly publishing its in house magazine *Taruchintan* and half yearly Newsletter, Vaniki Samachar.

FRI, Dehradun

- Regular reports on Hindi work were submitted in the prescribed format.

Training a Hindi Software "Saransh" at ICFRE, Dehradun

- The scientists and staff of the Pathology Division participated in Hindi Goshthi on 3rd October 2010
- Hindi Diwas was organized on 14th September 2010. Hindi Essay and Shrut lekh competition was also organized for the officials of CSFER.
- Regular Rajbhasha samiti meetings were attended by officials by CSFER.
- Quarterly meetings regarding improvement in Hindi works were organized regularly.
- Scientific trainings/literature (pamphlets, brochures handouts etc.) have been developed in Hindi for different target groups.

IFGTB, Coimbatore

- IFGTB was awarded certificate and shield for commendable performance in implementation of official language for the year 2009-10 in Govt. Offices Category.
- Hindi Translator was recruited.
- Employees of IFGTB were nominated for training in Official language.
- Training was imparted to the employees of IFGTB in software "Saransh".
- Hindi Translator attended Half yearly meeting of TOLIC at Coimbatore.
- Preparation of brochure of IFGTB in Hindi.
- Submission of quarterly reports.
- Replying in Hindi for the communication received in Hindi.

IWST, Bangalore

Instructions regarding implementation of Rajbhasha issued by the Government of India and ICFRE during 2010-11were followed. In the chairmanship of the Director of the institute quarterly meetings of Rajbhasha were conducted regularly.

All efforts have been made to meet the target of 55% of correspondence in Hindi. The subject on the files available in different divisions and section of the institute has been written bilingually.

This institute is member office of Town official language implementation committee (NARAKAS) and takes active participation in seminars and meeting conducted time to time and the instruction/ suggestions are being followed.

Rajbhasha Orientation Programme for the officers of the institute on 31st August 2010 and 28th March 2011, Hindi noting and drafting for clerical staff on 25th June 2010 and a workshops on the working of Hindi software Saransh on 16th December 2010 were conducted.

Besides this, a workshop with an objective to provide general knowledge of Hindi stenography to the English stenographers was organised on 30th August to 10th September 2010 for the Hindi Pragya examination passed stenographers.

Two LDC's were trained in Hindi typing by placing them on depution to learn Hindi typing at Government of India Central Hindi training sub institute, Bangalore on 40 days full time Hindi typing conducted on computer.

"Hindi Pakhwada" and "Hindi Diwas Samaroh" were observed from 14th to 28th September2010.

FRC, Hyderabad

- Hindi fortnight was celebrated at Forest Research Centre from 14th to 24th September 2010. Essay, singing and eloquence competitions were conducted to celebrate the occasion.
- A workshop on implementation of Hindi was conducted at FRC, Hyderabad on 15th December 2010. Shri S.P. Choubey, Director, Rajbhasa, delivered a lecture on the importance and provisions of Rajbhasa in the official works of the MoEF.

TFRI, Jabalpur

- Organized Hindi pakhwara at TFRI, Jabalpur.
- Organised training/workshop in Hindi for the ministrial and technical staff of the institute.

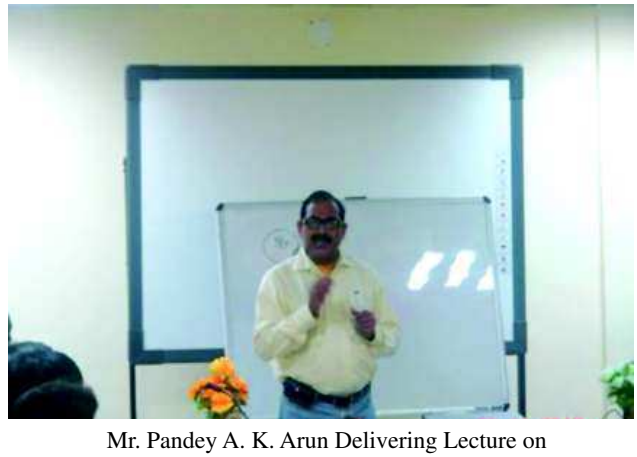
RFRI, Jorhat

"Hindi Week" was celebrated in Rain Forest Research Institute, Jorhat from 8th to 14th September 2010. The opening ceremony was inaugurated by Shri N.K. vasu, Director, RFRI. In his speech, Director briefly explained the importance of Hindi as an official language in Central Govt. offices/organizations. Almost all employees of RFRI attended the ceremony and most of them participated in various competitions like Hindi essay writing, dictation, poem recitation etc. The week long programme was ended on 14th September 2010 with the celebration of "Hindi Divas". Prizes and certificates were awarded to the best performers. This time, a special award was given to Shri S.N. Rahang for doing day to day official work in Hindi.

Officials Attending the Hindi Divas Ceremony at RFRI, Jorahat

Ms. I Ao, IFS and GC (R.) Distributing the Prizes

- A workshop in Hindi on the topic "Problems & Solutions regarding the implementation of Official Language in Office" was held on 29th November 2010 in the Conference Room of the Institute. Mr. N. K. Vasu, Director, RFRI chaired the session. Other attendants included I. Ao, GC(R), Scientists & other Officials of the Institute. Mr. Pandey A. K. Arun, Manager (Official Language), United Bank of India, Jorhat delivered a lecture in the workshop as Guest Lecturer.



Mr. Pandey A. K. Arun Delivering Lecture on Official Language Issues

Participants in the Workshop

- A workshop entitled "Use of Hindi in the Computer" was organized on 4th March 2011 in the Biotechnology & Genetics Division. Special emphasis was given on the practical use of Hindi in the day to day official works.

AFRI, Jodhpur

During the year 2010-11, 88.42% noting on the files were written in Hindi. Four Hindi workshops were conducted. Hindi magazine of the institute "AFRI DARPAN" were made more userfriendly and research activities were publicised in simple Hindi. Hindi fortnight was observed from 14th to 28th September 2010 during which various competitions were conducted. During Hindi fortnight, official language prizes for the year 2009-10 for the works in Hindi were given to the officials.

Two officials of the institute got five day training to work in Hindi on computer through C-DAC, Noida. The information book of the institute has been published in Hindi.

Institute was awarded with Rajbhasha Chal Vaijyanti and with appreciation certificate by NARAKAS, Jodhpur for the year 2009-10 for use of Hindi in the institute. Training and extension materials were prepared in Hindi and distributed. Useful and standard scientific articles/materials were sent for publication in different Hindi magazine.

HFRI, Shimla

Besides providing training material in Hindi, with a view to giving Hindi a proper place in the working system of the office, following forms were changed in Hindi/Bilingual:

1. All orders related to leave
2. Leave forms
3. Medical forms
4. Tour allowances and leave tour form facility
5. Credit Voucher
6. Debit forms
7. Application form for forest advance
8. Expenditure sanction forms
9. Application for vehicle
10. Annual confidential Report forms and office order in bilingual

A review committee has been constituted to review the progress of implementation of Rajbhasha Hindi in the institute. The committee in different reviews observed that percentage of work in Hindi has increased considerably in comparision to the earlier.

Saransh Software provided by the Headquarters has been installed in all the computers, which made the work easy. A training programme was also conducted for making the officers and officials well versed with the use of the software.

The institute regularly participated in the meetings of Town Official Language Implementation Committee, Shimla.

Hindi Diwas on 14th September and Hindi fortnight from 13th to 26th September was observed in the institue. Different competions were organised during the fortnight and the certificates were provided to the winners.

Director, HFRI, Shimla Distributed Certificates to the Winners of Essay Writing Competition

IFP, Ranchi

- Shri Binay Kumar Mishra, DCF and Shri A. K. Pandey, UDC attended the meeting of Ranchi Nagar Rajbhasa Karyanvayan Committee held on 25th August 2010 and 28th January 2011 at Ranchi.

4.8 Awards and Honours

FRI, Dehradun

- Dr. Rashmi, Scientist-C, Chemistry Division bagged Young Scientist Award for Best

Presentation (2010) in the 2nd Rashtriya Yuva Vaiganik Sammelan, Dehradun.

- Presentation entitled "HPTLC Fingerprinting profile of *Phaseolus trilobus* root" by Navpreet Kaur, Rashmi, Y.C. Tripathi was awarded Ist Prize for Best Presentation in the 7th Symposium on Phytochemistry and Ayurveda: Potential and Prospectus' held on 25th December 2010 at Dehradun.
- Presentation entitled 'Green approaches towards characterization of *Tinospora sinensis*' by Shipra Nagar, Vineet Kumar and Y.C. Tripathi was awarded Ist Prize for Best Presentation in the Conference on Environmental Conservation, Sustainable Natural Resource Management and Strategies for Regional Development - with reference to Uttarakhand, 1st and 2nd May 2011, Organized by Department of Chemistry, D.B.S. Post Graduate College, Dehradun.
- Dr. Parul Bhatt, Scientist-C received young scientist Award for presenting a research paper entitled "Characterization of DGPR and its applications as biofertilizers for growth enhancement in Chickpea (*Cicea Arietinum* L.)"at 5th Uttarakhand State Science & Technology Congress held from 10th to 12th November 2010 at Doon University, Dehradun.
- C.M. Mathavan and A. K. Raina received 3rd Prize in Poster presentation entitled "Pedospheric distribution of soil cationic micronutrient status under various landuse systems in Uttarakhand" at National conference on landscape restoration processes: Challenges and opportunities held at FRI, Dehradun on 22nd and 23rd February 2011.
- Dr. H.S.Ginwal was awarded by Brandis Award for best research publication for the year 2009, published in Indian Forester (Ginwal, H.S. and V.S. Jadon 2009). Observations on provenance variation in *Pinus kesiya* Royle ex Gordon using RAPD markers. Indian Forester 135 (4) : 449-458).
- Ms. Parveen, Scientist-C received award for best oral presentation on "Conservation and Propagation of Important and Threatened Medicinal Plants through Tissue Culture" during the technical session on "Sustainable Resource Utilization, Biodiversity characterization" of the "International conference on wildlife and biodiversity conservation vis-a-vis climate change" held at Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, Srinagar, J & K, India from 3rd to 5th June.
- Ms Parveen, Scientist-C and Ms Shivani Dobhal, Scientist WoS-B was awarded SAP for attending Pre-Congress Training from 15th to 21st August 2010 and IUFRO World Congress, Seoul, Korea from 23rd to 28th August 2010.
- Dr. Manisha Thapliyal won the Young Scientist Award for best oral presentation in Environmental Science & Forestry for her paper "Seed Morphology, Germination and Desiccation Studies in *Diploknema butyracea*" at 5th Uttarakhand State Science & Technology Congress, Doon University, Dehradun from 10th to 12th November 2010.

IFGTB, Coimbatore

- Dr. R. Yasodha obtained a travel award from IUFRO to attend the XXIII IUFRO Forestry Congress at Seoul, North Korea from 23rd to 28th August 2010.
- Dr. Modhumita Dasgupta, Scientist-E was awarded the Scientist Assistance Program (SAP) grant to attend the XXIII IUFRO World Congress 2010 from 23rd to 28th August 2010 at Seoul, Republic of Korea.

TFRI, Jabalpur

- Dr. R.K. Verma, Head, Forest Pathology Division received Association for Plant Taxonomy (APT), Prof. K.S. Thind Medal for the year 2010 for his significant contribution in the field of Mycology.

RFRI, Jorhat

- RFRI, Jorhat was awarded for progressive use of Official Language in the autonomous category in the 22nd meeting of Town Official Language Implementation Committee, Jorhat on 7th March 2011.

Shri N. K. Vasu, Director, RFRI, Jorhat is Receiving the Award

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 the "National Technology Day" at Shatabdi Van Vigyan Kendra by F.R.I, Dehradun on 11th May 2010. On this occasion, almost 800 students participated from different schools. On this occasion, entry to all the six museums was free.

World Environment Day

- FRI, Dehradun organized Environment Awareness programme while celebrating the World Environment Day & FRI Day in Convocation Hall of main building on 5th June, 2010. Dr S.S.Negi, Director, FRI appealed to clean surroundings and make it free from plastic and polythene. All the six museums were also kept free to the visitors during the celebration of the World Environment Day & FRI Day.
- FRC, Hyderabad observed the World Environment Day' by planting tree saplings at the FRC campus, Hyderabad on 9th June 2010.
- AFRI, Jodhpur observed the World Environment Day on 5th June 2010 by way of preparation of banner on the theme "Many Species, One Planet, One Future" and various activities such as lectures and plantation of tree saplings. A pamphlet was also released and distributed on the occasion to create awereness among the people.
- Confederation of Indian Industry and Young India alongwith IWST and Jain College of Engineering celebrated Environment Day on 5th June 2010. Dr. Pankaj K. Aggarwal, Extension Officer delivered a key note address during the function. Planting program was also done.
- HFRI, Shimla, in close collaboration with Himachal Pradesh State Forest Department (Wildlife) organized an "Awareness Generation Workshop of School Children and Local Villagers" on the "World Environment Day" i.e. on 5th June 2010 at Potter's Hill, near Himachal Pradesh University, Summer Hill, Shimla. The function was attended by the officers of State Forest Department of Himachal Pradesh, including representatives

Celebration of Wold Environment Day
at Potter's Hill, Shimla

of NGOs. About 150 school children from various schools alongwith their teachers and villagers from nearby villages participated in the activity. For encouraging the school children, competitions like Quiz Competition, Declamation contest, Slogan writing and Drawing/ painting competition were also organized by the institute.

Wildlife Week

- FRI, Dehradun observed the "Wildlife Week" from 1st to 7th October 2010. On this occasion the institute had organized an exhibition in the information centre of the FRI main building.
- RFRI, Jorhat observed the Wildlife Week form 1st to 7th October 2010. Painting competition, photo exhibitions, screening of Wildlife movies in the institute and Demo Village, bird watching and talks on wildlife.

Children Participating in a Drawing Compition at RFRI

Vigilance Awareness Week

- FRI, Dehradun observed "Vigilance Awareness week" from 25th October to 1st November 2010. During the week, an essay competition on the subject "Bhrashtachar ke Virudh Jagrukta Utpatti Evam Prachar" was organised. A workshop was also organised in the board room of FRI.
- Vigilance awareness week was observed at IFGTB, Coimbatore during the November 2010. Various competitions were held and prizes were distributed during the validiction of the awareness week.
- "Vigilance Awareness Week" was observed at FRC, Hyderabad from 25th October to 1st November 2010. Essay writing and eloquence competitions were conducted to observe the occasion.

National Science Day

The Forest Research Institute celebrated the National Science Day on 28th February 2011. During this day, there was free entry to all six museums for the school children and visitors.

World Forestry Day

Forest Research Institute celebrated the World Forestry Day. An Exhibition was organized at the FRI Information Centre which included posters and models depicting the achievements of the institute. FRI museums were thrown open to the public for the day. A large number of students

Participants of the Workshop "Enhacing Water Potential of the Watershed : Issues and Concerns" at HFRI, Shima

from various educational institutions and the general public availed this ticketless opportunity.

A one day's brainstorming interactive workshop on "Enhancing Water Potential of the Watershed: Issues and Concerns" was organized at HFRI, Shimla on 23rd March 2011. The workshop had also been integrated with the celebration of International Year of Forestry. About 60 participants from Himachal Pradesh Forest Department, Line Departments of Government of Himachal Pradesh, Scientists from UHF, Nauni, Solan Integrated Institute of Himalayan Studies, Representatives of Non-governmental Organization including Progressive Farmers, participated in this workshop.

World Forestry Day was organized at RFRI, Jorhat on 21st March 2011 at the "Demo Village- Mellang Grant", Jorhat,Assam. Painting competition for school children, release and display of posters on forestry activities, tree planting etc. were activities of the day involving the villagers.

Shri N.K. Vasu, Director, RFRI, Jorhat Releasing a Poster on Biodiversity of NE Commemorating International Year of Forest at RFRI Demo Village (Meleng Grant)

Van Mahotsava

Van Mahotsava was celebrated at FRC, Hyderabad by planting trees in the FRC campus, on 27th July 2010.

AFRI, Jodhpur celebrated "Van Mahotsav" ' at Kendriya Vidhyalya No. 2, Sikargarh Army Area, Jodhpur on 23rd July 2010. Around 150 seedlings of various shade trees were planted by the teachers and student in the KV campus. Director, Principal, HODs and some of students put their views on importance of forest and wild life. On the occasion of 'Van Mahotsav ' a brochure was published and distributed among students of Kendriya Vidhyalya No. 2, Sikargarh Army Area, Jodhpur.

Miscellaneous

Forest Research Institute, Dehradun participated the "Second yearly Dehradun Tree Festival" on the occasion of birth anniversary of Pandit Jawaharlal Nehru at Citizen For Green Doon, 140/9 Rajpur Road, Jakhan, Dehradun.

Birth Anniversary of Late Shri. Hari Singh (Former IGF) at Siri Fort Auditorium complex, New Delhi on 10th December 2011. On this occasion, a book "Hari Singh : A life sketch" was released. Dr. P.J.Dilip Kumar, Director General of Forest and special secretary, Govt. of India was the chief guest of this function.

Earth Day was celebrated at IWST, Bangalore at on 23rd April 2010. A plantation programme was organized. Mr. A.K. Verma, PCCF & MD, KSFIC and Prof. Ravindranath, IISc, Bangalore delivered talks on the occasion in addition to Director, IWST.

Demonstration cum interactive meeting was organized on 3rd September 2010 at Sitharamahattarapalya village of Yentaganahalli Panchayat by IWST, Bangalore. The villagers

were briefed about institute's different activities which are beneficial for the farmers and other village community. The information on techniques i.e., development of model nurseries, sandal plantation techniques, bamboo propagation and their uses etc. were given. The farmers were also told about the economic benefits and local usability (possible end use) various lesser known and plantation grown timbers i.e., *Acacia auriculaeformis*, *Dalbergia sissoo* (sissoo) and *Hevea brasiliensis* (rubber-wood), *Grevillea robusta* (silver oak), *Melia composita* (malabar neem), *E.* hybrid etc. Farmers enquired about the availability of seedlings of these species so that they can grow in their own fields.

Under the ongoing project titled "Integrated Community based Forest Management Project in Bihar", to give a further impetus to the agroforestry programme in North Bihar in general and district Vaishali in particular, a "Buyer-Seller Meet" on 27th and 28th July 2010 was organized at Patna which facilitated a direct interaction between the growers/ farmers involved in the activity and the agencies which either market or consume the agroforestry produce.

A wood user interactive meet and product exhibition was organized in the Institute of Wood Science and Technology during 23rd and 24th March 2011. The exhibition and meeting was inaugurated by Mr. Kaushik Mukherjee, Principal Secretary, Department of Forests, Govt. of Karnataka. The inaugural programme was also attended by Deputy. Director General Doordarshan, Bangalore along with local MLA. During, the meet, interactive sessions with architects, builders, interior decorators, handicraft sectors and wood utilization sector was organized. The wood product exhibition was well accepted by local peoples, students and several organizations. Large number of local people, students and wood industries visited the exhibition. The closing of the exhibition was done by Small scale industries and Forest Minister, Karnataka.

Participated in XI Paschimi Rajasthan Hasta-shilp Utsav 2011, Jodhpur organized by DIC and District administration to acquaint students, NGOs, progressive farmers and others with research highlights and technologies of AFRI from 2nd to 11th January 2011.

International Day for Biological Diversity on 22nd May 2010 was celebrated at AFRI, Jodhpur by on way of preparation of banner on the theme "Biodiversity, Development and Poverty Alleviation" and various activities such as lectures by scientific dignitaries and plantation of tree saplings. A pamphlet was also released on the occasion and distributed for wide publicity to create awereness among the people.

World Day to Combat Desertification on 17th June 2010 was celebrated at AFRI, Jodhpur by way of preparation of banner on the theme "Enhancing soils anywhere enhances life

Buyer-Seller Meet on Consumption of Agroforestry Produces at Patna

everywhere" and various activities such as lectures and plantation of tree saplings. A pamphlet was also released on the occasion.

Distinguished Visitors

Dr. Phil Harris, Prof. of Plant Scinece, Deptt. of Geography and Enviornment, Conventry University, UK visited AFRI, Jodhpur and delivered a guest lecture on 17th May 2010.

Shri Anant Roy, Honourable Forest Minister, West Bangal visited AFRI, Jodhpur on 20th and 21st October 2010. He learned about developed technologies and activities by AFRI, Jodhpur. He visited labs, interacted and addressed to Forest officials and scientists of AFRI, visited AFRI nursery. Director AFRI, CCFs Jodhpur and wild life informed to MIC, FT WB about various works. He also visited VVK works at Mohangarh and Bikaner with Shri M.R. Baloch, Head, Agroforestry and Extension Division, AFRI and with local Forest officials of state forest department, Rajasthan.

Shri K.S.Chouhan, IFS, CCF, Haryana, Panchkula, Shri Jagdish Chander, IFS,CF, Research Circle, Pinjore, Shri Balbir Singh Khokha, HFS, Divisional Forest Officer, Seed Collection Division, Pinjore and Sh. Paramjit Sagwan, Divisional Forest Officer, Research Division, Pinjore visited Institute from 31st January to 2nd February 2011. Detailed discussion was held with Director, Head of the Divisions related to forestry and agroforestry work of AFRI in arid regions of Rajasthan.

To provide further boost to forestry research activities especially in the Cold Deserts of Leh and Ladakh, falling in the state of Jammu & Kashmir, Sh. Jai Ram Ramesh, Hon'ble Minister of State (I/C) Environment & Forests inaugurated Cold Desert Field Research Station at Leh on 14th July 2010 in the presence of Jenab Mian Altaf Ahmed, Hon'ble Minister of Forest, Ecology and Environment, Govt. of J&K and Shri Chhering Dorjey, Hon'ble Chairman, Ladakh Autonomous Hill Development Council, Leh (J&K) and Shri Hem Pandey, IAS, Joint Secretary, MoEF, Govt. of India, New Delhi. Dr. G.S. Rawat, DG, ICFRE, Shri Mohinder Pal, IFS, Director, HFRI and other distinguished dignitaries and guests were also present during the inaugural ceremony of the station.

Inauguration of Cold Desert Field Research Station at Leh by the Then Hon'ble Minister of State (I/C) Environment & Forests, Shri Jai Ram Ramesh

For making the people more aware of the environmental issues in the present day scenario, a discussion followed by a film show was organized on 17th September 2010 by an Expert Team from British Council, New Delhi in association with WWF Shimla Unit. Senior functionaries of the Council besides officials from the institute attended the same.

Melas

Forest Research Institute participated in the Basant Mela organized by ITBP, Seemadwar, Dehradun from 11th February to

14th February 2011.During this programme, an exhibition was also arranged in the Basant Mela.

IFGTB, Coimbatore organised the second Karshaka Mela in association with Department of Forests and Wildlife, Kerala at Fine Arts Society Auditorium, Ernakulam, Kerala on 31st January 2011. Shri Binoy Viswam, Hon'ble Minister for Forests and Housing, Govt. of Kerala, Shri Dominic Presentation, Member of Legislative Assembly, Ernakulam, Shri T.M. Manoharan, IFS, Principal Chief Conservator of Forests and Head of Forest Force, Kerala, Senior officers of the Forest Department, scientists from KFRI, NGO representatives participated. About 600 farmers from various parts of Kerala took part in the mela. A workshop on cultivation and management of tree species suited to Kerala was organised.

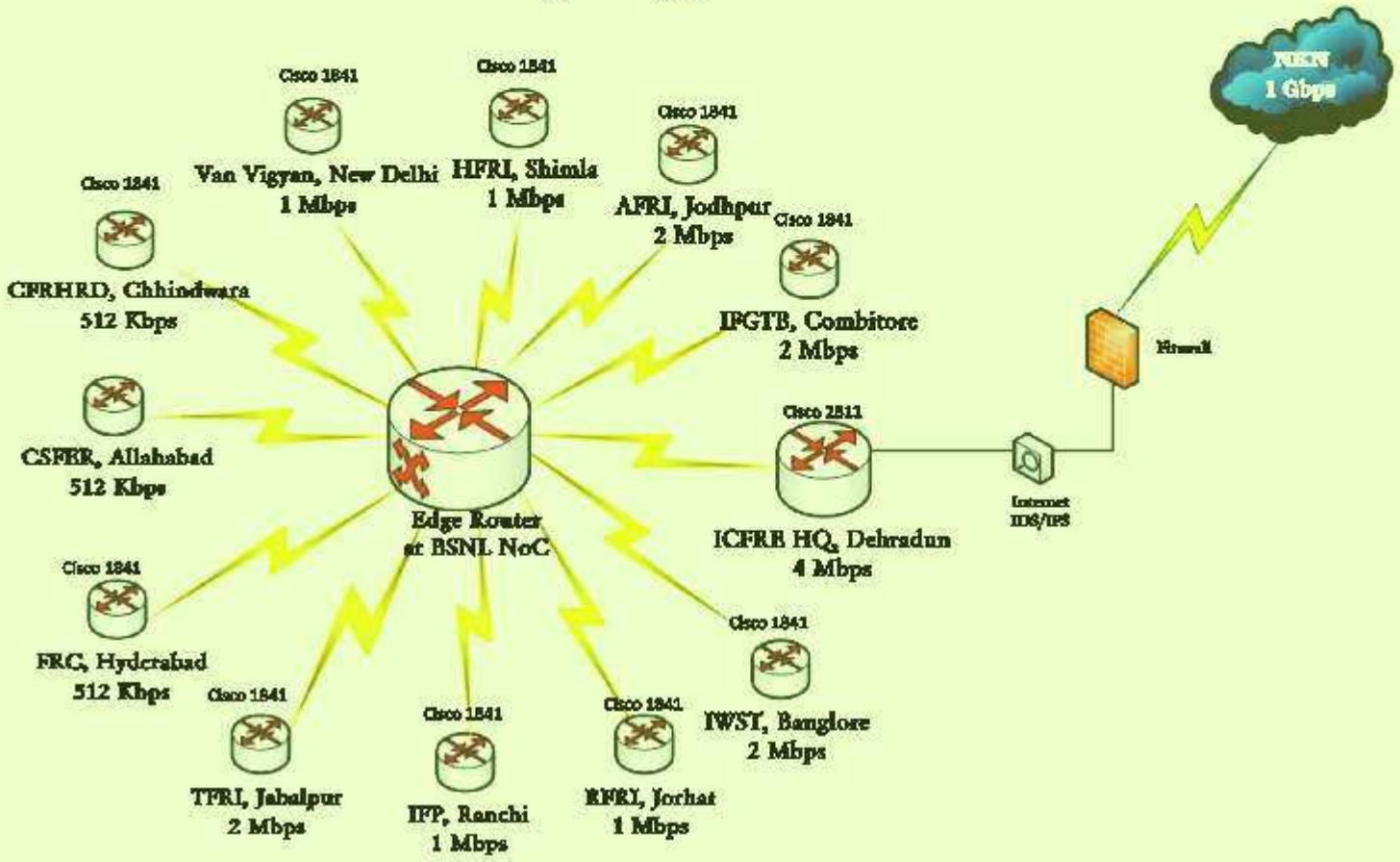
IFGTB, Coimbatore participated in the Palakkad District Tree Growers Association on 18th February 2011 at Perumatty and discussed about the cultivation and management of tree species suitable for Palakkad region, the marketing, quality planting stock production, plantation technologies, clonal forestry, seed handling methods, etc to more than 150 farmers.

IFGTB, Coimbatore participated by puting up a stall in the Forest Fest "Vana Vishmayam" organized by Kerala Forest Dept. From 6th to 10th February 2011 at Thiruvananthapuram.

IFP, Ranchi set up an exhibition stall in Kissan Mela 2011 organized by Rama Krishna Mission, Morhabadi, Ranchi at Getalsud, Ranchi from 4th and 5th February 2011. The IFP's stall was adjudged the best and was awarded 1st Prize.

IFP, Ranchi participated in Kissan Mela 2011 organized by Indian Institute of Natural Resins and Gum (ICAR), Namkum, Ranchi (IINRG), at Ranchi on 10th February 2011.

ICFRE
MPLS Topology



ADMINISTRATION AND INFORMATION TECHNOLOGY

ADMINISTRATION AND INFORMATION TECHNOLOGY

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 monies, 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.

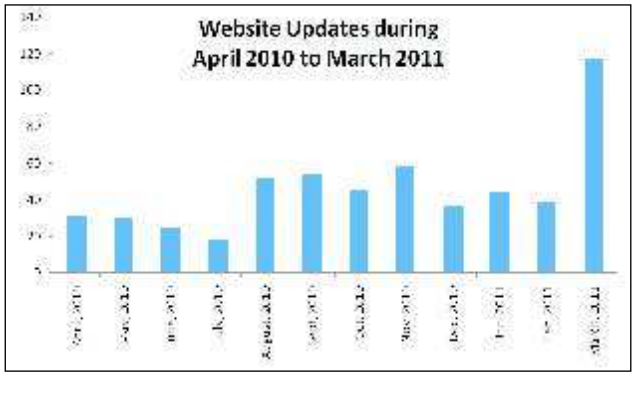
5.1 Information Technology

Information Technology (IT) is a pervasive and essential presence in today's world. It is touching lives and work like never before. ICFRE too is using Information Technology to progressively enhance organizational efficiency and user satisfaction. The Information Technology Division under the Directorate of Administration in ICFRE caters to the IT needs of the ICFRE Head Quarters and the Institutes under it that are spread across the country. The changes and advances in the area of IT take place at an extremely fast pace and ICFRE also strives to keep abreast with those changes. Meeting the organizational objectives and keeping abreast with the latest technology were the drivers for IT during 2010-11 in ICFRE.

ICFRE implements the e-Governance programme envisaged by the Ministry of Environment & Forests, New Delhi in terms of IT infrastructure and capacity building. Some of the basic hardware and software infrastructure that has been provided from the level of LDC upwards to the functionaries of ICFRE is as follows:

a. PCs and printers along with application software like word processor, spread sheet and presentation software has been provided.
b. Access to the websites has been provided. The website is bilingual and ICFRE strives to provide the latest information to its employees and the general public too through the websites of ICFRE and its institutes.
c. Access to internet is available to ICFRE functionaries through Local Area Networks which are also linked together through a Wide Area Network across the country spanning the Institutes and centres of ICFRE.
d. Email services of the organization are accessible to the users of ICFRE in all the institutes and centres of ICFRE along with the functionaries in the ICFRE Head Quarters. In this connection it is pertinent to mention that around 14 lakh email transactions took place through ICFRE web-server. This is a good indicator of the degree of adoption of IT in the organization.

As stated above, ICFRE has its own website which is accessed by users of the organizations and others. To provide current information to users at any time, the website is regularly updated. The graph below demonstrates the priority accorded by IT Division of ICFRE to updating the information for the users.



The basic infrastructure is mentioned above. Some of the important initiatives at ICFRE warrant greater details as shown below:

a. Development and usage of Indian Forestry Research & Information System (IFRIS).
b. Wide Area Network across the Institutes of ICFRE in the country.
c. Steps taken towards getting integrated with high bandwidth and scalable programme of the Government of India called National Knowledge Network (NKN)
d. Establishment and usage of ICFRE Server Farm (Data Centre).

Development and Usage of IFRIS

IFRIS was conceptualized with the aim to implement a comprehensive IT solution with the following objectives:

a. To convert some of the present working manual systems into automated systems.
b. To enhance access, efficiency, transparency and accountability in the context of work in the organization.
c. To enhance responsiveness of ICFRE through workflow automation and knowledge management.
d. To enhance ease of access to information and services by users and stakeholders in ICFRE.

The project was planned as a three stages activity viz. Conceptualization, Project Development and Software Development and Implementation. The work was assigned to M/s Sobha Renaissance Information Technology, Bangalore through competitive bidding. The project took off during the month of January 2008 and the system was partially functional in 2009-10. It is expected to be fully deployed in 2010-11.

IFRIS broadly comprises of two main parts viz. Indian Forestry Research Management Information System (IFRMIS) and Indian Forestry Research Administration Information System (IFRAIS). Some key components of IFRIS are as follows:

a. Research Projects Database including externally funded projects.
b. Grants and Research proposals.
c. Role based access to information/reports.
d. Downloadable summary of research reports.
e. Personnel Information, Pay Roll and Financial Accounting System Procurement and Inventory.
f. Real time availability of information on centralized data repository.

The approach in implementation of IFRIS has been to focus on those modules which touch the largest number of users in vital ways so that a transformation in institutional culture from working merely on hard copies to working in the digital sphere takes place. Pay Roll management system is one such example through which the pay rolls are generated by application software (IFRIS). Another example is putting in place the personnel information management module with particular emphasis on leave sub-module. Today, this allows us to deal with leave applications online, thus, saving a lot of time and paper. It also helps in making users more computer savvy and bringing about the transformation in institutional culture mentioned earlier.

Development of In-house IT Expertise and Enhancing User Capacity

Alongside bringing a cultural transformation, ICFRE has also created an in-house expertise in trouble shooting and modifying in a minor but fruitful way the existing software applications so that greater user satisfaction is achieved and greater facilities are available to them.

Project Institutional Framework has become an effective platform wherein Institute Apex Committees, Technical Committee and ICFRE Apex Committee regularly conduct meetings to

gather expectations and concerns of stakeholders and to review implementation progress.

e-Champions, the change agents, have been identified from all the Institutes for change management and adoption of application at the levels of organization. e-Champions have been trained through training-cum-workshops at ICFRE.

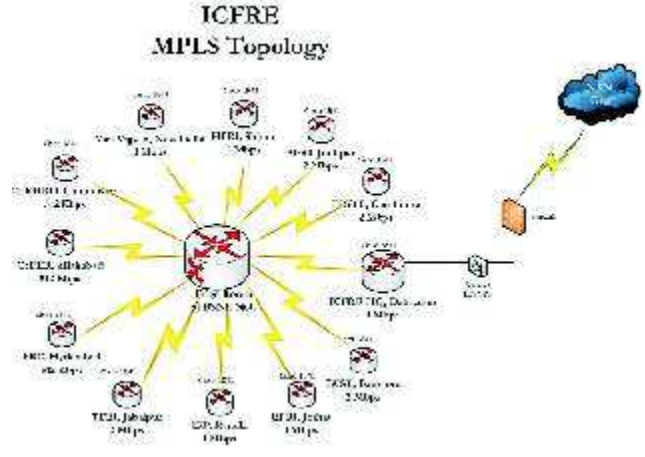
Wide Area Network Across the Institutes of ICFRE in the Country

All the institutes of ICFRE are connected with each other through a Wide Area Network (WAN). This is implemented through Multiple Protocol Level Switching - Virtual Private Network (MPLS-VPN) provided by Bharat Sanchar Nigam Limited (BSNL). All the digital data communication of ICFRE - including a fast internet connectivity, video conferencing across the institutes, data entry and retrieval, website and email services – take place through the aforesaid WAN. This has ensured that the management of related software and hardware is centralized and more efficient and focussed than would be the case in the absence of a WAN.

The WAN has created an organizational culture in ICFRE of communicating and sending documents through Email, sharing of ideas singly or through group Emails, use of applications across the WAN and spreading and enhancing familiarity with the application interface, recognition of the power and advantages of IT usage amongst the officials of ICFRE and eagerness to acquire IT skills that makes working faster and easier. This is paradigm shift in work culture that bodes well for the future.

The WAN of ICFRE also allows the organization to conduct video conferences that save time of money substantially. During the year 2010-11, more than 200 video conferences were held.

The diagram below gives an idea of the WAN topology.



National Knowledge Network

ICFRE moved towards getting integrated into the National Knowledge Network which is expected to provide high and scalable bandwidth with the possibility of connecting productively with other research and educational organizations in the country. Besides, NKN provides high bandwidth that would translate into better internet access and may also be a means to connect the various institutes of ICFRE through a higher bandwidth WAN that the one presently being used.

ICFRE Server Farm (Data Centre)

The ICFRE Server Farm (Data Centre) is at the very core of IT services that ICFRE provides. It hosts the IFRIS application and other allied key services like:

a. Database and application services.
b. Email, Web services, Domain Name Services and Proxy services.
c. Antivirus and other security products like Firewalls, Intrusion detection and prevention system etc.
d. Content filtering services like Anti-SPAM, Anti-Spyware etc.
e. Suitable Data Backup and Network Monitoring tools.

Based on its architecture, the type of services hosted and the monitoring protocols put in place, the ICFRE data centre has been granted in ISO 27001-2005 certified data centre and Services status.

5.2. Sevottam

The Sevottam framework consists of three components viz. The Citizens' Charter, Pulic Grievance lodging and redressal mechanisms and service delivery capability. ICFRE 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

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.

5.2.3 Details of Training Programmes, Workshops, etc. held for Proper Implementation of Charter

Providing information about the organization to its clients is one of the main functions of the Citizens' Charter. To achieve this, a large number of training programmes and workshops etc. were held by ICFRE and its institutes for the clientele of ICFRE. Some of these, only indicative of the kind of trainings and programmes that are taken up by ICFRE, are listed below:

1. Workshop on Non Timber Forest Products Marketing: Issues and Strategies was organized in February 2011 by Tropical Forest Research Institute, Jabalpur. Target groups for the workshop were harvesters, collectors, cultivators, members of the Joint Forest Management Committees, traders and manufacturers of herbal products.
2. Training Workshop on Conservation and Management of Forest Genetic Resources was organized by the Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore during 5th to 9th July 2010. Workshop was cosponsored by the ICFRE, Forest Research Institute, Malaysia (FRIM), APAFRI, Biodiversity International and

International Timber Trade Organization (ITTO).

3. IFGTB also organized a two days training on "PCR based Methods of Gene Isolation" on 29th and 30th July 2010 for students pursuing research in areas of Biotechnology, Biochemistry, Botany and allied sciences. The training was attended by eighteen researchers from various universities and colleges including Bharathiar University, Coimbatore, Forest College and Research Institute, TNAU, Coimbatore, Bharathidasan University, Tiruchirappalli, St. Josephs College, Tiruchirappalli, Kerala Forest Research Institute, Peechi and in house research fellows. The training encompassed both theory and practical sessions on methods of gene isolation and functional validation. Hands-on-training were provided on RNA isolation, PCR techniques, Competent cell preparation, cloning and Reverse Northern techniques.

a. An intensive hands on training programme on "Instrumentation Methods and Chemical Analysis" was imparted during 27th and 28th September 2010 at IFGTB. A training manual on "Metabolite Profiling: Current Techniques" was also released during the training programme. A total of 20 trainees from various colleges, institutions, organizations and Universities namely, Andhra University, Visakhapatnam; Shri Dharmasthala Manjunatheshwara College, Mangalore; Tamilnadu Agricultural University, Bharathiar University, Kongunadu Arts and Science College, PSG College of Arts and Science, Coimbatore participated in the training programme.

b. A Stakeholders' Consultation for "Setting up of Forestry Research Need Assessment: Institutionalizing the Process in the State of Himachal Pradesh" was organized at Himalayan Forestry Research Institute (HFRI), Shimla on 06th August 2010. The Principal Chief Conservator of Forests, Himachal Pradesh also participated in the consultation being a stakeholder.

c. Institute of Wood Science and Technology organizes 5 days and 3 days training courses on topics like field identification of important timbers, timber joinery, classification and grading of timbers, wood protection, modern seed and nursery technology, wood seasoning and preservation, extraction/purification techniques and instrument analysis, plant identification, field methods and herbarium techniques, integrated pest management, application of statistics in forestry and agroforestry system: concept and case studies. These trainings are being organized since year 2005-2006.

d. The Institute also conducts RAG meeting, Stakeholders interactive meet/liaison meetings, Indo-Italian seminar and compulsory training for IFS officers every year.

5.2.4 Details of Publicity Efforts Made and Awareness Campaigns Organized on Charter for the Citizen/Clients

The Charter itself has been given wide publicity by way of making it available on the World Wide Web. Besides, ICFRE made substantial and varied efforts regarding publicity and awareness generation programmes taken up to meet the objectives spelt out in the Citizens' Charter. An illustrative list, not exhaustive, of such efforts is given below.

a. The Institute of Wood Science and Technology (IWST) at Bangalore has the following publications/technical bulletins in English, Kannada and Telugu. They are made available to the public on payment basis.

	Brochures	Language
1	Sandal	Kannada
2	Tamarind	Kannada
3	Bamboo	Kannada
4	Casuarina	Kannada
5	Neem	Kannada
6	Eucalyptus	Kannada
7	Jatropha	Kannada
8	Gmelina (Shivani)	Kannada
9	Moringa (Nugge)	Kannada
10	Agarbathis	English
11	Catarmarans	English
12	Sandal	English
13	Biodeterioration of Wood and its Prevention in Indian Coastal Waters	English
14	Sandal	Telugu
15	Tamarind	Telugu
16	Bamboo	Telugu
17	Casuarina	Telugu
18	Neem	Telugu
19	Eucalyptus	Telugu
20	Red Sanders	Telugu
21	Catamarans	Telugu
22	Catamarans	Tamil
	Technical Bulletins/Information Series	
1	A Rapid and Non Destructive Technique for Estimating Growth Strain in Trees and Logs	English
2	Detection, Identity and Management of Insect Pests of Timber	English
3	Wood Seasoning & Preservation	English
4	A Guide to some Important Timbers in South Indian Markets	English
5	Sandalwood Tree (pests and diseases and their management)	English
6	Portable Distillation Unit to Extract Essential Oil	English
7	Ammonia Plasticization of Coconut Wood for Value Addition	English
8	SAP Displacement Techniques for Treating Small Girth timber on Bamboo	English/Kannada
9	Whitefly Pests in Forestry and their Management	English
10	Arbuscular Mycorrhizal (AM) Fungi as Biofertilizer in Forestry	English
	Books	
1	Santalam Album (Sandal)	English
2	Biodeterioration of Timber and its Prevention in Indian Coastal Waters - 3rd Progress Report 1982-2005	English
	Proceedings	
1	Forestry, Forest Products and Coastal Population	English
2	Wood Preservation in India: Challenges, Opportunuties & Strategies	English
3	Intellectual Property Rights in Forestry Issues	English
4	Conservation, Restoration and Sustainable Management of Mangrove Forests in India	English
5	Conservation, Improvement, Cultivation and Management of Sandal	English

b. IFGTB organized an interactive workshop with farmers on 5th June 2010 on World Environment Day which was attended by representatives from industries, farmers, and others. A total of 200 farmers participated in the workshop.

c. IFGTB conducted the stakeholders' workshop on Forestry Research and Extension on 31st May 2010 with the Department of Environment and Forests, Andaman and Nicobar Islands. The workshop was chaired by the PCCF, A&N Islands and attended by PCCF (WL), APCCF (Planning and Development), CCF (Research) and other senior forest officials besides a team of officers and scientists from IFGTB.

d. TFRI, Jabalpur organized "Stakeholders Meet" for Madhya Pradesh at Bhopal on 5th April 2010 and for Chhattisgarh at Raipur on 23rd April 2010. The institute also organized "Stakeholders' consultation meeting" at Nagpur (Maharashtra) on 13th May 2010 and at Bhubaneswar (Orissa) on 24th May 2010.

e. TFRI, Jabalpur imparted training to the Range Officer trainees (47 nos.) from Forest Rangers Training College, Balaghat (M.P.) on 13th May 2010.

f. TFRI, Jabalpur conducted a training on Vermicompost/Biofertilizers at Bhaisajhar Nursery, Bilaspur on 17th and 18th May 2010 to the trainees of Chhattisgarh Rajya Van Vikas Nigam (CRVVN) Ltd., Bilaspur.

g. TFRI, Jabalpur imparted training to the trainee Forest Guards (39 nos.) from Van Vidyalaya, Govindgarh, District Rewa (M.P.) on 18th May 2010.

h. TFRI, Jabalpur imparted training to the trainee Forest Guards (86 nos.) from Van Vidyalaya, Betul (M.P.) on 24th May 2010.

i. TFRI, Jabalpur organized a training for forest officials of Chhatisgarh on "Recent Advances in Nursery Techniques" from 27th to 29th May 2010.

j. RFRI, Jorhat organized stakeholders' meeting-2010 for the states of Assam, Meghalaya, Arunachal Pradesh and Sikkim at Forest School Jhalukbari, Guwahati on 31st May 2010. Stakeholders' meeting-2010 for the states of Mizoram and Tripura were held at PCCF Office, Aizawl, Mizoram on 3rd June 2010 and PWD conference hall, Agartala, Tripura on 7th June 2010 respectively. Stakeholders meeting 2010 for the states of Nagaland and Manipur were held at PCCF office, Kohima, Nagaland on 29th June 2010.

k. AFRI Jodhpur organized one day interactive meeting on "Climate Change Concerns: Needs, Opportunities and Gaps" on 14th June 2010 to discuss the research needs, and the financial, technological and capacity needs and constraints to address climate change concerns vis- a-vis forest products in the arid zone of India. Representatives from Botanical Survey of India, Zoological Survey of India, Desert Medicine Research Centre, Central Arid Zone Research Institute, Defence Research and Development Organization, Jai Narayan Vyas University, State Forest Department, Agriculture Research Station, NGOs and other departments participated in the meeting along with officers and scientists from AFRI. Dr. A. S. Faroda, Retired Director, CAZRI, Jodhpur chaired the session.

l. IFP, Ranchi organized a Stakeholders' Meet in the State of Jharkhand on 25th May 2010 at the institute. The meeting was attended by 32 persons including various stakeholders in the state.

m. IFP, Ranchi organized a stakeholders' Meet in Patna, Bihar on 15th June 2010. The meeting was attended by 29 persons including various stakeholders in the state.

n. At IFP Ranchi, the team of UNDP cell conducted a field visit in the project sites of Khunti district of Jharkhand on 6th July 2010 for providing field

demonstration-cum- training to the farmers of Janumpiri, Bari and Kotna villages.

o. IFP Ranchi conducted a two days training programme on "Lac Cultivation Through Scientific Method" in Ranka Block, Garhwa District of Jharkhand on 16th and 17th June 2010 in which 185 numbers of farmers and cultivators participated.

p. FRI, Dehradun organized a four-days' training on "Afforestation Techniques" for the officers, JCO's and NCO's of Eco Task Force of the Territorial Army from 20th to 23rd April 2010. A total of 39 personnel from Eco Task Force of Territorial Army attended the training programme.

q. FRI, Dehradun conducted five days' training programme on "Handmade Paper from *Lantana camara*" from 7th to 11th June 2010. The programme was sponsored by Department of Science and Technology under the project "Utilization of Economic Potential of *Lantana camara*". Twelve participants from different parts of India attended the training programme. During the training course, the participants were given hands on training for handmade paper manufacturing using *Lantana camara* and its value addition to fetch high income.

r. FRI, Dehradun organized a training programme on "Collection, Storage and Plantation of seeds" from 28th to 30th June 2010 at VVK, Hoshiyarpur for foresters and farmers.

5.2.3 Details of Internal and External Evaluation of Implementation of Charter in the Organization and Assessment of the Level of satisfaction among Citizen/ Clients:

Charter is in the process of being evaluated and edited internally to bring it in greater conformity with the mandated delivery standards.

5.3 Welfare Measures for the SC / ST/ Backward / Minority Communities

Welfare of the SC/ST/backward/minority communities is a major management concern in the ICFRE. Some of the details are given below which illustrate this by way of actions taken in different Institutes of the Council.

a. The Grievance redressal cell for SC/ST/ OBC employees of ICFRE(HQ) was formed vide Secretary, ICFRE, order no 63-37/2010-ICFRE dated 23rd February 2011. The Deputy Director General (Education) functions as the chief liaison officer for SC/ST/ OBC. A Scientist functions as the liaison officer for SC. One Deputy Conservator of Forests functions as the liaison officer for OBC. Controller of Accounts functions as the liaison officer for ST. All these functionaries are identified, in the orders concerned, by name. The service of Dr. Anil Negi, Scientist-C, Directorate of Education has been taken by the GRC for the functioning of the cell.

b. Four interactive meetings of grievances redressal cell for SC/ST/OBC employees at ICFRE, Dehradun were organized during the year 2010-11. Various decisions were taken by the cell in its meetings for the welfare of SC/ST/ OBC employees of ICFRE.

c. Election of office bearers of SC/ST/OBC employees welfare association of ICFRE (HQ) and FRI was conducted on 5th April 2010.

d. Category wise list of SC/ST/OBC employees at ICFRE and its Institutes was prepared.

e. Two days training programme was organized on 30th & 31st August, 2010 for the officers/ officials of ICFRE(Hqr) and its Institutes dealing with the matters "Maintaining the Roster, Grievance Settlement Procedures, duties of Liaison Officer and Follow up of

Orders/ Instructions of Govt. of India relating to reservation and other Related Issues" at ICFRE, Dehradun.

f. SC/ST/backward/minority community welfare committees have been formed in the Institutes of ICFRE and liaison officers have been designated.

IFGTB, Coimbatore conducted sensitization meeting by sexual harassment and complaints committee on sexual harassment of women at workplace on 19th November 2010.

Sensitization lecture on RTI act was given by the public information officer.

ANNEXURES

Annexure-I

NAMES AND ADDRESSES 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, FRI, Phone (Office): 0135-2224444 0135-2755277 E-mail: negiss@icfre.org, dir_fri@icfre.org	Shri A.S. Rawat, Group Coordinator (Res.), FRI Phone (Office): 0135-2224316, 0135-2752670, 0135-2224580, 0135-2752183 (R) E-mail: rawatas@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, 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 - 641002.	Dr. N. Krishnakumar, Director, IFGTB, Coimbatore, Phone: 0422-2431942 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: 080-2334011 (O)	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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Annexure-II

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Annexure-III

List of Abbreviations

AAS	-	Atomic Absorption Spectrophotometer
ABA	-	Abscisic Acid
ACA	-	Ammonical Copper Arsenic
ADG	-	Assistant Director General
AFED	-	Agroforestry and Extension Division
AFRI	-	Arid Forest Research Institute
AM	-	Arbuscular Mycorrhizal
AMF	-	Arbuscular Mycorrhyzal Fungi
ANOVA	-	Analysis of Variance
ATMA	-	Agricultural Technology Management Authority
AWTC	-	Advanced Woodworking Training Centre
BA	-	6-Benzyl Adenil
BAP	-	Benzlaminopurine
BAU	-	Birsa Agricultural University
BCC	-	Biodiversity and Climate Change
BGTI Div.	-	Biotechnology, Genetics & Tree Improvement Division
BHU	-	Banaras Hindu University
BOD	-	Biochemical Oxygen Demand
BR	-	Biosphere Reserve
BRIS	-	Biosphere Reserve Information Series
BSI	-	Botanical Survey of India
BT	-	Box Trench
CAZRI	-	Central Arid Zone Research Institute
CBL	-	Clear Bole Length
CBNRM	-	Community Based Natural Resource Management
CCA	-	Copper Chrome Arsenic
CCB	-	Copper Chrome Boron
CCF	-	Chief Conservator of Forests
CCF-II	-	Country Cooperation Framework –II
CEC	-	Cation Exchange Capacity
CF	-	Conservator of Forests
CFRHRD	-	Centre for Forestry Research Human Resource and Development
CG	-	Chhattisgarh
CIMAP	-	Central Institute of Medicinal and Aromatic Plants
CNSL	-	Cashew Nut Shell Liquid
C & I	-	Criteria and Indicator
CO(F)	-	Coordinator (Facilities)
CPP	-	Country Partnership Programme
CPT	-	Candidate Plus Tree
CRIDA	-	Central Research Institute for Dryland Agriculture

CSMCRI	-	Central Salt & Marine Chemical Research Institute
CSIR	-	Council for Scientific and Industrial Research
CSO	-	Clonal Seed Orchard
CT	-	Contour Trench
CTPS	-	Chanderpura Thermal Power Station
DBH	-	Diameter at Breast Height
DBT	-	Department of Bio-technology
DCF	-	Deputy Conservator of Forests
DEMO	-	Demostration
DNH	-	Dadra & Nagar Haveli
DDG	-	Deputy Director General
DFID	-	Department for International Development
DG	-	Director General
DNA	-	Deoxyribo Nucleic Acid
DNTP	-	Deoxyribonucleotide Triphosphate
DSAE	-	DS Agri Estate Private Limited
DST	-	Department of Science & Technology
DUS	-	Distinctiveness Uniformity Stability
DV	-	Demo Village
DVC	-	Damodar Valley Corporation
EBC Div.	-	Ecology & Biodiversity Conservation Division
EC	-	Exchangeable Capacity
EC	-	Electrical Conductivity
EIA	-	Environmental Impact Assessment
E-mail	-	Electronic mail
EM	-	Environment Management
EMP	-	Environmental Management Plan
ENVIS	-	Environmental Information System
EPN	-	Entomo-pathogenic Nematode
ERS	-	Environmental Research Station
ETP	-	Entire Trans Planting
EWI	-	Earth Watch Institute
FAS	-	Financial Accounting System
FDA	-	Forest Development Agencies
FED	-	Forest Ecology Division
FGTB	-	Forest Genetics and Tree Breeding
FPD	-	Forest Protection Division
FMS Div.	-	Forest Management & Silviculture Division
FPO	-	Food Products Order
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
G	-	Gradonie
GA	-	Gibbrelic Acid
GBH	-	Girth at Breast Height
GCA	-	General Combining Ability
GC/MS	-	Gas Chromatography /Mass Spectrometry
GCV	-	Genotypic Coefficient of Variation
GEER	-	Gujarat Ecological Education & Research
GFD	-	Gujarat Forest Department
GFRC	-	Gujarat Forest Rangers College
GIS	-	Geographic Information System
GLC	-	Gas Liquid Chromatograph
GoI	-	Government of India
GSFD	-	Gujarat State Forest Department
GSFDC	-	Gujarat State Forest Development Corporation
GPS	-	Global Positioning System
GUI	-	Graphical User Interface
HARP	-	Horticultural & Agroforestry Research Programme
HNB	-	Hemwati Nandan Bahuguna Garhwal University
HP	-	Himachal Pradesh
HPLC	-	High Pressure Liquid Chromatograph
HPLC	-	High Power Liquid Chromatograph
HPLC	-	High Performance Liquid Chromatography
HRD	-	Human Resource Development
HSCST	-	Haryana State Council for Science and Technology
IAA	-	Indole Acetic Acid
IBA	-	Indole Butyric Acid
ICFRE	-	Indian Council of Forestry Research & Education
ICT	-	Information and Communication Technology
IDRC	-	International Development Research Centre
IFGTB	-	Institute of Forest Genetics & Tree Breeding
IFP	-	Institute of Forest Productivity
IFRIS	-	Indian Forestry Research Information System
IGAU	-	Indira Gandhi Agricultural University
IGNP	-	Indira Gandhi Nahar Pariyojana
IIRS	-	Indian Institute of Remote Sensing
IINRG	-	Indian Institute of Natural Resins and Gums
ILRI	-	Indian Lac Research Institute
ISSR	-	Inter Simple Sequence Repeat
ISM	-	Indian School of Mines

IT	-	Information Technology
ITTO	-	International Tropical Timber Organization
IWST	-	Institute of Wood Science & Technology
JFMC	-	Joint Forest Management Committee
JFM	-	Joint Forest Management
JNKVV	-	Jawaharlal Nehru Krishi Vishwavidyalaya
JSFDCL	-	Jharkhand State Forest Development Corporation Ltd.
KVK	-	Krishi Vigyan Kendra
LAN	-	Local Area Network
LC	-	Lethal Concentration
L-DOPA	-	L-3,4-dihydroxyphenylalanine
MADP	-	Medicinal Aromatic and Dye Plants
MAP	-	Medicinal & Aromatic Plants
MD	-	Managing Director
MG	-	Mega Gram(10^6g)
MKU	-	Madurai Kamaraj University
MLA	-	Member of Legislative Assembly
MMS	-	Modified Murashige and Skoog
MoEF	-	Ministry of Environment & Forests
MoE	-	Modulus of Elasticity
MoR	-	Modulus of Resistance
MoU	-	Memorandum of Understanding
MoWR	-	Ministry of Water Resources
MP	-	Madhya Pradesh
MPCA	-	Medicinal Plant Conservation Area
MPFD	-	Madhya Pradesh Forest Department
MPMFP	-	Madhaya Pradesh Minor Forest Produce
MPSBDB	-	Madhya Pradesh State Biodiversity Board
MS	-	Maharashtra
MTE	-	Mid Term Evaluation
MW	-	Microwave
NAA	-	Naptha Acetic Acid
NBARD	-	National Bank Agriculture & Rural Development
NAP	-	National Afforestation Programme
NBM	-	National Bamboo Mission
NBPGR	-	National Bureau of Plant Genetic Research
NBRI	-	National Botanical Research Institute
NFLIC	-	National Forest Library and Information Centre
NFT	-	Nitrogen Fixing Tree
NGO	-	Non Government Organization
NMBA	-	National Mission of Bamboo Application
NMPB	-	National Medicinal Plants Board
NPK	-	Nitrogen-Phosphorus-Potassium

NTFP	-	Non Timber Forest Produce
NWFP	-	Non Wood Forest Products
NRC	-	National Research Centre
NRCAF	-	National Research Centre for Agroforestry
OBC	-	Other Backward Class
OSR	-	On Station Research
PCCF	-	Principal Chief Conservator of Forests
PCR	-	Polymerase Chain Reaction
PCV	-	Phenotypic Coefficient of Variation
PDA	-	Potato Dextrose Agar
PDBC	-	Project Directorate of Biological Control
PDKV	-	Dr Panjabrao Deshmukh Krishi Vidyapeeth
PIMS	-	Personnel Information Management System
PMS	-	Payroll Management System
PSB	-	Phosphate Solubulizing Bacteria
PFAA	-	Prevention of Food Adulteration Act
PF	-	Project Formulation
PRA	-	Participatory Rural Appraisal
QPM	-	Quality Planting Material
RAPD	-	Random Amplified Polymorphic DNA
RBD	-	Randomized Block Design
RFD	-	Rajasthan Forest Department
RH	-	Relative Humidity
RIMS	-	Research Management Information System
RPC	-	Research Policy Committee
RS	-	Remote Sensing
R/S	-	Root/Shoot
RSFD	-	Rajasthan State Forest Department
RTI	-	Right To Information
SAUs	-	State Agriculture Universities
SC	-	Schedule Caste
SASVPESY	-	Samudai Adharit Samanvit Van Pravardhan Evam Sanrakshan Yojna
SE	-	Somatic Embryo
SEPC	-	Shellac Export Promotion Committee
SFD	-	State Forest Department
SHG	-	Self Help Group
SIC	-	Soil Inorganic Carbon
SLEM	-	Sustainable Land and Ecosystem Management
SLR Div.	-	Soil & Land Reclamation Division
SOC	-	Soil Organic Carbon
SOM	-	Soil Organic Matter
SPA	-	Seed Production Areas
SPM	-	Suspended Particulate Matter

SSOs	-	Seedling Seed Orchards
ST	-	Scheduled Tribe
SWC	-	Soil Water Content
TBO	-	Tree Borne Oilseeds
TOF	-	Tree Outside Forest
TREE	-	Training Research Extension & Education
TC	-	Tissue Culture
TDZ	-	Thidiazuoron
TEM	-	Transmission Electron Microscopy
TERI	-	The Energy and Resources Institute
TFRI	-	Tropical Forest Research Institute
TFO	-	Technical Facilitation Organisation
TFT	-	Thin Film Transistor
TLC	-	Thin-Layer Chromatograph
ToR	-	Term of Reference
USDA	-	United States Department of Agriculture
UNDP	-	United Nation Development Programme
UT	-	Union Territory
UV	-	Ultra Violet
UV IR	-	Ultra Violet Infrared
VAM	-	Vesicular Arbuscular Micorrhizae
VD	-	V-ditch
VPC	-	Vegetative Propagation Centre
VPN	-	Virtual Private Network
VVK	-	Van Vigyan Kendra
WAS	-	Wild Ass Sanctuary
WB	-	West Bengal
WPM	-	Woody Plant Media
WWF	-	World Wide Fund
ZSI	-	Zoological Survey of India

Published by
MEDIA AND PUBLICATION DIVISION
Directorate of Extension
INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION
(An Autonomous Council of Ministry of Environment and Forests, Government of India)
P.O. New Forest, Dehradun (Uttarakhand)