

ANNUAL REPORT

2007-2008



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

Patron :

Shri Jagdish Kishwan, IFS
Director General,
Indian Council of Forestry Research and Education,
Dehradun

Published by :

Media and Publication Division,
Directorate of Extension,
Indian Council of Forestry Research and Education,
P.O. New Forest, Dehradun-248006 (Uttarakhand), India

Compiled and Edited by :

Dr. Rabindra Kumar, DDG (Extension), ICFRE
Sarvesh Singhal, ADG (M&P), ICFRE
Ramakant Mishra, RO (M&P), ICFRE

Processed by :

D.S. Rauthan, Foreman (Printing), (M&P), ICFRE
Surendra Singh, RA-I (M&P), ICFRE
A.S. Rawat, Compositor (M&P), ICFRE

April 2008

Printed at : India Offset Press, A-1, Mayapuri Industrial Area, Phase-I, New Delhi
Phone : 011-28116494, 28115486

Front cover : Macropropagation of Guggal (*Commiphora wightii*), Tissue culture technique of Guggal and decortication of fruits (*Jatropha*) at AFRI, Jodhpur

Back cover : Wooden handicrafts made of Rubberwood (*Hevea brasillensis*) at IWST, Bangalore



जगदीश किशवान
महानिदेशक एवं
कुलाधिपति ब.अ.स. विश्वविद्यालय
JAGDISH KISHWAN
Director General and
Chancellor, FRI University



भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद्
(आइएसओ 9001 : 2000 प्रमाणित संस्था)
(पर्यावरण एवं वन मंत्रालय, भारत सरकार की एक स्वायत्त संस्था)
पो.ओ. न्यू फॉरेस्ट, देहरादून-248 006
Indian Council of Forestry Research and Education
(An ISO 9001:2000 Certified Organisation)
(An autonomous body of Ministry of Environment and Forests,
Government of India)
P.O. New Forest, Dehra Dun — 248 006

FOREWORD

Indian Council of Forestry Research and Education (ICFRE) is the premier forestry research organization undertaking programmes, aimed at holistic development of forestry research, education and extension for sustainable management and development of forestry resources in the country. It is a matter of great pleasure to share the information relating to activities of the Council through the Annual Report with our forestry sector organizations, other stakeholders, partners, and people at large.

The year 2007-08 was important from the point of view of climate change for us. As, at Bali COP-13, the Indian concept of compensated conservation for awarding policy approach of forest conservation, and resultant incremental carbon stocks was recognized, and found place in the "Bali Action Plan" (BAP). To develop methodologies relating to the concept, the ICFRE organized two workshops at New Delhi, one national for capacity building for Clean Development Mechanism, Afforestation and Reforestation Projects (CDM A/R), and second international for developing methodologies for assessment of enhancement of forest carbon stocks due to conservation, sustainable management of forests and increase in forest cover.

ICFRE also participated in the 26th SBSTA/SBI meetings organized by the United Nations Framework Convention on Climate Change (UNFCCC) from 7th to 18th May 2007 at Bonn, Germany. The ICFRE delegation emphatically put forth Indian stand on REDD.

ICFRE was awarded ISO 9001-2000 quality management system certificate during the year. The Council made sincere efforts with State Forest Departments for establishment of Van Vigyan Kendras and Demo-Villages to strengthen forestry extension activities. A number of consultancy studies related to EIA, EMP, CATP, and socio-economic survey mainly in hydropower and mining sectors were also undertaken.

Countrywide, forestry education is promoted by providing financial support to various universities imparting forestry education. In the year 2007-08, the Council released Rs. 500.50 lakhs as grant in aid to twelve universities. Along with this, the Council took a lead and finalized a standard and unified forestry syllabus for B. Sc. and M. Sc. forestry courses being run in various agricultural universities. It also finalized the guidelines for the Accreditation of Forestry Colleges as well as forestry curriculum at under graduate and post graduate level.

This report is intended to provide insight into research, education and extension activities of ICFRE, and it gives me immense pleasure in presenting this ICFRE Annual Report for the year 2007-2008.

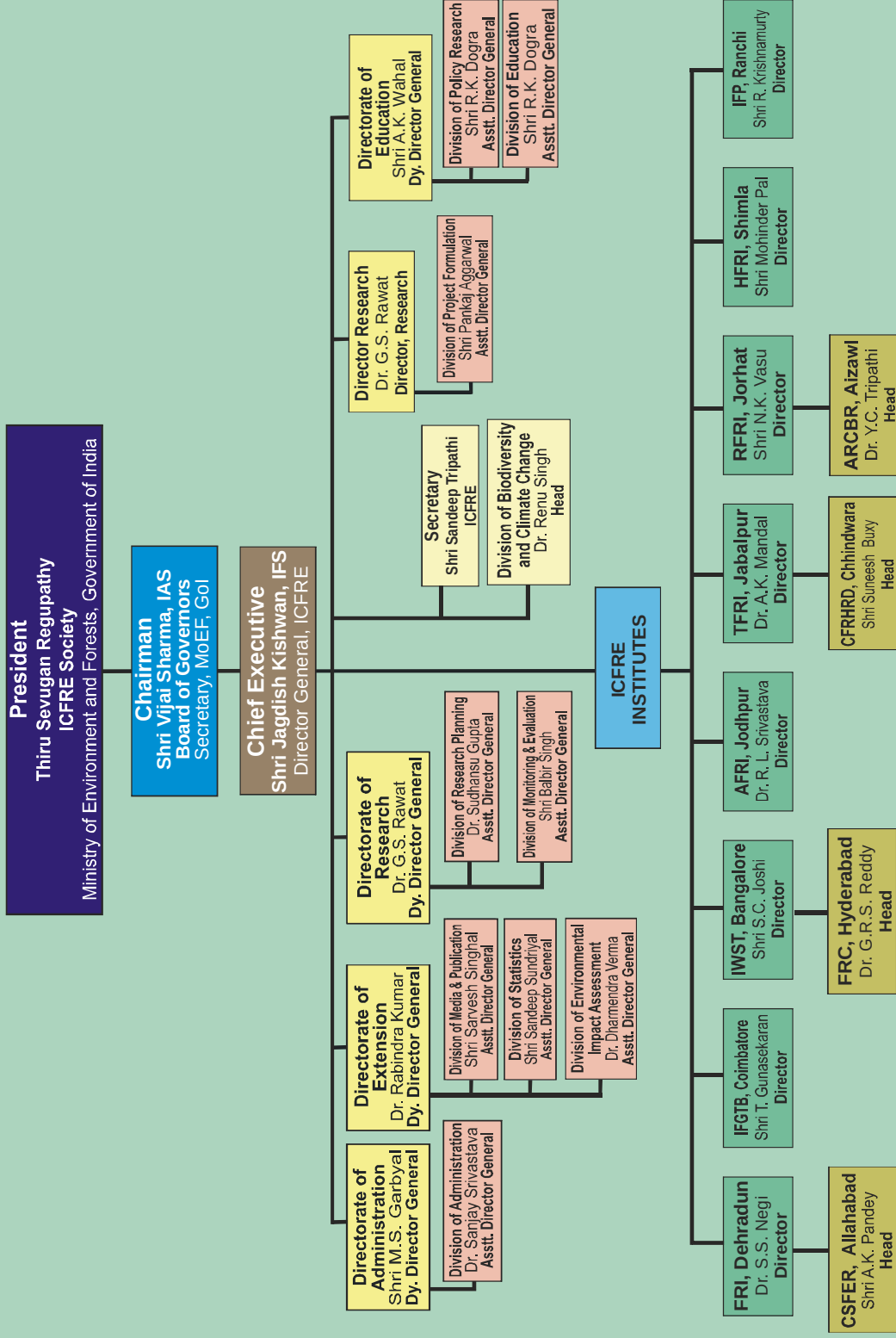
Dated : 20th October 2008


(Jagdish Kishwan)
20.10.2008

दूरभाष / Phone : 0135 - 2759382 (O), 2754748 (R)
2224855 (O)
2224509 (R)

ई.मेल / e.mail : jkishwan@nic.in
jkishwan@icfre.org
फैक्स / Fax : 0135-2755353

ORGANIZATIONAL STRUCTURE OF ICFRE



CHAPTER 1



INTRODUCTION

Indian Council of Forestry Research and Education (ICFRE), an apex body in the national forestry research system, has been undertaking the holistic development of forestry research through need based planning, promoting, conducting and coordinating research, education and extension covering all aspects of forestry. The Council deals with the solution based forestry research in tune with the emerging issues in the sector, including global concerns such as climate change, conservation of biological diversity, combating desertification and sustainable management and development of resources. Topical research by the Council enhances public confidence in the ability of forest managers and researchers to successfully handle challenges related to natural resource management.

Objectives of ICFRE

- 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 under the Council

ICFRE has eight Regional Research Institutes and four Research Centres located in different bio-geographical regions of the country to cater to the forestry research needs of the nation. The regional research Institutes are located at Dehradun, Coimbatore, Bangalore, Jabalpur, Jorhat, Jodhpur, Shimla and Ranchi and the Centres are at Allahabad, Chhindwara, Hyderabad and Aizawl.

Research Institutes under the Council are:

- Forest Research Institute (FRI), Dehradun
- Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore
- Institute of Wood Science and Technology (IWST), Bangalore
- Tropical Forest Research Institute (TFRI), Jabalpur
- Rain Forest Research Institute (RFRI), Jorhat



- Arid Forest Research Institute (AFRI), Jodhpur
- Himalayan Forest Research Institute (HFRI), Shimla
- Institute of Forest Productivity (IFP), Ranchi

Advanced Research Centres under the Council are:

- Centre for Social Forestry and Eco-Rehabilitation (CSFER), Allahabad
- Centre for Forestry Research and Human Resource Development (CFRHRD), Chhindwara
- Forest Research Centre (FRC), Hyderabad
- Advanced Research Centre for Bamboo and Rattans (ARCBR), Aizawl

Salient Achievements/Highlights of Research by ICFRE and its Institutes

ICFRE

- Participation by Director General, ICFRE and Head, Biodiversity and Climate Change Division, ICFRE in 26th SBSTA/ SBI meetings of the UNFCCC from 7th to 18th May 2007 at Bonn, Germany.
- Participation by Director General, ICFRE in High Level Meeting on Forests and Climate organized under the 'Global Initiative on Forests and Climate' of the Department of Foreign Affairs and Trade, AusAID and Department of the Environment and Water Resources, Government of Australia from 23rd to 25th May 2007 at Sydney, Australia.
- Participation by Director General, ICFRE in the Expert International Workshop on 'Global Carbon Monitoring System, Forest Biodiversity Measurement and Assessment Methodology' in Tuczno (Poland) on 18th and 19th October 2007.
- Participation of ICFRE delegation in the United Nations Climate Change Conference (COP/ MOP) at Bali, Indonesia from 3rd to 14th December 2007.
- Organised a national workshop on "Forestry Projects for Climate Change Mitigation in India: Stakeholders Dialogue and Capacity Building" at New Delhi on 21st and 22nd February 2008.
- Organised an international workshop on "Developing Methodology for Assessment of Enhancement of Forest Carbon Stocks due to Conservation, Sustainable Management of Forests and increase in Forest Cover" at New Delhi on 7th and 8th March 2008.
- Initiated activities pertaining to "Assessment of soil carbon stocks and dynamics in forest soil of India for the period 1995-2007" under national project on "Second National Communication to United Nations Framework convention on Climate Change".
- ICFRE has been awarded ISO 9001:2000 Quality Management System Certification.

INSTITUTES

FRI, Dehradun

- Patents obtained on Black hair dye composition and a process for preparation thereof.
- Patent for a “New eco-friendly economical and non-hazardous wood preservative ZiBOC - comparable to CCA” was applied in December 2007.
- Patent for a “New efficacious eco-friendly wood preservative lignin copper complex A and B” Patent applied PAT/4.19.14/03046/2003.
- The ENVIS Centre on Forest published Annotated Bibliography on Participatory Forest Management and two special issues of ENVIS Forestry Bulletin on Forest Genetics and Tree Improvement and Medicinal Plants.
- Tissue culture technology was developed for the protocol development of four *Eucalyptus* hybrids FRI-6, FRI-10, FRI-13 and FRI-15.
- Mass scale multiplication protocol for two others *Eucalyptus* hybrids FRI-5 and FRI-14 were also developed successfully.
- A modified solar kiln has been installed. Its work efficiency is encouraging and the cost of the new kiln is about 25-30% less than the prevalent model, design is simpler so that specialist carpenter is not required and the modified kiln is equally efficient in seasoning of wood.
- A tentative schedule to dry *Populus deltoides* to less than 15% MC levels from 90% MC levels in two steps of vacuum level-temperature combinations has been developed.

IFGTB, Coimbatore

- More than 140 species of plants including 10 RET species have been collected from various parts of southern India and introduced in Botanical garden and maintained.
- A total of 687 plant species belonging to 493 genera and 127 families have been identified from the 1128 sacred groves in 91 villages of the district Alappuzha are the only remnants of natural forests once present.
- Suitable seed handling techniques for four important NTFP species namely, *Calophyllum inophyllum*, *Decalepis hamiltonii*, *Garcinia gummigutta* and *Sapindus emarginatus* were standardized.
- Developed *in vitro* axillary bud proliferation protocol for the multiplication of mature plants of *Bambusa nutans* and *Dendrocalamus giganteus*.

IWST, Bangalore

- An instrument for rapid estimation of stiffness of wood in standing trees and logs was designed and fabricated.



- A robust method for determination of dynamic MoE, shear modulus and Poisson's coefficient of discontinuous fibre filled thermoplastic composites was developed.
- A technology package for manufacturing of bamboo fibre filled polypropylene composites was developed.
- A simple laboratory method has been developed to determine quantity of jigat in adulterated samples by UV-spectroscopic method. The developed method will help to meet the needs of end users / stakeholders.
- A simple method using UV-spectroscopy has been developed for estimation of sandalwood oil in adulterated mixture. The developed method will help to meet the needs of end users / stakeholders.
- The annual loss of revenue caused by insect borers in bamboo depots was estimated to be around 25 %, the main borer on commercial bamboo being *Dinoderus minutus*.
- Three hundred species of xylophagous insects were recorded from fallen logs at Nagarhole national park.
- Twenty species of fungi and 42 species of mycophagous insects were recorded from fungi inhabiting fallen logs.
- A Microsporidian pathogen is isolated from the teak defoliator, *Hyblaea puera* for the first time.
- Protocols have been developed for micro-propagation of *Bambusa pallida* and *Bambusa nutans* using nodal shoot segments of mature clumps.
- Micro-propagated plants of five species of bamboos were found to perform better in terms of growth as compared to seed and macro-propagated plants.

TFRI, Jabalpur

- Supplementing egg parasitoid, *Trichogramma raoi* in teak seed orchards @1.20 lakh/ha proved effective to minimize the intensity of pest attack and loss in annual growth as compared to non-supplemented sites.
- Compendium on Achanakmar – Amarkantak Biosphere Reserve prepared and submitted to Ministry of Environment and Forests, Government of India.
- The new genera of fungi described as *Acrodictiella* and *Kamalomyces* are new to science.
- Four strains of *Ganoderma lucidum* were screened for enzyme production and found as best source of glucanase enzyme, which has medicinal value.
- Six isolates of *Pseudomonas solanaceum* and *Xanthomonas* sp. were identified as potentially dangerous pathogen from the FDCM teak nursery of MP and MS.
- Cultivation techniques of *Rauvolfia serpentina*, *Andrographis paniculata*, *Gymnema sylvestre* and *Tinospora cordifolia* were standardized.

- Non-destructive harvesting practices of *Terminalia arjuna*, *R. serpentina*, *A. paniculata*, *G. sylvestre* and *T. cordifolia* were developed.
- Developed tissue culture protocol of *Bambusa nutans* and *Bambusa tulda*.
- Genetic diversity analysis of trees and populations of Indian teak using ISSR and AFLP molecular markers.

RFRI, Jorhat

- Establishment of Van Vigyan Kendra in six north-eastern states.
- Establishment of model village at Koliapani, Jorhat.
- Laid out demonstration and extension trial of *Acacia mangium* at Koliapani model village.
- Established seedling seed orchard of *Aquilaria malaccensis*.

AFRI, Jodhpur

- Developed site index equation for *Tecomella undulata* plantations in Indira Gandhi Nahar Pariyojna (IGNP) area of Rajasthan.
- Raised performance trial from 23 elite accessions, native trials from 160 accessions and spacing and pollarding trials of *Jatropha curcas*.
- SE Maturation percentage was significantly improved.
- Severe infestation of a semilooper, *Achaea janata* (noctuidae) has been noticed on all mehndi (*Lawsonia inermis*) growing areas at Sojat road (Pali).
- The pathogens, *Rhizoctonia bataticola*, causing charcoal root rot and *Rhizoctonia solani* were isolated and identified from Guggal collected from Basan Nursery, Gandhinagar.
- The root infection was recorded 54% while, AM spores were found 210 /100 gms of soil in mehndi.

HFRI, Shimla

- Entomo-pathogen, which resulted in large scale mortality of larval and pupal population in field as well as in laboratory conditions, was identified as *Bacillus cereus* var. Mycoides (Flugge) Smith, Gorden and Clark. The study indicated that this biological control agent can play an important role in eco-friendly management of this pest.
- *Polygrapzhus longifolia* Stebbing was identified as one of the most destructive pest of Chir Pine trees as this beetle bore directly into the bark for oviposition and made the tree vulnerable for the attack of other insect borers like *Cryptorhynchus rufescens* Roelfs and *Sphaenoptera atterrma* Kerremens subsequently.
- *Plusia orichalcea* Fab. (Lepidoptera: Noctuide) had been graded as the most serious defoliator of *Saussurea costus* (Falc) Lisch, *Picrorhiza kurroo* Royle ex Benth., *Arctium lappa* Linn, *Heracleum candicans* Wall.ex DC., *Angelica glauca* Edgew., and *Valeriana jatamansi* Jones. This is the first report of the insects on these plants.



- *Rheum moorcroftianum* Royle belonging to the family Polygonaceae, is a robust perennial herb with large basal leaves and have 1-3 erect cylindrical hairy spikes of greenish flowers turning to reddish as the fruit matures. The flowering and fruiting occurs during the month of June and July. It is distributed from Himachal Pradesh to Nepal between 3600-4700 m above msl. During floristic survey in the state of Himachal Pradesh, the plant has been found in open slopes between 3700-4200 m above msl in drier areas of Giavung Valley in cold deserts of district Kinnaur (Himachal Pradesh).

IFP, Ranchi

- Germplasm bank of selected oil yielding trees was established under the project funded by NABARD. Propagation methods for clonal multiplication were standardized and sufficient numbers of clonal ramates of selected oil yielding trees (*Derris indica* and *Madhuca latifolia*) were raised for further field evaluation.
- A MoU was signed between the IFP and the Damodar Valley Corporation Limited for providing consultancy and services for “Planting and Green Belt Development around Chandrapura Thermal Power Station, DVC”.

CHAPTER 2



INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION

The activities of forestry research, education and extension at ICFRE headquarters are as under:

FORESTRY RESEARCH

1. BIODIVERSITY AND CLIMATE CHANGE (BCC) DIVISION

Biodiversity and Climate Change (BCC) Division, ICFRE has taken up several short and long term policy programmes to address the problems of Biodiversity Conservation and Climate Change.

A. Biodiversity

- i. **Preservation Plots:** Preservation plots are important instruments for meeting the targets of significantly maintaining or monitoring changes in biodiversity under Convention on Biological Diversity (CBD). In this direction the BCC Division has prepared a concept note on Preservation Plots for incorporation in all India coordinated project proposed by Silviculture Division, FRI, Dehradun. Research Policy Committee of the Council accepted the project in February 2008.
- ii. **Forest Invasive Species:** The Convention on Biological Diversity in the 8th Article calls on Governments 'to prevent the introduction, control or eradication of those alien species which threaten ecosystem, habitat or species'. An attempt has been made by BCC Division to examine the invasion and spread of introduced plantation tree species and the problems associated with these in India. For this purpose, brief information on some Forest Invasive Species was compiled and placed on ICFRE website.
- iii. BCC Division contributed in providing suggestion to Ministry of Environment and Forests on 'Constraints in Operationalising the Biological Diversity Act, 2002 and Biological Diversity Rules, 2004' in June 2007.
- iv. **IV National Report on Biodiversity to Convention on Biological Diversity (CBD):** BCC Division, ICFRE compiled and prepared a report on ICFRE input for 4th National Report on Biodiversity to Convention on Biological Diversity (CBD) after receiving inputs from different regional institutes of ICFRE and submitted to Ministry of Environment and Forests, Government of India in March 2008.



B. Climate Change

BCC Division has taken up one externally aided project related to Climate Change.

Assessment of soil carbon stocks and dynamics in forest soil of India for the period 1995-2007: The project is funded by the UNDP-GEF, the project activity is subcontracted to ICFRE by Ministry of Environment and Forests, Government of India through Winrock International India under its project: 'Enabling activity for preparation of India's Second National Communication to the UNFCCC'.

The Second National Communication (SNC) to UNFCCC also known as NATCOM –II, is a national reporting which is obligatory under the UNFCCC agreement. Preparation of Second National Communication is a time bound activity and Ministry of Environment and Forests on behalf of Government of India, require to furnish the information in accordance with the decisions of Conference of the Parties (CoP) of UNFCCC towards fulfilment of obligation under the convention.

Second National Communication has given the following tasks to ICFRE:

- Estimation of soil organic carbon stock in forest soil of India.
- To assess soil carbon dynamics due to land use change from forest to non-forest and *vice versa*.
- To review and compile related emission factors.
- To develop QA/ QC plan and estimation of uncertainties in the assessment.

ICFRE intends to complete this national reporting in collaboration with Indian Institute of Remote Sensing (IIRS), Dehradun. BCC Division of ICFRE is the nodal point of communication with collaborator and regional Institutes of ICFRE, initiated all activities pertaining to the project.

C. Other Activities

- Participation by DG, ICFRE and Head, Biodiversity and Climate Change Division, ICFRE in 26th SBSTA / SBI Meetings of the UNFCCC:** Shri Jagdish Kishwan, DG, ICFRE and Shri Sandeep Tripathi, Head, BCC Division, ICFRE participated in the 26th SBSTA/SBI meetings organized by the United Nations Framework Convention on Climate Change (UNFCCC) from 7th to 18th May 2007 at Bonn, Germany on nomination by the Ministry of Environment and Forests, Government of India, New Delhi.

During SBSTA, among other issues, the following important issues related to LULUCF were deliberated at length: (i) Reducing emissions from deforestation in developing countries, (ii) Demonstrating the eligibility of land for CDM A&R Projects, and (iii) Increasing the limit for small scale CDM A&R Projects. As an outcome, CDM-EB in its 31st meeting has again decided to call for public input on issue of demonstrating land eligibility for CDM A&R Projects. ICFRE has made its submission as an observer organization to UNFCCC and also through Government of India. Regarding increasing the limits of small scale CDM A&R Projects, India has a position not to increase the limit at present.

ICFRE delegation puts forcefully its input and intervention on the issue of REDD. On this hotly debated issue of REDD, the Indian concept of “Compensated Reduction” got wide support during SBSTA–26. United States also supported India’s stand by asserting that a “Range of Actions” to reduce emissions from deforestation needed to be considered which according to United States, included “Forest Conservation and Stabilization” efforts also. European Union considered using the phrase “Range of Actions” as a compromise formula because of Brazil’s opposition to the Indian proposal. Congo Basin countries led by Cameroon/Gabon stressed on including ‘stabilization of forest’ as the policy approach suitable to countries in their region with low rate of deforestation. Since stabilization is an outcome of the process of conservation, India has been supportive of Congo Basin approach. Many countries including Indonesia, Malaysia, Bangladesh and Singapore expressed support in their interventions for ‘forest conservation’.

- ii. **Participation by DG, ICFRE in High Level Meeting on Forests and Climate:** Shri Jagdish Kishwan, DG, ICFRE participated in the high level meeting on ‘Forests and Climate’ which was organized under the ‘Global Initiative on Forests and Climate’ by Department of Foreign Affairs and Trade, AusAID, and Department of the Environment and Water Resources, Government of Australia from 23rd to 25th May 2007 at Sydney, Australia.
- iii. **Participation by DG, ICFRE in the Expert International Workshop on Global Carbon Monitoring System, Forest Biodiversity Measurement and Assessment Methodology:** Shri Jagdish Kishwan, DG, ICFRE attended the expert international workshop on ‘Global Carbon Monitoring System, Forest Biodiversity Measurement and Assessment Methodology’ in Tuczno, Poland on 18th and 19th October 2007.
- iv. **International Round Table on Reducing Emission from Deforestation in Developing (REDD) Countries :** Shri V.R.S. Rawat, Scientist ‘D’, BCC Division attended the international round table on Reducing Emission from Deforestation in Developing (REDD) Countries in Brussels on 24th October 2007, which was organized by Climate Focus BV, the Netherland and CATIE (Tropical Agricultural Research and Higher Education Centre) at Le Chatalain Hotel in Brussels.
- v. **Participation of ICFRE delegation in the United Nations Climate Change Conference (COP/ MOP) Bali, Indonesia:** Bali hosted the third meeting of the Parties to the Kyoto Protocol (COP/MOP 3), in conjunction with the thirteenth session of the Conference of the Parties (COP-13) to the Climate Change Convention from 3rd to 14th December 2007. The ICFRE delegation, comprising Shri Jagdish Kishwan, DG, ICFRE; Shri Sandeep Tripathi, Secretary, ICFRE and Advisor, BCC, Dr. Renu Singh, Head, BCC Division; and Dr A. Ramachandran, Forest Utilisation Officer, Tamil Nadu participated in the United Nations Climate Change Conference along with the Government of India delegation.

About 180 nations participated in the conference. The ICFRE delegation actively participated in different agenda items of the COP, COP/MOP and SBSTA assigned to it during the Bali



conference. In particular, the delegation was fully involved in the negotiations in agenda items 5 Reducing Emissions from Deforestation in Developing REDD Countries and 9(b) (implications of possible changes to the limit for Small Scale Afforestation and Reforestation Clean Development Mechanism Project) of the SBSTA related to forestry during the conference.

In Bali, the Indian delegation achieved a breakthrough in putting forth India's concern of forest conservation as a mitigation measure on the centre stage of the REDD. India was putting forth the concept of 'Compensated Conservation' since Nairobi COP, through workshop in Cairns and SBSTA meeting in Bonn.



Participation of ICFRE Delegation in United Nations Climate Change Conference Bali, Indonesia

The Indian proposal on forest conservation/sustainable management of forests, and increment in forest cover as a *policy approach to enhance carbon stocks found place not only in the preamble but also in the operative part (paras 3rd and 7th) of the COP decision on REDD*. Similarly, COP decision on Bali Action Plan (BAP) contains reference, inter-alia, to *policy approach and positive incentives relating to the role of conservation, sustainable management of forests and enhancement of forest carbon stocks*.

vi. Forestry Projects for Climate Change Mitigation in India: Stakeholders Dialogue and Capacity building:

A two days national workshop was organized by the Indian Council of Forestry Research and Education, at New Delhi on 21st and 22nd February 2008 under the aegis of Ministry of Environment and Forests, Government of India. The workshop was inaugurated by the Chief Guest, Dr. Prodipto Ghosh, Distinguished Fellow, TERI and Former Secretary to the Government of India, Ministry of Environment and Forests, Shri P.R. Mohanty, Director General Forests and Special Secretary to the Government of India, was the Guest of Honour. A total of 88 delegates participated in the workshop.



Delegates in National Workshop

- vii. **Developing Methodology for Assessment of Enhancement of Forest Carbon Stocks due to Conservation, Sustainable Management of Forests and Increase in Forest Cover:** An international workshop was organized by the Indian Council of Forestry Research and Education on 7th and 8th March 2008 at New Delhi under the aegis of the Ministry of Environment and Forests, Government of India. The workshop focussed on the possible methodological approaches, and modalities and procedures for assessing positive increment in forest carbon stocks due to increase in forest cover and sustainable management of forests/conservation.



Delegates in International Workshop

The workshop was inaugurated by the Chief Guest, Shri Namo Narain Meena, Hon'ble Minister of State for Environment and Forests, Government of India. A total of 68 delegates including representatives from eight countries: China, United Kingdom, Papua New Guinea, Sri Lanka, Thailand, India, Bhutan and Malaysia participated in the workshop. Shri Jagdish Kishwan, Director General, ICFRE welcomed the participants, Shri J.C. Kala, Former Director General of Forests and Secretary to the Government of India, Ministry of Environment and Forests, was the Guest of Honour.

- viii. **Participation of DG, ICFRE in the Bangkok Climate Change Talks 2008:** As part of the Government of India delegation led by Shri Shyam Saran, Prime Minister's Special Envoy on Climate Change, Shri Jagdish Kishwan, Director General, Indian Council of Forestry Research and Education attended the United Nations sponsored meeting in the Thai capital, from 31st March to 4th April 2008, aimed at developing a work programme for the next two years to help countries draw up a deal to cut greenhouse gas emissions after 2012, when the first phase of the Kyoto Protocol expires. The Climate Change talks in



Bangkok convened sessions of both the Adhoc Working Group on Long-term Cooperative Action (AWGLCA) under the Convention (first session) and the Adhoc Working Group on further Commitments for Annex I Parties under the Kyoto Protocol (first part of the fifth session), during which Parties needed to advance the Bali Road Map agreed last December 2007. The AWGLCA work programme finalised at Bangkok includes a workshop on Reducing Emissions from Deforestation and Role of Conservation, Sustainable Management of Forests and Enhancement of Forest Carbon Stocks.

The five days conference was aimed at building on the Kyoto Protocol, in which 37 industrialised countries and the European community committed to reducing emissions by at least five percent against 1990 levels by 2012.

- ix. **ISO 9001 : 2000 Certification for ICFRE:** BCC Division also works for maintenance of ISO 9001 : 2000 Quality Management System. ICFRE has been awarded ISO 9001 : 2000 Quality Management System certification.
- x. **Climate News Letter:** BCC Division prepared quarterly Climate News Letters regularly covering latest developments and upcoming events etc. in the field of Climate Change which were placed on the ICFRE website during 2007-08.

D. Training

- i. A one week refresher training course sponsored by the Ministry of Environment and Forests, Government of India, New Delhi for Indian Forest Service officers on “Climate Change and Relevance to Forestry Sector” was organized by the BCC Division at ICFRE Dehradun from 7th to 11th January 2008. Sixteen IFS officers of different states participated in the training course. The programme was highly appreciated and rated by the participants.



Participants and Organisers of one week refresher training course for IFS officers

- ii. Shri V.R.S. Rawat, Scientist 'D', BCC Division, ICFRE Dehradun attended 10 days training course on "Micro-meteorological Measurement and CO₂ Flux Measurements" during 17th to 26th July 2007 at Younsei University, Seoul, Korea. The training course was organized by AsiaFlux, a network of CO₂ flux study sites in Asia.

2. RESEARCH PLANNING (RP) DIVISION

Research Planning Division, Directorate of Research deals with the planning, processing and execution of new research project proposals funded by ICFRE following bottom-up, transparent and participatory approach. Also the Research Planning Division is dealing with Bamboo Technical Support Group (BTSG) – ICFRE, Dehradun.

During the year 2007-08, following achievements have been made by this division :

- It coordinated the Research Advisory Group (RAG) meetings at Institute level on the dates mentioned below:

TFRI, Jabalpur	-	30 th –31 st Aug. 2007
IWST, Bangalore	-	4 th –5 th Oct. 2007
HFRI, Shimla	-	23 rd –24 th Oct. 2007
FRI, Dehradun	-	6 th –7 th Nov. 2007
IFP, Ranchi	-	6 th –7 th Sept. 2007
RFRI, Jorhat	-	27 th –28 th Nov. 2007
AFRI, Jodhpur	-	21 st –23 rd Sept. 2007
IFGTB, Coimbatore	-	12 th –13 rd Dec. 2007
- Research Policy Committee Meeting (RPC): The projects approved by RAGs were placed before RPC, which was convened on 25th to 28th February 2008 under the chairmanship of Shri Jagdish Kishwan, DG, ICFRE to give the final approval to the new research proposals submitted by eight research institutes under ICFRE.

During IX RPC, 100 new projects were discussed by RPC members, out of which 10 projects were not approved and 8 projects were approved for external funding and 82 project were approved for ICFRE funding. The Institute wise outcome of IX RPC is as follows:



Sl. No.	Name of the Institute	Placed before RPC	Not approved	Approved	
				For External Funding	ICFRE Funding
1.	Institute of Wood Science & Technology, Bangalore	19	3	1	15
2.	Himalayan Forest Research Institute, Shimla	7	—	1	06
3.	Rain Forest Research Institute, Jorhat	7	—	—	07
4.	Institute of Forest Genetics & Tree Breeding, Coimbatore	20	5	—	15
5.	Institute of Forest Productivity, Ranchi	9	1	2	06
6.	Arid Forest Research Institute, Jodhpur	4	1	1	02
7.	Tropical Forest Research Institute, Jabalpur	5	—	1	05
8.	Forest Research Institute, Dehradun	29	—	2	26
	Total	100	10	8	82

During the RPC, it was desired by the chairman that every project will have extension and IPR component. Also, The All India Coordinated projects on identified species were presented by the directors of the lead institute and were discussed in length.

Name of the Species	Nodal Institutes	Name of the Species	Nodal Institutes
Eucalyptus	IFGTB, Coimbatore	Preservation Plots	FRI, Dehradun
Poplar	FRI, Dehradun	Forest Soils of India	FRI, Dehradun
Invasive species	FRI, Dehradun	Bamboo	RFRI, Jorhat
Lesser known tree species	FRI, Dehradun	Jatropha	AFRI, Jodhpur
Sissoo	FRI, Dehradun	Teak	TFRI, Jabalpur
Sal	FRI, Dehradun		

Second Directors' Meet :

On 19th and 20th November 2007, Second Directors' Meet was organized in the Board Room of ICFRE hqrs, under the chairmanship of Shri Jagdish Kishwan, 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 was recognized as Bamboo Technical Support Group (BTSG) by the National Bamboo Mission, a Centrally Sponsored Scheme of Government of India under Ministry of Agriculture, in July 2007 with a budget of Rs. 34.30 lakhs for 2007-08. It was constituted for 11 States viz. Jammu & Kashmir, Punjab, Haryana, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Bihar, Madhya Pradesh, Chhattisgarh, Rajasthan and Gujarat.

The Council has designated Forest Research Institute (FRI), Dehradun and Tropical Forest Research Institute (TFRI), Jabalpur for the purpose of conducting training programmes for farmers and field functionaries of the eleven constituent States of BTSG, the former is responsible for the states of Uttarakhand, Uttar Pradesh, Himachal Pradesh, Jammu & Kashmir, Haryana, Punjab and Rajasthan, while the latter for Bihar, Chhattisgarh Madhya Pradesh and Gujarat. The trainings are imparted as per the guidelines of the Mission and cover aspects pertaining to nursery, plantation, and utilization and marketing bamboos.

Activities carried out by BTSG - ICFRE, Dehradun during 2007-08:

- i. Training for farmers/field functionaries was provided through FRI, Dehradun and TFRI, Jabalpur.
- ii. March 2008 issue of the Indian Forester was published as special bamboo issue and other literature including manuals, brochures, posters, pamphlets, handouts etc were also published on bamboo.
- iii. National Conference on Bamboos: Management, Conservation, Value addition and Promotion was organized by Tropical Forest Research Institute, Jabalpur from 12th to 14th March 2008.

3. MONITORING AND EVALUATION (M&E) DIVISION

Monitoring and Evaluation Division, Directorate of Research, deals with the review and evaluation of all the ongoing research projects of ICFRE Institutes. It suggests corrective measures for timely completion of the projects and achievement of the objectives with perfection. During 2007-08, the review/ evaluation of 423 (ICFRE funded-254 and 169 externally aided) ongoing research projects of all ICFRE Institutes was done. Apart from above, independent review of 19 (completed/ ongoing) research projects has also been carried out through independent subject matter experts/agencies. This Division also collects information on Annual Action Plan from the institutes for preparation of consolidated Annual Action Plan for ICFRE.



4. PROJECT FORMULATION (PF) DIVISION

Project Formulation Division, Directorate of Research acts as a facilitator between the ICFRE Institutes/Centres and potential donor agencies for the formulation of Research Projects in the identified thrust areas and their submission to various National and International donor agencies for funding as per their funding requirements. It also co-ordinates the release of the funds to ICFRE Institutes/Centres and evaluates the project proposals with regard to their suitability in the identified thrust areas.

The Division is collaborating with a number of National and International donor agencies for project funding. Presently, 163 projects funded by National donor agencies and 5 projects funded by International donor agencies are being implemented in eight Institutes and three Centres of ICFRE. Besides this, 79 projects and 6 projects are in the pipeline for funding by National and International donor agencies respectively.

Main National donor agencies are Ministry of Environment & Forests (MoEF), Department of Bio-technology (DBT), Department of Science and Technology (DST), National Medicinal Plant Board (NMPB), National Bank for Agricultural and Rural Development (NBARD), Council of Scientific and Industrial Research (CSIR) and National Mission of Bamboo Applications (NMBA) etc.

Main International Donor Agencies are Japan International Co-operation Agency (JICA), Swedish International Development Agency (SIDA), International Foundation for Science (IFS), International Tropical Timber Organisation (ITTO), United State Department of Agriculture (USDA) and Department for International Development (DID) etc.

The Division co-ordinated the formulation of a number of project proposals of ICFRE Institutes as per the guidelines and funding requirements of donor agencies in the identified thrust areas and suitable proposals were processed for their approval and submission to National / International donor agencies such as the collaborative project proposals of AFRI, Jodhpur and IFGTB, Coimbatore on “New biocontrol opportunities for prickly Acacia: exploration in India” with Allen Fletcher Research Station Australia; All India Co-ordinated Project (AICP) of IFGTB, Coimbatore on Eucalyptus Gall Wasp, All India Co-ordinated Project (AICP) of FRI, Dehradun on Poplar.

Besides this, the Concept Note of All India Co-ordinated Project (AICP) of RFRI, Jorhat on Bamboo was scrutinised, redrafted and submitted to NMBA for financial assistance. Concept note on the “Establishment of Van Vigyan Kendras and Demonstration Villages” worth Rs 19.00 crores was also redrafted (based on the write-up received from Directorate of Extension), and submitted to MoEF for onward submission to JICA for funding.

A number of MoUs and Agreements for the implementation of collaborative projects/ programmes of ICFRE Institutes / Centres were scrutinised and processed for the approval of the competent authority viz. MoUs of IWST Bangalore with Department of Bio-technology (DBT),

Konkan Speciality Poly products Pvt. Limited (KONSPEC), National Medicinal Plants Board (NMPB) and Italian Trade Commission; MoUs of IFP, Ranchi with Chandrapura Thermal Power Station (CTPS), Collaborative Agreements of IFGTB, Coimbatore and AFRI, Jodhpur with Allen Fletcher Research Station (AFRS), Australia etc.

Bihar Project:

The Division Coordinated the execution of comprehensive Bihar Project titled, “Samudai Adharit Samanvit Van Prabandhan Evam Sanrakshan Yojana in Bihar State” (Phase – I) being implemented by ICFRE with Environment and Forest Department of Bihar State. Activities related to ICFRE component on Poplar based agroforestry programme on farmer’s fields in Vaishali’s District of North Bihar were monitored through field visits. Review meetings were arranged regularly and minutes were issued by this Division to monitor the progress of the cited project and to record the decisions for taking further necessary actions in this regard.

History of Forests of India –After 1947:

In continuation with the Book titled “The Forests of India” written by E.P. Stebbing in 4 volumes which gives the chronology of forest development in India from 1796 to 1947: It has been decided to document the History of Forests in India for the subsequent period from 1947 to 2005 and the work has been entrusted to ICFRE. After detailed consultations with the Experts, the Chapters of this Book have been finalized which include Forest Policy, Forest Acts and Laws, Forest Administration, Forest Management, Wildlife Management, Forestry under Five Year Plan, Social Forestry, Participatory Forest Management and Out - turn Revenue etc.

Ten Chapters have been finalized and the first part of the proposed book “Post – Independence Developments in Indian Forestry”, Vol. I” is likely to be published very soon.

FORESTRY EDUCATION

5. EDUCATION DIVISION

Education Division, Directorate of Education provides financial support to the Universities imparting forestry education in the country in order to strengthen the infrastructural facilities of the forestry faculties such as infrastructural development, purchase of scientific equipments, books/ journals, to make mist chambers and similar other teaching/research facilities at teaching campuses, sports/games and other student’s amenities, establishment of interpretation centre-cum-museum, computers, teaching manuals, organization of workshop/seminars etc., participation of teachers in workshop/seminar etc and students’ educational tours. Overall Rs. 500.50 lakhs as Grant-in-aid was released to the 12 universities in the financial year 2007-08 i.e. from April 2007 to March 2008.

Standardization and unification of forestry syllabus for under graduate/post graduate courses: This directorate has finalized syllabus of B.Sc./M.Sc. (Forestry) courses being run in various state agricultural universities so as to ensure delivery of quality education to safeguard the interests of student community in general and forestry sector in particular.



Accreditation of Forestry College/Course Curriculum: To validate the course curriculum and the college imparting the same, process of accreditation on the pattern of AICTE has been initiated by framing the necessary guidelines.

H.R.D. Programmes: The ICFRE has adopted a five years HRD programme for capacity building of the managerial, scientific and the technical cadre. HRD programme of ICFRE, aims at-

- Increasing the management skills of the manager and senior researchers and to keep them abreast with current thinking and trends in forestry research.
- Enhancing the core competence of the researchers in their area of specialization through training, research workshops, seminars etc. and
- Providing in-service training in professional skills, lab management, field investigation etc. to all levels of supporting staff.

Trainings organised

1. Training on “Research Methodology” held at IASRI, New Delhi, from 7th to 18th January 2008.
2. Training on “Research Management and Administration” held from 3rd to 14th March 2008 at ASCI, Hyderabad.
3. Training on “Basic Forestry” held from 11th February to 18th April 2008 at State Forest Service College (SFSC), Dehradun.

6. POLICY RESEARCH (PR) DIVISION

Policy Research Division, Directorate of Education has been mandated to conduct “Policy Research” works in the arena of forestry. In consonance with the above mandate, a Committee was constituted by MoEF, GoI, vide order No. 12-1/2006-FP dated 23rd August 2006 to deliberate upon and finalize issues of the subject areas of Policy Research work.

The Committee decided to start the work on following three subjects :

- Scientific basis to assess the proportion of forest and tree cover in the country.
- Analyze the linkages of forestry to national priority of poverty alleviation thus bringing policy prescriptions in tune with the goals/objectives of National Development Perspective.
- Formulation of policy and legislative measures on certification mechanism for regulation and marketing of quality seeds/planting stock for tree improvement to give an impetus to plantation activities at regional/national levels.

On the recommendations and suggestions of the committee, this Directorate initiated consultancies on Policy Research Studies through following agencies :

Subject area

“Rationale for prescribing the requisite forests and tree cover in India”

Consultant

Academy of Forest and Environment Sciences, Dehradun

“Need for institutional and regulatory mechanism for certification of planting stock material of forest seed and vegetative origin”

M/S Piare Lal and others,
Phagwara (Pb.)

“Analyzing the linkage between Poverty Alleviation and Forestry Programmes”

M/S TNS India Pvt. Ltd.
New Delhi

Of the above, draft report has already been submitted by M/S Piare Lal and others consultants viz. “Need for institutional and regulatory mechanism for certification of planting stock material of forest seed and vegetative origin” and further follow up on the same is in process.

FORESTRY EXTENSION

7. MEDIA AND PUBLICATION (M&P) DIVISION

Media and Publication Division, Directorate of Extension 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 keeps MoEF apprised of those. The division publishes the Quarterly Newsletter of ICFRE (that brings out the latest significant achievements made by the ICFRE Institutes) and the ICFRE Brochure. The reports of ICFRE and its institutes are collected, compiled, edited and published as the Annual Report of ICFRE, which is tabled in Parliament. Editing, vetting and processing of books, brochures, pamphlets and technical reports of ICFRE Institutes taken up by this division as mandatory before their final publication.

Work on establishment of Van Vigyan Kendras (VVKs) in collaboration with SFDs and selection of Demo villages for adoption by ICFRE Institutes have progressed considerably. The Van Vigyan Kendras at Karnataka and Himachal Pradesh have already started working while in other States these are at various stages of establishment. In the Demo villages selected by ICFRE Institutes, demonstration and extension of technologies for example agroforestry models, establishment of Model/Hi-tech nurseries, training and transfer of simple technologies, etc. are being carried out.

8. STATISTICS DIVISION

Statistics Division, Directorate of Extension published four volumes, Volume 51-54, of the Quarterly bulletin “Timber Bamboo Trade Bulletin”. Other activities of the division are as follows:

Project 1: Establishment of a Network to Facilitate Collection, Processing and Dissemination of Statistics Pertaining to Tropical Timber and other Forestry Parameters in India –Funded by the International Tropical Timber Organization (ITTO)

Status: a. Eight Regional workshops, in each of ICFRE Institutes, were conducted to sensitize the State Forest Departments about the Forestry Statistical Reporting System (FSRS).

b. National Seminar-cum-Workshop of stakeholders was held on 26th and 27th March 2008 for finalizing objectively verifiable indicators and presenting the proceedings of the regional workshops. The workshop was jointly funded by the CSO and the ITTO projects.



Project 2: A Sample Survey to Estimate Rates and Ratio of Timber and Non-Timber Forest Products of India – Funded by Central Statistical Organization (CSO)

Status: Data collection, analysis and report finalization was done.

Miscellaneous

1. Collection and dissemination of data for Joint Forest Sector, Questionnaire of International Tropical Timber Organization (ITTO).
2. Collection, compilation and data entry for the biennial publications of 'Forestry Statistics India' 2005 and 2007.

9. ENVIRONMENTAL IMPACT ASSESSMENT (EIA) DIVISION

Environmental Impact Assessment Division, Directorate of Extension has been undertaking EIA studies nationwide for various developmental activities. The following studies have been completed by the Environmental Impact Assessment Division during the year 2007-08:

1. Mid-Term Evaluation of National Afforestation Programme sponsored by NAEB, Ministry of Environment and Forests, Government of India.

The NAP scheme is implemented by National Afforestation and Eco-development Board (NAEB), Ministry of Environment and Forests, Government of India as a 100% Central Sector/ Centrally Sponsored Scheme (SC/CSS) under the IXth and Xth five year plans. To identify constraints and impediments in the implementation of NAP through the FDA-JFM mechanism and to suggest corrective measures to accelerate the pace



Training organized by Kolhapur FDA,
Maharashtra

of work to attain the envisaged targets/goals, the NAEB awarded the Mid-Term Evaluation of NAP scheme to the Indian Council of Forestry Research and Education (ICFRE), Dehradun. Accordingly, ICFRE with the help of experts from the Institutes carried out the extensive survey in all the 27 states nationwide covering 182 FDAs. The final draft report of the consultancy has been submitted to NAEB.

2. Rapid Environmental Impact Assessment Studies for Talkatora Indoor Stadium upgradation project for New Delhi Municipal Corporation (NDMC).

Talkatora Stadium in New Delhi is situated adjacent to the central ridge forest. NDMC has planned to upgrade the Talkatora stadium and proposed to construct a five story building within the stadium for Common Wealth Games to be held during 2010 in New Delhi. Accordingly, rapid environmental impact studies were carried out to get the environmental clearance from the MoEF. The ICFRE was awarded with the consultancy by the NDMC to conduct rapid EIA. The detailed study was conducted and the final report was submitted to the NDMC.



Talkatora Stadium upgradation site, New Delhi

3. Environmental Impact Assessment studies, socio-economic and ecological studies for exploitation of bauxite deposits areas in Galikonda, Rakthakonda and Chittamgondi of Visakhapatnam district for Andhra Pradesh Mineral Development Corporation (APMDC) Ltd.

The Government of Andhra Pradesh (GoAP) has major reserves of 600 million tonnes of bauxite deposits in the tribal areas of Eastern Ghats. Andhra Pradesh Mineral Development Corporation (APMDC) has proposed to expedite the extraction of minerals at three deposit sites such as Galikonda, Rakthakonda in Anantagiri Mandal and Chittamgondi in Araku Mandal of Vishakhapatnam district. In order to seek environmental clearance for the above mining activity M/s. APMDC has appointed the Indian Council of Forestry Research and Education (ICFRE), Dehradun to undertake detailed EIA, SIA and EMP studies for the proposed mining sites. Accordingly, ICFRE with its expert team from Wood Biodegradation Centre (Marine), Visakhapatnam, and Institute of Forest Genetics and Tree Breeding, Coimbatore, undertook detailed survey. The draft report of consultancy has been submitted to APMDC.

4. Catchment Area Treatment Plan for Bauxite Mining in Galikonda, Rakthakonda and Chittamgondi for Andhra Pradesh Mineral Development Corporation Ltd.

Andhra Pradesh Mineral Development Corporation (APMDC) has proposed to expedite the extraction of minerals at three deposits such as Galikonda, Rakthakonda in Anantagiri Mandal and Chittamgondi in Araku Mandal of Vishakhapatnam district. In order to seek environmental clearance for the above mining activity M/s. APMDC has appointed the Indian Council of Forestry Research and Education (ICFRE), Dehradun to undertake detailed catchment area treatment plan for the proposed mining sites. ICFRE with its expert team from Wood Biodegradation Centre (Marine) Visakhapatnam and Institute of Forest Genetics and Tree Breeding, Coimbatore, undertook a detailed study. The draft report of consultancy has been submitted to APMDC.

5. Environmental Management Plan (EMP) for Renuka Dam Project in Sirmour district of Himachal Pradesh for Pabbar Valley Power Corporation Limited, Himachal Pradesh State Electricity.



The Renuka Dam, a storage structure, has been proposed to be constructed on the river Giri near Dadahu village in Sirmaur district, Himachal Pradesh by the Pabbar Valley Power Corporation Limited (Himachal Pradesh State Electricity Board). This project is a joint venture between Himachal Pradesh Government and Government of Delhi in order to extend drinking water facility to Delhi before the Commonwealth Games, 2010. The project proposes to store rain water to facilitate drinking water for Delhi and to generate 40 MW electricity. The height of the dam will be 148 metres with the reservoir length of 24 kilometres in river Giri. This will lead to submergence of 1197.60 ha of land. The consultancy was awarded to ICFRE by HPSEB to conduct detailed EIA/EMP studies. ICFRE with its experts from Forest Research Institute, Himalayan Forest Research Institute and with the help of sub contracts to M/s MANTEC Ltd. Delhi, undertook the detailed study. The draft report of the consultancy has been submitted to HPSEB.

6. Preparation of EIA and EMP with Catchment Area Treatment Plan (CATP), Hydrology and Drainage Studies for Ankua Iron Ore deposits in Jharkhand for JSW Steel Ltd. Mumbai.

JSW Steel Ltd. proposes to set up and operate a 10 million tonne (MT) per annum capacity Integrated Steel Plant (ISP) along with 900 MW Captive Power Plant (CPP), iron ore mines, coal mines and limestones/dolomite mines in the state of Jharkhand. Ankua Iron Ore deposits are stretched over a forest area of 999.90 ha in the district of W. Singhbhum. JSW Steel Ltd. has awarded the study for EIA and EMP studies with Catchment Area Treatment Plan, Hydrology and Drainage studies to the ICFRE. The consultancy is in progress; so far one season (winter) data has been collected.

GENERAL ADMINISTRATION

10. ADMINISTRATION AND INFORMATION TECHNOLOGY CELL

(Admin. & IT)

The Information Technology Cell, Directorate of Administration, ICFRE caters to all the Information Technology needs of the users at ICFRE and its Institutes / Centres. The activities of the cell are broadly classified in the following;

- LAN-WAN - Support
- Procurement and Maintenance of Hardwares
- E-Governance
- New Proposals
- Trainings
- Providing IT Support for the technical presentations in the Video Conference, Meetings, Conferences, Seminars and Workshops etc.

LAN / WAN - Support

- Regular Maintenance / Monitoring of MPLS VPN viz.; 11 MPLS Leased Line and 2 Mbps 1:1 Internet bandwidth.

- Regular Maintenance and reporting of e-mail, Internet etc. for around 600 users across ICFRE Hqtrs, FRI, IFGTB, TFRI and AFRI.
- Updating of www.icfre.gov.in a CMS based website of ICFRE Hqtrs.
- Regular Maintenance of Proxy Server / Web Server for service provided to users of ICFRE Hqtrs. and ICFRE's Institutes.
- Regular Maintenance and reporting of Network Antivirus facility at the ICFRE Hqtrs. and FRI campus through a centralized AV Server.

Procurement and Maintenance of Hardware

The IT Cell undertakes the maintenance of computer and peripheral hardware installed at ICFRE Hqtrs. and FRI through the third party vendor's. The hardwares have been categorized and inventoried accordingly for its proper maintenance and coordination with the vendors. Different types of hardware are under AMC of five different vendors.

The IT Cell is also managing AMC of Photocopiers, ICFRE through three different vendors looking after their own brand of machines broadly, Xerox, HCL and Ricoh.

Rate Contract of consumable items and Printers cartridges is also processed and operated for provisioning of consumables to the users of ICFRE Hqtrs., through three different vendors.

E-Governance

- The Indian Forestry Research and Information System (IFRIS) was planed and after completion of two initial stages viz. conceptualization and project development including Business Process Re-engineering, now the third stage viz. software development and implementation is under way and the final roll out of the application is planned in March 2009.
- The ICFRE Wide MPLs – VPN is in place and the Internet / email services have been centralized and are being managed from the ICFRE Hqtrs.
- The Video Conferencing has been successfully installed at ICFRE Hqtrs. and its eight regional Institutes spread all across the various geographical regions of the country.
- New Content Management System (CMS) based ICFRE Website is in place.



Initiatives

- The upgradation of old hardware (Desktops, Printers and Laptops) shall be taken up on priority basis.



- The ICFRE Institute wise maintenance of Local Area Network shall be consolidated and managed through single third party vendor.
- A ICFRE wide single central antivirus is being envisaged and shall be place soon.

Training

- Imparted in-house training to Officers and staff of ICFRE and its Institutes.
- Securing computer through proposed usage of Centralized Antivirus.

MISCELLANEOUS

IT Cell provides technical support in conducting Video Conferencing among ICFRE institutes. IT Cell provided support to ICFRE Hqtrs. and FRI with regard to the IT and Visual Arrangements in all the Meetings, Conferences, Seminars and Workshops etc. organized at ICFRE Hqtrs. and FRI in the year 2007-08.

PUBLICATIONS

Brochures/Pamphlets

1. संदीप त्रिपाठी, व विजय राज सिंह रावत और ओमकुमार (2007). स्वच्छ विकास क्रिया विधी। वनीकरण एवं पुनःवनीकरण परियोजनाये, वन दर्पण अंक 7, भारतीय वन सर्वेक्षण, देहरादून।
2. रेनू सिंह, विजय राज सिंह रावत और ओमकुमार (2008). सी.डी.एम. सिकं परियोजनाये वनीकरण एवं पुनःवनीकरण परियोजनाओ के क्रियान्वयन पर प्रश्नोत्तरी। भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद देहरादून द्वारा प्रकाशित।
3. Renu Singh and V.R.S. Rawat (2008). Resource Manual on Climate Change and Relevance to Forestry Sector for Indian Forest Service Officers, ICFRE, Dehradun.
4. V.R.S. Rawat and Om Kumar (2008). Frequently Asked Questions about CDMA & R Project. Published by ICFRE Publication 2008.

CHAPTER 3



INSTITUTES AND CENTRES OF ICFRE

Research Institutes and Centres

Page No.

3.1	Forest Research Institute (FRI), Dehradun	33
	• Centre for Social Forestry and Eco-Rehabilitation (CSFER), Allahabad	87
3.2	Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore	91
3.3	Institute of Wood Science and Technology (IWST), Bangalore	111
	• Forest Research Centre (FRC), Hyderabad	136
3.4	Tropical Forest Research Institute (TFRI), Jabalpur	141
	• Centre for Forestry Research and Human Resource Development (CFRHRD), Chhindwara	166
3.5	Rain Forest Research Institute (RFRI), Jorhat	169
	• Advanced Research Centre for Bamboo and Rattans (ARCBR), Aizawl	183
3.6	Arid Forest Research Institute (AFRI), Jodhpur	185
3.7	Himalayan Forest Research Institute (HFRI), Shimla	199
3.8	Institute of Forest Productivity (IFP), Ranchi	219

FOREST RESEARCH INSTITUTE DEHRADUN

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

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

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



PROJECTS COMPLETED DURING THE YEAR 2007-2008

PLAN PROJECTS

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

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

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

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

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

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

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

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

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

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

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

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



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

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

Project 7: To study ecological succession in restored mined land

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

1. Gloss of the samples treated with preservative plus finishes increased up to 38% as compared to samples treated with finish alone.
Percent increase in gloss is in the order:- Sprit polish > linseed oil polish > Wax polish > clear varnish.
2. Study on the performance of different finishes shows that gloss at different humidity conditions exhibited that loss in gloss of the samples that received double treatment i.e. preservative and polish was less as compared to the samples that received polish treatment.
Percent loss in gloss is in the order- Clear varnish > Wax polish > sprit polish > linseed oil polish.
3. Fungus attack was observed on samples that received polish treatment only.
4. Study on the effect of UV radiation on the performance of different finishes shows that loss in gloss of the samples that received polish treatment was more as compared to the samples that receive polish and preservative treatment.

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

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

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

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

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

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



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

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

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

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

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

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

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

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

Field trials were conducted in a 5 years old plantation of *D. sissoo* at Nihal Gate range under Tarai Central forest division, Haldwani. Out of eight combinations of biocontrol agents, systemic fungicides and insecticide, treatment T₃ (*Pseudomonas fluorescens* in FYM) gave the maximum survival.

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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

Findings:

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

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

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

EXTERNALLY AIDED PROJECTS

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

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

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

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

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

Project 3: Forest Fire Monitoring and Management

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

The amount of Gaseous emissions of as CO, CO₂ and Methane emitted from the different forest during/after fire have been estimated at different distance such as 10 m, 20 m, 40 m, 50 m, 60 m, 70 m, 80 m, 90 m and 100 m from the source of fire.

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

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

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



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

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

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

Findings: Phenol formaldehyde resin was prepared and analysed using commercial grade phenol and formaldehyde. Particle boards were prepared at 17.5 kg/cm², 21 kg/cm² and 24 kg/cm² pressure levels using 10%, 12% and 14 % phenol formaldehyde resin with pressing temperature 150°C. For reducing the water absorption of boards, 0.5 and 1.0 % wax emulsion was also used for making particle boards. Particle boards thus obtained were tested for various physical and mechanical properties such as density, moisture content, water absorption, swelling due to surface absorption, Modulus of Rupture (MoR), tensile strength perpendicular to surface etc. as per relevant IS specifications. It was observed that the particle boards prepared at 24 kg/cm² pressure level using 14 % resin meet the IS specifications.

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

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

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

Findings:

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

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

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

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

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

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



Catamixis baccaroides in FRI Botanical Garden



Catamixis baccaroides in original habitat

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

**Molecular characterization of *Fusarium* isolates
RAPD**

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

Cluster analysis

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

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

ISSR

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

Cluster analysis

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

SSR

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

Cluster analysis

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

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

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



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

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

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

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

PROJECTS ONGOING DURING THE YEAR 2007-2008

PLAN PROJECTS

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

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



Regeneration of *Cedrus deodara* in
Jageshwar



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

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

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

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

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

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

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

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

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

1. Physiological parameters viz., photosynthesis, transpiration, internal CO₂ and leaf temperature in field and laboratory conditions.
2. Biochemical estimation of chlorophyll, carotenoids, sugars, protein, starch, amino acids and phenols.

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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



Asparagus racemosus with beans



Ocimum sanctum



Rauvolfia serpentina

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

Project 28: Analytic studies on woody cell wall architecture

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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



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

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

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

EXTERNALLY AIDED PROJECTS

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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



Demonstration hut

*Abrus precatorius* at conservation site

Nursery beds

Project 8: Eco restoration studies in Uranium Mines

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

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

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

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

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



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

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

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

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

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

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



Eremostachys superba in flowering in FRI Botanical Garden

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

NEW PROJECTS INITIATED DURING THE YEAR 2007-2008

PLAN PROJECTS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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



View of South Delhi Ridge Forest



Biotic pressure on site

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



Ejection holes



Frass



Pupa

Damage by oak borer on *Quercus dilatata*

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

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

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

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

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

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

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

EXTERNALLY AIDED PROJECTS

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

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

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

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

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

Status: Surveyed the catchments area of the Giri River, starting from Rajban to Nehripul, Himachal Pradesh. Dig out in the soil profile in different land uses viz. miscellaneous forests, agriculture, Eucalyptus and Khair at Satone, Sadiyar, Ranukajee and Chadni, H.P. in the catchments area and collected soil samples from different genetic horizons. Geological formations of these areas were also studied and rock samples were also collected for mineralogical investigations. Soil samples for organic carbon estimation were collected by opening soil pit of 30 cm³ from different land uses. Bulk density samples were collected from different sites. Soil samples collected so far were processed for various estimations and analysis are under process.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

NATIONAL FOREST LIBRARY AND INFORMATION CENTRE

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

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



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

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

FOREST RESEARCH INSTITUTE UNIVERSITY

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

Academic Courses and Admission

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

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

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

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

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

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

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

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

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

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

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



Convocation of Forest Research Institute University:

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

Following number of degrees were awarded in the convocation.

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

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

Extra Curricular Activities:

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

Special lecture:

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

4. Dr. Podwils, Director, DAAD International Funding Agency of Federal Republic of Germany, visited FRI University on 14th August 2007 and he was briefed to all students/Research Scholars on various schemes and opportunity available in Germany.
5. Dr. S.D. Singh, IFS delivered a lecture on “Forestry Research” to the FRI University students.
6. Special lecture was organized on “Personality Development” for all FRI University students on 4th March 2008.
7. Special lecture was attended by FRI University students on “Application of Nano Science in Forestry” on 27th March 2008.

CONSULTANCIES

1. Installation of a solar kiln at Pipli, Haryana for Haryana Forest Development Corporation Limited and at Jalandhar for M/s Process-cum-Product Development Centre (PPDC), Meerut. The kiln has been installed and handed over to the client after successful trial and training of their staff.
2. Identification of technological gaps and possible remedial measures in wood based sports goods cluster at Jalandhar for Dr. B.R. Ambedkar National Institute of Technology, Jalandhar
3. Consultancy was provided to M/s Indo-Gulf Fertilizer, Jagdishpur, Sultanpur; M/s Tata Chemicals, Babrala, Badaun; M/s Shriram Alkali and Chemicals, Bharuch, Gujarat and M/s Chambal Fertilizers and Chemicals Limited, Kota on Cooling Towers.
4. Forest Department of Uttarakhand for Biostablization of Varunavat landslide.
5. Tehri Hydro Development Corporation Ltd., Tehri for stablization of left and right bank slopes of Koteshwar Hydro Electric Project with the help of suitable vegetation.
6. Commonwealth Games, DDA, New Delhi.
7. M/S Faridabad Gurgaon Mineral, New Delhi.
8. Bodhgaya Temple Mangement Committee for management of heritage tree Bodhi Vriksha.
9. New Delhi Municipal Council, New Delhi for management of diseases in plantation trees.
10. Archaeological Survey of India for the management and conservation of trees at Ta Prohm Temple, Siem Reap, Cambodia.
11. RIO Tinto Exploration India for Baseline study on the flora and fauna of Chhatarpur forest area of Madhya Pradesh.

AWARDS

1. DAAD Reinvitation Fellowship for two months in Germany was awarded to Dr. Meena Bakshi, Scientist-C to work in Bayerische Forstamt fur Forstliche Saat und Pflanzenzucht from November-January 2008. Worked on isozymes, microsatellites of *Pinus wallichiana* and *Dalbergia sissoo* using advanced DNA Sequencer.
2. Sudhir Kumar Sharma was awarded “FELLOWSHIP AWARD” to attend the International Conference on Plant Tissue Culture and Agri biotechnology held at Kualalumpur (Malaysia) from 17th to 21st June 2007.



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

PATENTS

1. Patent applied on “New eco-friendly, economical and non-hazardous wood preservative ZIBOC- comparable to CCA”
2. Black hair dye composition and a process for preparation thereof.
(Application no. 1910/DEL 207 dated 10th September 2007).

DISTINGUISHED VISITORS

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

CENTRE FOR SOCIAL FORESTRY AND ECO-REHABILITATION ALLAHABAD

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

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

PROJECTS COMPLETED DURING THE YEAR 2007-2008

PLAN PROJECT

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

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

PROJECTS ONGOING DURING THE YEAR 2007-2008

PLAN PROJECT

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

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



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

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

EXTERNALLY AIDED PROJECT

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

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

NEW PROJECTS INITIATED DURING THE YEAR 2007-2008

PLAN PROJECTS

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

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

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

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

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

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

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

PUBLICATION

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

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



CONFERENCE/MEETINGS/WORKSHOPS/SYMPOSIA/EXHIBITIONS

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

INSTITUTE OF FOREST GENETICS AND TREE BREEDING, COIMBATORE

The Institute of Forest Genetics and Tree Breeding (IFGTB) is a national Institute formed in April 1988 under the Indian Council of Forestry Research and Education (ICFRE), an autonomous Council under the Ministry of Environment and Forest, Government of India. It was formed by upgradation of the Forest Research Centre (FRC), Coimbatore under the Forest Research Institute and Colleges, existing since 15th December 1959. Certain other organizations and schemes viz., Forest Soil-cum-Vegetation Survey (FSVS), Coimbatore, Disease and Insect Survey (DIS), Coimbatore, Indo-Danish Project on Seed Procurement and Tree Improvement (IDPSPTI), Tropical Pines Research Centre (TPRC), Kodaikanal Eucalyptus Research Centre (ERC), Ooty and Environmental Research Station (ERS), Ooty were also merged with the FRC to form the Institute.

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

	No. of projects completed in 2007-08	No. of ongoing projects in 2007-08	No. of projects initiated in 2007-08
Plan Projects	3	23	10
Externally Aided Projects	5	14	-
Total	8	37	10

PROJECT COMPLETED DURING THE YEAR 2007–2008

PLAN PROJECTS

Project 1: Enhancing productivity in *Casuarina* species through inter-provenance and inter-specific hybridization [IFGTB/RP-30/2003-08]

Findings: Forty families of inter-provenance and inter-specific hybrids of *Casuarina equisetifolia* and *C. junghuhniana* were produced through control pollination. Three field tests were established at Veedur (Tamil Nadu), Panampalli (Kerala) and Sriharikota (Andhra Pradesh) to test the performance of F₁ progeny. All the tests were assessed for height and survival at 6 months age. Survival was more than 90% in Veedur and Panampalli and 85% in Sriharikota. Inter-specific hybrid families showed better height growth than local seedlings and seed orchard progenies of pure



Hybrid trial of *Casuarina* showing vigorously growing inter-specific hybrid trees and slow growing trees of parentspecies (Panampalli, Kerala)



species. The best inter-specific hybrid family showed 35 to 53% better height growth than local seedlot and 17 to 21% over orchard progenies. The average height of the best 5% of trees was 49 to 68% more than that of local seedlot and 29 to 32% over orchard progeny. The trials will be maintained upto 5 years age and periodic assessment of growth and form traits will be gathered for further ranking of families and individuals.

Project 2: Status and floristic diversity of sacred groves—the only remnants of natural forests in Alappuzha District, Kerala [IFGTB/RP-35/2005-08]

Findings: Alappuzha is the smallest (1414 km² area) district in Kerala with a high population density (1492 persons per km²) and is the only district in the State without natural forests. The sacred groves of the district attract utmost attention as they are the only remnants of natural forests once present. Undertaken field survey in all the six taluks of the district covering 91 villages and enumerated 1128 sacred groves. The total area recorded under these groves was 83.55 ha. Nearly 40% of the groves had sacred pond associated with it. Considerable variations were observed with respect to extent of the groves and species composition. Area of these groves ranged from 0.003 to 36 acres. Most of the groves are abode of many endemic and rare plant species. A total of 687 plant species belonging to 493 genera and 127 families have been identified from these groves. Many sacred groves in the district face threat due to the dense human population and change in socio-economic status. Break up of ancestral joint family system to nuclear families is the major reason for deterioration of these valuable resources. Sanskritisation and changes in beliefs are also attribute to this denudation. Over exploitation of the resources by 'Ulladans' a tribal community and removal of litter alongwith the seeds from the floor have also led to its retrogression to a great extent. Exotic weeds namely, *Mikania micrantha*, *Lantana camera* and *Chromolaena odorata* overgrow the native species and play a major role in degradation. Sacred groves require complete protection from human interferences and is the only way to preserve these priceless treasures of nature. 'Ulladans' should be made aware of the importance of the vegetation system and the rational and sustainable exploitation of the resources. People who clear the grove after transferring the deities to the serpent worship temples for various developmental activities should also be sensitized to avoid further damage. Officials of Forest Department, Research Organizations, NGOs and Educational Institutions should take lead in imparting knowledge on the functional role and importance of sacred groves. They also should help in ecological restoration of the retrogressing sacred groves by way of selecting and planting suitable plant species. In general, each sacred grove was found to possess its own unique biological, ecological, cultural and economic dimensions. Financial supports / rewards to the individuals and trusts maintaining these groves will go a long way in preserving them intact for posterity.

Project 3: Studies on seed handling and storage behaviour of important NTFP species [IFGTB/RP-34/2005-08]

Findings: Suitable seed handling techniques for four important NTFP species namely, *Calophyllum inophyllum*, *Decalepis hamiltonii*, *Garcinia gummigutta* and *Sapindus emarginatus* were standardized. Fruits of *C. inophyllum* have to be picked up at yellow-green stage of fruit maturity. Seeds were found to be desiccation sensitive with a Lowest Safe Moisture Content of 15%, and

studies showed that seeds can be stored for 30 days at temperature range of 10 to 20°C to prolong viability. Significant reduction in carbohydrate content and oil content could be the key factors involved in reducing viability within a period of 30 days, a tendency common in recalcitrant seeds. It is, therefore, advisable to store seeds in sealed polythene bags at a temperature range of 10 to 20°C.

D. hamiltonii seeds extracted from fruits collected during late March-April were found to be well matured and recorded 83% germination. Soaking in hot Water (60°C) for 24 hours was found to improve germination significantly to 98% than control. Germination on paper medium followed by transplanting to root trainers with red earth, sand and FYM (1:1:1) was found suitable for this species. Low temperature storage was not favourable and ambient storage (32±1°C) was found the best. *Decalepis* seeds can be classified as intermediate in storage behaviour with more inclination towards recalcitrance. Ambient storage of fresh seeds in sealed polybags upto 2 months is advisable. Depulping *G. gummigutta* fruits to extract seeds followed by abrasion of seeds with sand and washing with kerosene were found suitable pretreatments for cleaning seeds and rendered them suitable for germination. Shade drying seeds for 2 weeks was found suitable than sun drying and seed were desiccation tolerant. Upto 6 months, seeds withstood ambient temperature whereas upto one year storage 20°C was found favourable. The seeds did not show good storage response to different pre-storage trials such as seed dusting with protectants and moist sand storage. Seeds could be classified as intermediate in nature. Thus, storing *G. gummigutta* seeds in air tight pet jars without any storage treatments is the most suitable one.

S. emarginatus seeds with initial moisture content of 8.826 % showed germination of 62.5%. Pretreatments did not improve germination. Increasing trend in carbohydrate content over a period of 12 months storage could be attributed to setting of improved desiccation tolerance in the seeds. Seeds can be classified as orthodox in nature. *S. emarginatus* seeds can be safely stored in sealed polybags at room temperature or in a refrigerator upto 9 months.

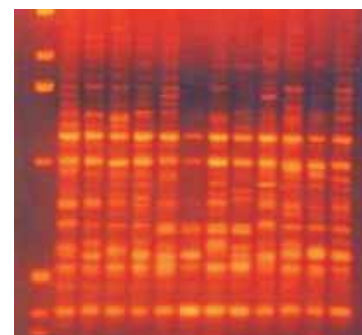


Flowering, fruiting, seeds and seedlings of *Sapindus emarginatus*

EXTERNALLY AIDED PROJECTS

Project 1: Genome evaluation and characterization in Casuarinas and Eucalyptus for improving productivity and conservation

Findings: The project aimed at assessing the genetic diversity in different population levels in *Casuarina* and *Eucalyptus*, specifically targeting those which are currently utilized under the breeding program developed by the Institute. The second major focus of the project was on developing end use markers for diagnosing species identity and specific traits. The genetic diversity existing between and within six eucalypts and five *Casuarina* species were assessed



ISSR-PCR profile of the species *Eucalyptus tereticornis* for genetic diversity estimation



using ISSR marker system. Subsequently, nine species-diagnostic markers were identified for *Casuarina* and *Allocasuarina* species and twenty one diagnostic markers were identified for five species (*E. camaldulensis*, *E. citriodora*, *E. grandis*, *E. tereticornis* and *E. urophylla*).

These markers were converted into SCAR markers in *C. equisetifolia* and *C. junghuhniana*. At the sub specific taxa level, genetic diversity was estimated within and between fifteen provenances of *E. tereticornis*, six progenies of seed orchards of *E. camaldulensis* and *E. tereticornis*, forty superior performing clones of *E. tereticornis* and *E. camaldulensis*, four SSOs of *C. equisetifolia* and two SSOs of *C. junghuhniana* using ISSR marker system. Further, three putative markers were identified using RAPD and four markers using SSRs for non-rooting clones of *E. tereticornis* and the SSR markers were validated at the family level. The project also provided leads for developing early selection markers for pulping trait in *E. tereticornis*, where in allelic diversity in the CCR and CesA genes were correlated with the holocellulose, lignin and pentosan content of the wood.

Project 2: Identification of Broad Spectrum Antifungal Proteins from Elite Medicinal Plants for Control of Plant Pathogens

Findings: The project aimed at identification and characterization of broad spectrum antifungal proteins from medicinal plants including *Acorus calamus*, *Withania somnifera*, *Piper longum* and *Rauwolfia tetraphylla*. Initially the above mentioned species were screened for antifungal proteins and *A. calamus* and *W. somnifera* were short listed for protein purification. Further, optimized the source tissue, developmental stage and buffer composition for extraction of total proteins with antifungal activity from these two species. Subsequently, purified a 32 KDa antifungal protein from leaves of *A. calamus* with pI value of 7.93, pH optima at 5.6 and temperature optima at 36°C. The protein was localized in the epidermal layers and xylem lumen of the leaf tissues. The peptide sequence showed similarity to peroxidase from *Oryza sativa*. It inhibited the hyphal extension of major pathogens including *Trichosporium vesiculosum*, *Macrophomina phaseolina* and *Fusarium moniliforme*. In *W. somnifera*, an acidic lectin with 30 KDa size and pI value of 4.0 was purified. It showed a similarity with concanavalin; A like lectin from *Canavalia maritima* and inhibited the hyphal extension of *T. vesiculosum*, *M. phaseolina*, *F. moniliforme* and *Rhizoctonia solani*.

Project 3: Refinement of *in vitro* multiplication protocol for *Bambusa nutans* and *Dendrocalamus giganteus*

Findings: Developed *in vitro* axillary bud proliferation protocol for the multiplication of mature plants of *Bambusa nutans* and *Dendrocalamus giganteus*. Pruning of actively growing culms was effective in *D. giganteus* for the emergence of axillary shoots, where more explants with suitable size can be extracted for inoculation. Modification in supply of Nitrogen and Magnesium was found to be favorable for culture establishment and shoot multiplication in *D. giganteus*. Addition of low levels IBA was effective in controlling shoot necrosis of *D. giganteus* rooted plants. Glucose as a carbon source was identified as the major regulator for root induction in multishoots derived from mature plants like *B. nutans* and *D. giganteus*. Field demonstration trial was established with 500 plants of *B. nutans* in the ongoing field trial project for tissue culture plants.

Project 4: Selection and clonal propagation of commercially important medicinal plants [IFGTB/GO/TN-11/2005/Ext/2005-08]

Findings: 60% to 90% rooting of different genotypes was observed in the combination of 100 ppm IBA concentration and composted coirpith in *Tinospora cordifolia*. Cuttings from young trees of *Aegle marmelos* responded to the combination of 2000 ppm IBA concentration and vermiculite. 60% rooting was observed. In the case of *Terminalia bellerica*, woody branch cuttings were tried with different concentrations of IBA and potting media. Initially, 3% of rooting was observed in the combination of 2000 ppm IBA and vermiculite. Further, using serial propagation technique, rooting of cuttings from the rejuvenated plants was enhanced to 30% using the combination of IBA and NAA with a concentration of 1500 ppm each and soilrite. Eleven genotypes of *Tinospora cordifolia* were subjected to biochemical analysis for alkaloid content. High alkaloid content was observed in the roots of the genotype from Anaikatti with a value of 50.8 genotypes of *Aegle marmelos* were studied for alkaloid content. High alkaloid content was observed in the leaves (64) and fruits (80) from the genotype in IFGTB campus. Four genotypes of *Saraca asoca* were studied to find the tannin content. High tannin content was observed in the leaves (3.22) of the genotype from Peechi, Kerala and in the bark (22.03) of the genotype from Courtrallam. Twenty four genotypes of *Terminalia chebula* were studied to find the tannin content. High tannin content was observed in the bark (8.69) of the genotype from Bargur and in the fruits (7.36) of the genotype from Thalaimalai.

Project 5: Development of yield assessment methods for *Eucalyptus* species and *Anacardium occidentale* using image analyzer (Funding agency: Tamil Nadu Forest Plantation Corporation-TAFCORN) [IFGTB/EF-RP-22/2005-07]

Findings: Methods were developed for single tree height, diameter and volume estimation. Pictures taken from 10 to 30 metres ground distance with a reference scale at breast height can be measured using Image analyser. Correction factors were worked out for the above measurements to estimate actual height, diameter and volume. Height and diameter of single tree can be estimated in high precision and accuracy with an error of $\pm 1.0\%$. A formula was developed and validated for estimation of single tree volume from trunk surface area and height. This method of volume estimation showed an error of $\pm 3.02\%$.

PROJECTS ONGOING DURING THE YEAR 2007–2008

PLAN PROJECTS

Project 1: Genetic Improvement of *Eucalyptus tereticornis* Smith through controlled pollination and molecular characterization [IFGTB/RP-3/2002-08]

Status: Control pollinated hybrids in combination of *E. tereticornis* $\times$ *E. grandis*, *E. tereticornis* $\times$ *E. alba* and *E. tereticornis* $\times$ *E. pellita* were developed. Three trials were developed in Kerala and Tamil Nadu. The Tamil Nadu Forest Department has raised a full-sib trial consisting 6 full-sib families in the State Forest Research Institute at Kolapakkam. Growth parameters at 60 months



indicate *E. tereticornis* × *E. grandis* as a viable combination. Thirty hybrid selections have been made in Panampally, Kerala and Sadiwayal, Tamil Nadu for clonal testing during 2008-09 for field transfer.

Project 2: Genetic improvement of *Acacia auriculiformis* through half-sib progeny selection [IFGTB/RP-39/2005-10]

Status: Two progeny trials of 1 ha each consisting 132 half-sib families of selected superior trees were established at Palode (Trivandrum) and Vadakkancherry (Thrissur) in Kerala. Maintenance activities like weeding and fire tracing were undertaken in all four progeny trials established at Pondicherry, Vadakkancherry, Panampally and Palode. The trial at Panampally has been evaluated for growth parameters as well as stem form. Profound variations were observed for these characters among families.



Progeny trial (one and half year old) of *A. auriculiformis* at Panampally, Kerala

Project 3: Phenotypic selection, reproduction and propagation in *Ailanthus excelsa*: Perspectives for Safety Matches Industry and Farmers in Tamil Nadu [IFGTB/RP- 40/2005-09]

Status: Seeds were collected from different agroclimatic zones of Tamil Nadu, Rajasthan, Madhya Pradesh, Andhra Pradesh and Uttarakhand and seedlings were raised for establishing germplasm banks. One germplasm bank has been established in Tirupati, Andhra Pradesh. Two locations in different agroclimatic zones have been identified in Tamil Nadu for establishing two more germplasm banks.



Germplasm bank of *Ailanthus excelsa* at Tirupati, Andhra Pradesh

Project 4: Genetic transformation of *Eucalyptus tereticornis* and *Casuarina equisetifolia* to enhance salinity tolerance [IFGTB/RP-6/2002-05]

Status: A standard protocol for regeneration and transformation of *Eucalyptus tereticornis* was developed. Both direct and indirect transformation experiments were carried out by using different strains of *Agrobacterium* like GV2260 and EHA 105 with pCAMBIA 1305.2 and pCAMBIA 1305.1, GV2260 harboring the Osmotin gene and also LBA 4404 harboring the gene construct AtNH. Various pre-incubation treatments including *Agrobacterium* concentrations, cocultivation durations, sonication treatments (0 and 50 A), and calcium chloride treatments (0 and 20 µM) on the explants were optimized. Particle gun mediated transformation was attempted and the results indicated very good positive transient expression in *Eucalyptus tereticornis*. In *Casuarina equisetifolia* experiments were carried out in Epicotyls of the provenances 00254 (Karunya), 00249 (Pondichery), and also from other 17 provenances for dedifferentiation in media containing 5 µM BAP and 10µM BAP with 0.005 µM of NAA. Callus response was observed in all the provenances.

Project 5: Studies on the population structure and reproduction of *Pterocarpus marsupium* in Tamil Nadu and Kerala [IFGTB/RP-37/2005–08]

Status: Surveys were carried out in 13 distinct populations of *Pterocarpus marsupium* in Western Ghats of Tamil Nadu. In total, 283 representative trees were marked and studied for morphological parameters and phenology.

Project 6: Evolving silvicultural practices for *Casuarina junghuhniana* ssp. *timorensis* [IFGTB/RP-33/2005–09]

Status: A total of eight field trials have been established both in coastal and inland areas covering five agroclimatic zones in Tamil Nadu, using seedlings raised from 59 different seed sources. In all these field trials growth performance of *C. junghuhniana* at different spacing levels (0.5 x 0.5 m to 2 x 1.5 m- 7 levels) will also be evaluated.

Project 7: Identification of conserved motifs in genes conferring salt tolerance to develop strategies for gene isolation from salt tolerant tree species [IFGTB/RP-28/2005–08]

Status: More than 4500 sequences of the genes conferring salt tolerance were downloaded. A number of Bioinformatics software Tools such as Clustalw, CLC free workbench; Geneious, primer software etc. were used for analysis. Conserved motifs are identified for the different genes under the main classification such as Transcription factors Cellular signaling components, Ion transporters, Proton transporters, Water transporters, Molecular chaperones-protein stabilization, ROS scavenging, Membrane fluidity, Osmo protection etc. Primers are obtained from conserved motifs wherever exists for most of the genes using tools.

Project 8: Natural regeneration studies on important trees in Silent Valley National Park, Kerala [IFGTB/RP-32/2004-09]

Status: Enumeration of trees and their regeneration status in different ecosystems in Silent Valley National Park has been studied. A total of 96 tree species have been enumerated from the sample plots and recorded the girth, number of seedlings and saplings for preparation their population structure. Soil samples were collected for assessment of soil seed banks of trees in different ecosystems.

Project 9: Studies on the diversity of bee fauna of the Nilgiris [IFGTB/RP-36/2005–08]

Status: In total, 35 species of bees have been collected and data gathered on vegetation in 32 sampling locations covering 9 forest types and 4 plantations. The floral associations of these bees species were studied. Threat factors on bees were also assessed.

Project 10: Assessment on carbon pool potential of important tree species at different sites, ages and management regimes [IFGTB/RP-41/2006-11]

Status: To assess carbon pool potential in *Casuarina* plantations, 183 trees were felled from 63 plantations in four agroclimatic zones of Tamil Nadu under different soil types and under irrigated and rainfed conditions. Soil samples were also collected and analyzed for carbon.



Project 11: Assessment of insect pest problems of selected fast growing indigenous tree species in Tamil Nadu and Kerala [IFGTB/RP-42/2006-09]

Status: Insect pest surveys carried out in nurseries, plantations and natural population of *Gmelina arborea*, *Dalbergia sissoo*, *Ailanthus excelsa*, *Melia dubia*, *Thespesia populnea*, *Bombax ceiba* and *Morus alba* at Amaravathi, Arimalam, Melakadu, Bhavanisagar, Sathiyamangalam, Theni, Mayiladumparai, Thangachimadam, Kodumudi, Vangal and Mahadhanapuram in Tamil Nadu and Kulathupuza, Sanjivanivanam Poothotam, Kalluvarambu, Tuillivellam (Nilambur), Attapaddy, Walayar, Karvoor and Chalakudy in Kerala revealed the following important insect pests.

S. No.	Tree species	Pests recorded	Major pests	Natural enemies recorded
1.	<i>Gmelina arborea</i>	2 Sap suckers (<i>Clovia</i> sp. and <i>Tingis beelsoni</i>), 2 defoliators (<i>Myllocerus discolor</i> and <i>Eupterote geminata</i>), 2 stem borer (<i>Sahydrassus malabaricus</i> and <i>Indarbela quadrinotata</i>)	<i>E. geminata</i> , <i>S. malabaricus</i> , <i>I. quadrinotata</i> and <i>T. beelsoni</i>	One Entomopathogenic fungus on <i>S. malabaricus</i>
2.	<i>Dalbergia sissoo</i>	1 Sap sucker (Coccids), 3 defoliators (<i>Myllocerus discolor</i> , <i>M. viridanus</i> and <i>Dasychira mendosa</i>) and 1 unidentified defoliator	<i>M. discolor</i>	—
3.	<i>Ailanthus excelsa</i>	2 Lepidopteran defoliators (<i>Atteva fabriciella</i> and <i>Eligma narcissus</i>), 1 stem borer (<i>I. quadrinotata</i>), 1 sap sucking mealy bug (<i>Maconellicoccus hirsutus</i>) and the leaf minor	<i>A. fabriciella</i> , <i>E. narcissus</i> and <i>M. hirsutus</i>	One Coccinellid beetle (predator) on the mealy bug <i>M. hirsutus</i> , 2 different spiders on the larvae of <i>A. fabriciella</i>
4.	<i>Melia dubia</i>	<i>Boarmia virigata</i> , 1 scale insect (Coccids) and 1 grass hopper <i>Orthacris</i> sp.	<i>Orthacris</i> sp.	—
5.	<i>Thespesia populnea</i>	2 Defoliators (<i>Orthacris</i> sp. and a lepidopteran pest)	<i>Orthacris</i> sp.	—
6.	<i>Bombax ceiba</i>	1 Scale insect, stem borer <i>Batocera</i> sp., and the bark feeding borer <i>I. quadrinotata</i> .	<i>I. quadrinotata</i> and <i>Batocera</i> sp.	—
7.	<i>Morus alba</i>	1 Defoliator - <i>Spodoptera litura</i> , 1 mealy bug <i>M. hirsutus</i> (Pink mealy bug) and white flies	<i>S. litura</i> and <i>M. hirsutus</i>	Two Coccinellid beetles on the mealy bug <i>M. hirsutus</i>

Data on the percentage/intensity of attack of the pest, nature of damage caused and the climatic conditions such as temperature and humidity were also recorded. The insect specimens collected from the field were reared in lab condition and preserved for further studies and also for identification purposes. Out of 13 insect species identified so far, 3 were new record on the host plants (*Gmelina arborea*, *Bombax ceiba* and *Thespesia populnea*) studied.

Project 12: Origin, distribution and genetic diversity of *Jatropha curcas* in India [IFGTB/RP-43/2006-08]

Status: Fifteen enzyme systems have been evaluated for their efficacy in distinguishing the accessions. While three (formate dehydrogenase, malate dehydrogenase and peroxidase) were found useful, twelve did not exhibit any variation and had fixed monomorphic alleles. Each polymorphic enzyme system produced one well resolved polymorphic region except peroxidase which had three. On an average, 4 loci (26.67%) were found to be polymorphic (P) and mean observed number of alleles per locus (A) was 1.533. Average observed heterozygosity (H_o) was 0.1082 and expected value (H_e) was 0.0993 with and gene flow $N_m=0.2177$ showing low level of genetic variation among different accessions suggesting poor segregation of genes over generations. The isozyme variation was measured by standard gene diversity measures using POPGENE v. 1.32. Dendrograms constructed for the above 55 accessions using the zymograms reveal that all the land races have very low heterozygosity.

DNA extraction procedures were standardized to avoid latex contamination. PCR protocols were optimized by carrying out variations in $MgCl_2$ concentration, primer concentration, DNA and buffer volume.

EXTERNALLY AIDED PROJECTS

Project 1: Germplasm collection and production of improved planting stocks of *Terminalia chebula* Retz. and *Terminalia bellerica* [IFGTB/EF-RP/2005-08]

Status: Vegetative propagation in *Terminalia chebula* and *T. bellerica* have been standardized. Among the rooting of branch cuttings, airlayering, budding and grafting the wedge grafting method was found to be relatively successful. Grafting of selected trees in Kallar, Talwadi, Bargur and Kalrayan hills areas of Tamil Nadu were attempted. Selection criteria for plus tree selection based on fruit yields and quality have been standardized. Eighty five superior trees of *T. chebula* and 17 superior trees of *T. bellerica* have been selected in various places in Tamil Nadu based on fruit yield. Fruit samples have been collected from these identified trees for biochemical analysis. Four distinct populations *T. chebula* and five populations of *T. bellerica* were screened for medicinally important biochemical compounds like total phenols, tannins, gallotannin, free gallic acid and ellagitannins to investigate



Terminalia chebula trees in farmland at Kalrayan Hills, Tamil Nadu



the relationship between geographic location and the biochemical content. Though variations were being observed between populations for all these compounds, the tree- tree variation within populations were higher.

Project 2: Population structure and reproduction in *Bruguiera* and *Ceriops* : implication on conservation [IFGTB/EF-RP-26/2005-08]

Status: Based on three years of observation in Pitchavaram, it is understood that flowering is strongly seasonal. Studies in 5 different taxa of Rhizophoraceae reveal unique reproductive phenology and pollination syndromes. Inflorescences are borne sub-terminally only on the second and third nodes immediate to the meristamatic tips of vegetative branches. Flowers are strongly protandrous and dichogamous. Spatially anthers are placed well above the gynoecium. After complete anther dehiscence and dispersal, the stigma projects out of the dried anther mass. On a temporal scale, male and female phases are separated 1-2 days. *Bruguiera* and *Ceriops* are entomophilous. *Bruguiera cylindrica* is pollinated by thrips (intra floral pollination) while *Ceriops decandra* is pollinated by diverse taxa of insect visitors. Pollen fertility in *Bruguiera* and *Ceriops* is comparatively lower to the values reported in other out breeding woody perennials. Despite having multiple ovule system (4-6), only one ovule succeeds in developing into a propagule. In *B. cylindrica*, propagules develop within 3-4 months and in *C. decandra* and *C. tagal*, it is 6-8 months. Diverse floral features, high pollen output, very high pollen to ovule ratio and low reproductive success noticed in *Bruguiera* and *Ceriops* places them amongst highly out crossing woody perennials.

Project 3: Field performance of micro and macro-propagated planting stock of selected five commercially important Bamboo species [IFGTB/EF-RP-17/2004-07]

Status: It is a networking project among IFGTB, IWST and KFRI for raising demonstration trial of tissue culture (TC) plants for five species. IFGTB has established trials for three species namely *Dendrocalamus strictus*, *Pseudoxytenanthera stocksii* and *Bambusa bambos* in an area of 25.0 ha. Growth performance of the tissue culture raised plants has been assessed with the cuttings and seedling raised plants. Preliminary results showed that the cutting propagated plants of *P. stocksii* showed 4.2 shoots per clump whereas the micro-propagated plants of the same clone produced 5.7 shoots. In *D. strictus*, cutting propagated plants produced more number of shoots (8.5) than the micro-propagated plants.



Three months old tissue culture raised plants of *Bambusa bambos* in the field

Project 4: Germplasm conservation and establishment of seed stands for production of quality seeds and seedlings [IFGTB/EF-RP-9/2003-06]

Status: Standardized seed handling techniques including storage, testing and germination for *Saraca asoca*, *Tinospora cordifolia*, *Oroxylum indicum*, *Gymnema sylvestre*, *Strychnos potatorum*, *Aegle marmelos*, *Embllica officinalis*, *Embelia ribes* and *Asparagus racemosus*.

Project 5: Evaluation of superior planting stock of *Acacia mangium* in agroforestry systems at different eco-climatic zones of Kerala and Tamil Nadu [IFGTB/EF-RP-11/2003-06]

Status: Eight experimental plots (in 2.8 ha) with superior planting stocks of *Acacia mangium* under agroforestry systems have been established and intercropping activities carried out in Tamil Nadu and Kerala. Six representative trees in three girth classes were felled for biomass estimation in two plots.

Project 6: Ecorestoration for Tsunami devastated coastline of Andaman Group of Islands [IFGTB/EF-RP-20/2004-07]

Status: The project envisages planting of 60 ha areas, over a period of three years. Out of the total target, an area of 41.2 ha has been completed so far in Sippighat, Chouldari, Kadakachang, Adajig, Rangat, Long Island and Casuarina Bay. Some of the plants are affected by Mealy Bug and the staff were advised to spray the pesticide Confidor. Insect samples along with twig have been collected for identification. About 300 Forest Department staff of Andaman have been trained in the establishment and management of nurseries and plantations.

Project 7: Establishment of Bamboo model plantations in different agroclimatic zones of Tamil Nadu using quality planting stock [IFGTB/EF-RP-21/2005-08]

Status: Model plantations of bamboo have been established in 60 ha with six different species of both tissue culture and macro-propagated planting stocks in five agro-climatic zones of Tamil Nadu.

Project 8: Bamboo Location Trial (BLT) – Funded by NMBA, TIFAC, DST [IFGTB/EF-RP-23/2005-07]

Status: Multi-location trials were established using 8 different bamboo species under 9 different nutrient management as well as under organic and inorganic farming methods.

Project 9: Development of post harvest techniques for seed production in *Jatropha curcas* (DBT Funded project) [IFGTB/EF-RP-24/2005-07]

Status: Flowering and fruiting phenology studies indicated that *Jatropha curcas* has high reproductive efficiency with reference to the selected locality, Anaikatti. Fruits at yellow stage gave 95% germination indicating the attainment of physiological maturity. Studies on effect of fruit colour (maturity) on oil content and quality showed that the colour/ maturity stage of the fruits processed for oil extraction had considerable effect on oil characteristics like Acid value, Iodine No., Peroxide Value and Viscosity. The results indicate that fruits need to be harvested at late yellow stage or black pulpy stage and is safer to avoid collecting fruits at dry stage. Effect of drying method on *Jatropha* oil was studied in seeds extracted from fruits at black pulpy stage. Considering the oil yield, shade drying for 10 days and oven drying at 40°C for 1 day were found suitable methods. However, desirable values for most of the oil characteristics in the oven drying treatment at 40°C for 1 day renders it superior to 10 days of shade drying treatment. Comparing the oil yield during the two seasons, it is found that during the second season (October-December), the oil yield in *Jatropha* is more than the first one (July-September). Also the oil physical and chemical



characteristics are favourable during the second season. It is essential to separate the shell or seed coat from seed in order to restrain loss of oil through absorption by seed coat and thereby maximize oil recovery. The experiment revealed that soaking *Jatropha* seeds for 24 hours in water followed by 2 hours drying helps in recovery of good seeds. The infection in the seeds was confirmed through the X-ray images. The quality characteristics of oil were low in 5% moisture content seeds compared to 6%. Hence it can be concluded that 6% moisture content is the Lowest Safe Moisture Content to which *Jatropha* seeds need to be dried. Effect of storage container on seed oil parameters and viability, was tested on seeds stored in different containers such as polybag, jute bag, cloth bag, paper bag and black polybag. The most apt material to store *Jatropha* seeds as revealed by the study would be cotton cloth bag or jute bag. Effect of different temperatures on storability of *Jatropha* showed interim results which suggest that seeds could be stored at 10-15 °C (normal refrigerated conditions) to obtain maximum oil content with desirable characteristics. Viability of seeds was observed to drop after nine months of storage. Studies are still in progress. Storage studies on effect of atmosphere, pre-storage treatments and mid-storage correction are in progress.

Project 10: Differential analysis of transcript expression in *Casuarina trichosporium* interaction to isolate defense-Related Genes [IFGTB/EF-RP/2006-09]

Status: The project aimed at cloning Initially, the conditions for elicitation of optimal disease response were standardized. Subsequently, transcript profiling in untreated and elicitor treated *C. equisetifolia* was performed using 9 arbitrary primers, 81 anchored DD -PCR primers and five gene - specific primers. Further, 183 amplicons were re-amplified and 75 selected fragments were cloned in pDRIVE vector and sequenced. The differentially expressed transcripts during elicitation included R gene, arabinogalactan, *hsp*, LEA-dehydrin, ARF, defensin, endochitinase, nodulin, extension and CRR transcripts and SCARFACE. Further, designed and synthesized 8 gene specific primer pairs and 7 nested primers for the above mentioned transcripts for RACE. Also constructed an expression library in lTriplEx2 vector with pfu / ml of 4×10^6 independent plaques and 75% recombinants.

Project 11: Infrastructure development of the Botanical Garden of the Institute of Forest Genetics and Tree Breeding and *ex-situ* conservation of selected rare and threatened species (Funding Agency: MoEF 2007) [IFGTB/EF-RP/2007-08]

Status: Ten RET species and 140 other plant species have been collected from Thanderai, Ulundurpet, Yercaud, Anaikatty and adjoining areas (Tamil Nadu), Anandagiri, Venkatagiri, Thirupati hills (Andhra Pradesh), Pondicherry, Trivandrum, Trissur, Kanjikkode, Pokkunnu, Calicut University, Kasargod (Kerala) and are being maintained in the Botanical garden. Infrastructure development works like repair of green house and labelling of plants in the garden have been completed.

Project 12: Bioproduction of secondary metabolites from *Aegle marmelos* [IFGTB/EF-RP/2006-09]

Status: Phytochemical screening of the leaves and roots of the species reveals, in general the secondary metabolites distributed in both the leaves and roots of the species. It was observed that steroids, carbohydrates, amino acids, reducing sugars, Triterpenoids, Catechin, Flavanoids were present in both the plant parts. Alkaloids and tannins were not detected in the leaves. Phenolic compounds were not detected in the roots. Anthroquinones and saponins were not detected in the species.

Different growth regulator concentrations were tested for the initiation of callus from different explants. It was observed that shoot and root explants responded well to the growth regulators while leaf explants showed slow and poor response. Response was good in explants inoculated in 6.0 mg / L 2, 4-D. Response was good with root and hypocotyl explants in eight different media compositions with the initiation period ranging from one to three weeks. Calli produced had a weight ranging from 85-100 mg on fresh weight basis.

Project 13: Establishment of seed production systems for NTFPs of Attapady hills [IFGTB/EF-RP/2006-08]

Status: The species under study were recommended by AHADS as they are important NTFP species utilized by the tribals. These species needed to be reintroduced into the area. Seed biology of *Aegle marmelos*, *Terminalia bellirica*, *Oroxylum indicum*, *Acacia concina*, *Saraca asoca*, *Asparagus racemosus* and *Caesalpinia sappan* were studied.

Seedlings of the above mentioned species were raised and planted as 100 plants plot in an area of 1.5 ha as a model seed production system for NTFPs at Vattaluki in Agali, Kerala, a tribal village. All the plants are surviving well.

Project 14: Developing strategies for describing, testing and registering varieties of forest tree species in India [IFGTB/EF-RP-23/2006-08]

Status: Selected trial plots of *Eucalyptus camaldulensis*, *E. tereticornis*, *Casuarina equisetifolia* and *C. junghuhniana* were visited in the State of Tamil Nadu. Probable characters which can be used as descriptors for these species were identified. These characters include both vegetative and reproductive characters.

NEW PROJECTS INITIATED DURING THE YEAR 2007–2008

PLAN PROJECTS

Project 1: Evaluation and characterization of clones of Casuarina with reference to yield, tree form, biomass, pulping characteristics and key nursery pests [IFGTB/RP/2007-12]

Status: Eighty seven clones of *C. equisetifolia* were short listed for field testing, prepared planting stock and established a field trial at Mayiladumparai, Karur District, Tamil Nadu during March 2008. Considerable variation was observed with reference to the rooting percentage in the clones. Planting stock is getting ready for two more trials. Raised an experiment to screen 124 selected clones for the key nursery pests and observations were recorded at 15 days interval. Low incidence of a new unidentified sap sucking insect pest was noticed in 6 clones initially. The pest had spread to 59 clones. Incidence of *Icerya purchasi* was observed in 64 clones. The percentage of incidence and intensity of attack was found to be 0.1 to 1.5% only.

Project 2: Improvement of Teak through selection, quality seed production, hybridization and clonal evaluation

Status: The potential plantations and SPAs short listed in the States of Kerala and Tamil Nadu for selection of plus trees. Seeds were collected from 70 selected trees from Parmbikulam and Nilambur.



Trees were identified for carrying out controlled pollination. Forty selected clones were multiplied vegetatively for establishing a clonal trial of teak. The rooting performance of different clones has been studied.

Project 3: Demonstration of agroforestry technologies for enhancing the livelihood opportunities in different agroclimatic zones of Tamil Nadu (IFGTB/RP-46/2007-10)

Status: Established 5 ha of demonstration plots of agroforestry models developed by IFGTB as well as National Research Centre for Agroforestry, Jhansi under three agroclimatic zones of Tamil Nadu. Tree species used for these models are Teak, Ailanthus, Melia and Casuarina.

Project 4: Evaluation of improved germplasm of *Eucalyptus camaldulensis* and *E. tereticornis* for productivity, wood traits, tolerance to insect pests and diseases and management for higher seed production

Status: Evaluation of *Eucalyptus* clonal trials for growth traits at three locations (Karunya, Kulathupuzha and Sathyavedu) has been completed.

Wood samples of 42 clones of *Eucalyptus* were collected from Karunya and Sathyavedu trials and submitted to the Institute of Wood Science and Technology (IWST), Bangalore for wood traits analysis.

Screenings have so far been carried out at these clonal trials at periodical intervals for the incidence of pests and diseases revealed the occurrence of the pests such as gall insect, thrips, aphids and bark feeding borer and diseases such as leaf spot, leaf blight and pink disease on coppices and grown up trees. The per cent incidence and intensity of attack of these pests and disease on individual clone were assessed and the identity of the pests and pathogens was established.

Collection of growth data and selection of trees for imposing different treatments for enhancing seed yield at 4 Seed Production Areas (SPAs) of *E. camaldulensis* and *E. tereticornis* at Panampally and Pudukottai have been completed.

Application of Panchakavya and Dasakavya in the nursery trial of *Eucalyptus* was done and recording of data on the incidence of insect pests and diseases on treated plants is in progress.

Project 5: Performance of selected clones of *Casuarina equisetifolia* for insect pest and disease tolerance and their response to bio-farming practices

Status: *Casuarina* cuttings collected from identified resistant clones were raised in nursery. Trees in the clonal trial of *Casuarina* in Coimbatore and in International provenance trial at Puducherry were screened for incidence of bark feeder and blister bark disease. Analysis for Phenol and Tannin content were completed for of 3 provenances. Pathogenecity test conducted with the pathogen *Trichosporium vesiculosum* on *C. equisetifolia* seedlings showed wilting symptoms with white lesion on stem and needles under glass house conditions. Further symptoms and assessments of progression of blister bark disease is in progress. Panchakavya and Dasakavya preparations were made and analysed for their chemical properties such as macro, micro nutrients and growth regulators. Microbial population present in the Panchagavya and Dasagavya were also assessed.

Project 6: Selection and conservation of red and sweet tamarind in southern India [IFGTB-49/GTB/2007-10]

Status: Extensive surveys were conducted in various parts of Tamil Nadu and Karnataka to identify red and sweet Tamarind trees. A total of 40 red and 30 sweet Tamarind trees were identified in different locations of the two States. Quantification of Anthocyanin and its stability was investigated in red Tamarind. Control pollination experiments were conducted between Natham red and Natham sweet clones and obtained viable fruit set indicating compatibility between the two clones. Vegetative multiplication of different red Tamarind was carried out through cleft grafting. The biochemical screening of sweet Tamarind is in progress.

Project 7: Studies on efficacy of secondary plant derivatives of *Aegle marmelos* on important insect pests of teak [P-21/2007-09]

Status: Completed the extraction work of different tissues of *Aegle marmelos* and *Acharas sapota* with aqueous, methanol, hexane and ethyl acetate. Tested those extracts of different tissues at the concentrations ranging from 1 to 10% against the teak insects *Hyblaea puera* and *Spodoptera litura* as per the standard bioassay procedure. During the feeding regime, it is observed that *A. marmelos* unripen - EtOAc and seed of 1% hexane brought about 80% larval mortality on *H. puera*. *A. sapota* seed hexane 1% brings about 60% larval mortality on *S. litura*. Results were compared with the control, Neem product and synthetic pesticide. Variation of chemical analysis of both the plant species were analysed for tannins, phenols, saponins, alkaloids and flavonoids, and these could be the causative factors of exhibiting bioactivity against insect pests. Individual secondary metabolites analysis is under progress.

Project 8: Screening and identification of potential isolates of Ectomycorrhizal fungi for increased productivity of *Acacia*, *Casuarina* and *Eucalyptus* tree species in nursery

Status: Pure cultures of different isolates of two different ECM fungi viz., *Laccaria fraterna* and *Pisolithus albus* were made from fresh basidiomata of these fungi collected from various plantations in Tamil Nadu, Kerala and Puducherry. Mass production of these cultures by selecting suitable culture medium was standardized.

Different types of inocula (basidiospores inoculum, vermiculite based mycelial inoculum and mycelium entrapped alginate bead inoculum) of different isolates of two ECM fungi were developed and methods standardized for long term storage and utilization.

Efficacy of different types of inocula of these ECM fungi on growth improvement of 3 different *Eucalyptus* species (*E. camaldulensis*, *E. tereticornis* and *E. grandis*) was tested in nursery and it was observed that the inoculated seedlings (90 days old) had better growth over uninoculated (control) seedlings. The study also indicated that among different inocula tested, the basidiospore and vegetative mycelial inocula of all the isolates of *P. albus* were superior in promoting the growth of the seedlings than other inoculum type during the period of observation. Further study is in progress.



Project 9: Assessment of population structure using SSRs and molecular characterization using RAPD in *Casuarina* species

Status: For assessment of population structure using SSR marker in *Casuarina* species, genomic DNA was extracted and amplified with GA and CA rich ISSR primers. Sixty amplicons were obtained from ISSR primers in search of SSRs. DNA profiling was done for 85 clones of *Casuarina equisetifolia* using RAPD technique.

Project 10: Association analysis of adventitious rooting traits using STS markers in *Eucalyptus tereticornis* and DNA profiling of eucalypts clones

Status: Contrasting phenotypes for rooting frequency was identified from the culled individuals of provenance trial cum seedling seed orchard available at Karunya field station. Sequence Tagged Site (STS) primers for vegetative propagation traits and gene specific (ARRO-adventitious rooting related oxygenase) primer pairs were synthesized and used for PCR amplification of poor and best rooters. Fingerprinting of 93 clones of *E. tereticornis* and *E. camaldulensis* assembled by IFGTB has been completed using RAPD-PCR.

Project 11: Evaluation of Teak CSO at Walayar using DNA profiling

Status: In evaluation of the genetic makeup of stock and scion of bud-grafted standing trees in the teak Clonal Seed Orchard at Walayar, Kerala, DNA profiling was done for 440 rametes of 20 clones using RAPD technique. Data analysis is in progress.

TECHNOLOGY ASSESSED AND TRANSFERRED

A technology has been developed for estimation of mean diameter of trees in plantations using Image analyzer by taking digital photographs. Using this technology, mean diameter of *Eucalyptus* plantations can be estimated with an error of $\pm 6\%$. This technology is applicable for species with bark, reflecting the flash light after sun set.

Single tree volume, height and diameter estimation technique from digital photographs has been developed using image analyzer. Using this technology, volume of trees can be estimated with $\pm 3.9\%$ error. Height and diameter of trees can be estimated with $\pm 2\%$ error. This technology is applicable for a wide range of species which has clear visibility of entire tree trunk. Day time photographs can also be processed for estimation of volume, height and diameter. Both these technologies have been transferred to TAFCON.

Potential isolates of Entomopathogenic fungi for management of Teak and *Casuarina* stem borers, *Sahyadrassus malabaricus* and *Indarbela quadrinotata* were identified from natural habitats of the pests, mass produced *in vitro* on agro-products and waste and standardized the method of application for control of these pests species under ICFRE funded project. Isolation, identification, evaluation and mass production of native entomopathogenic fungi for management of teak and *Casuarina* stem borers and the same has been advocated to the field staff of the Forest departments through various training programmes.

EDUCATION AND TRAINING

Students Development Programme: IFGTB hosted 77 PG Science and UG Engineering students to carry out their 2-6 month dissertations for their universities during the year 2007-08 in two sessions [summer (May-July) and winter (December-May)] under the ongoing research programmes of the Institute. The various fields under which the projects were carried out include DNA isolation, purification and amplification using PCR tools, DNA fingerprinting and marker systems, Genetic transformation of tree species, Database development and sequence analysis of genes conferring desirable traits, Tissue culture of trees, Vegetative and macro-propagation techniques, Cell culture, Reproductive and pollination ecology, Detection of hybrids using molecular markers, Instrumentation methods for analysis of primary metabolites, Bioassay directed identification, isolation and purification of secondary metabolites, Root and soil colonization of micro-flora, Mass multiplication techniques for pure culture production of biofertilizers, Insect - Host Plant interaction studies, Microscopic techniques and Image analysis and Carbon sequestration studies.

LINKAGES AND COLLABORATION

National

The Institute has collaborated with National Research Centre for agroforestry, Jhansi for demonstration of agroforestry systems in different agroclimatic zones of Tamil Nadu.

International

A project on “New biocontrol opportunities for Acacia exploration in India” formulated in collaboration with Alan Fletcher Research Station, Australia was approved by the State of Queensland acting through the Department of Primary Industries and Fisheries, Australia.

PUBLICATIONS

Brochures

Brochure on following species has been prepared.

Artocarpus heterophyllus, *Terminalia bellerica*, *Ailanthus excelsa*, *Terminalia chebula*, *Acacia nilotica*, *Phyllanthus emblica*, *Tectona grandis*, *Tamarindus indica*, *Syzygium cumini* and *Azadirachta indica*.

CONSULTANCIES

1. The Institute has carried out mid term evaluation of the National Afforestation Programme (NAP) undertaken by Forest Development Agencies (FDA) of Kerala and Tamil Nadu.
2. Dr. A. Nicodemus, Scientist-D offered consultancy to the Andhra Pradesh Paper Mills, Rajahmundry on genetic improvement of Casuarina through seed orchards.



3. B. Gurudev Singh, as a member of the team under the Consultancy by ICFRE carried out “Environmental Impact Assessment studies in the Bauxite mine areas of Arakku Valley”.
4. Dr. V. Mohan acted as a Technical Member to undertake Environment Impact Assessment (EIA) and Environment Management Plan (EMP) for Ankua Iron Ore Deposits in Jharkhand (ICFRE consultancy project).
5. Dr. V. Mohan, acted as a Technical Member to undertake Environment Impact Assessment (EIA) and Environment Management Plan (EMP) for bauxite mining in Jarrela Block III, Visakhapatnam, Andhra Pradesh State (under ICFRE consultancy project).
6. Dr. A. Balu, Scientist–E, extended Technical and Advisory services in respect of Eucalyptus gall insect pest management to (i) Tamil Nadu Forest Plantation Corporation (TAFCON), (ii) Andhra Pradesh Forest Development Corporation (APFDC), (iii) Karnataka Forest Development Corporation (KFDC) and (iv) Tamil Nadu Paper and Newsprint Ltd., (TNPL).
7. Dr. A. Balu, Scientist–E, extended Technical and Advisory services on Casuarinas needle borer problem and its management to Sriharikota High Altitude Range (SHAR).
8. Dr. C. Kunhikannan, Scientist-D has rendered his services as a team member for following consultancies.

Preparation of Catchment Area Treatment (CAT) Plan for proposed Bauxite mines in Araku Valley (Chittamgondi, Galikonda and Rekthakonda), Vishakhapatnam District, Andhra Pradesh by APMDC, Hyderabad through ICFRE, Dehradun.

Environmental Impact Assessment (EIA) studies at proposed Bauxite mines in Araku Valley Chittamgondi, Galikonda and Rekthakonda, Vishakhapatnam District, Andhra Pradesh, by APMDC, Hyderabad through ICFRE, Dehradun.

Mid-term evaluation of National Afforestation Programme (NAP) in the State of Kerala.

Preparation of Catchment Area Treatment (CAT) Plan proposed Bauxite mines in Jarrela blocks Vishakhapatnam District, Andhra Pradesh by APMDC, Hyderabad through ICFRE, Dehradun.

Environmental Impact Assessment (EIA) studies at proposed Bauxite mining areas in Jarrela blocks Vishakhapatnam District, AP by APMDC, Hyderabad through ICFRE, Dehradun.

Preparation of Catchment Area Treatment (CAT) Plan and proposed Iron Ore Mines in Ankua, Manoharpur, Jharkhand.

Environmental Impact Assessment (EIA) studies at proposed Iron Ore Mines in Ankua, Manoharpur, Jharkhand.

CONFERENCE/MEETINGS/WORKSHOPS/SYMPOSIA/EXHIBITIONS

1. Organized the Institutional Bio-Safety Committee (IBSC) meeting on 31st December 2007 to obtain clearance from Dept. of Biotechnology, Govt. of India for the projects involving DNA activities.

2. Conducted a national level network meeting on “*Eucalyptus* improvement” sponsored by the Department of Biotechnology, New Delhi on 20th and 21st April 2007.
3. A field visit cum meeting with experts from research institutes, Wood based industries, Forest departments and Forest development corporations was arranged on 17th April 2007 in Chennai to discuss the strategy to be adopted to prevent and contain the insect gall problem in *Eucalyptus*.
4. A technical meeting to formulate an All India Coordinated project on *Eucalyptus* gall insect pest management was organized at the Institute from 28th to 30th June 2007.
5. A National seminar on “Implications of the Protection of Plant Varieties and Farmer’s Right Act, 2001 in Forestry Sector” was organized at the Institute on 4th and 5th July 2007.
6. A National Workshop to “Identify Stakeholders and Capacity Building Needs in Forest Genetic Resource Conservation” under APFORGEN programme was organized at the Institute on 11th July 2007.

DISTINGUISHED VISITORS

1. Dr. R.B. Singh and Dr. A. Rabbani, Head, C and LD, Satish Dhawan Space Centre, Sriharikota /Engr ‘SF’, C & LD, SDSC, SHAR, Sriharikota on 15th May 2007.
2. Dr. Aravind Boaz, Director General (SACEP) South Asia Co-operative Environment Program, Colombo, Srilanka on 22nd September 2007.
3. Dr. Kyu Kyu Thinn, Staff Officer, Forest Department, Myanmar, on 22nd January 2008.
4. Dr. D.N. Tewari, Former Director General, ICFRE, on 22nd February 2008
5. Shri Namo Narayan Meena, Hon’ble Minister of State for Environment and Forests, Govt. of India.
6. Dr. V.L. Chopra, Hon’ble Member, planning Commission, Govt. of India.
7. Dr. B.N. Yogandar, Hon’ble Member, Planning Commission, Govt. of India.
8. Dr. D.N. Tiwari, Vice Chairman, State Planning Commission, Chhattisgarh.
9. Ms. Meena Gupta, IAS, Secretary, MoEF, Govt. of India.
10. Shri G.K. Prasad, IFS, Director General of Forests and Special Secretary, MoEF, Govt. of India.
11. Dr. S. Nagarajan, Chairman, Protection of Plant varieties and Farmers Rights Authority, Govt. of India.
12. Shri Jagadish Kiswan, Director General, ICFRE.
13. Mr. C.K. Sreedharan, IFS, Principal Chief Conservator of Forests, Tamil Nadu.
14. Dr. P.J. Dilip Kumar, IFS, Managing Director, Karnataka State Forest Development Corporation.
15. Prof. C. Ramasamy, Vice Chancellor, Tamil Nadu Agricultural University.
16. Dr. Ramani Jamunadas, ICRAF, Nairobi.
17. Dr. C.K. Gandhi Rajan, IPS, Inspector General cum Commissioner of Police, Coimbatore.
18. Dr. M. Sanjappa, Director, Botanical Survey of India.



19. Dr. Ganesan, Director, Tropical Botanical Garden and Research Institute.
20. Mr. Homg-Lay-Thong and Mr. Leesoon-Leong, Biodiversity International, Malaysia.
21. Shri R.K. Goel, IFS, Joint Secretary, MoEF, Govt. of India.
22. R.K. Ojha, Chief Conservator of Forests, Tamil Nadu.
23. Shri P.N. Unnikrishnan, Chief Conservator of Forests, Kerala.
24. Shri Bhagawan Singh, IFS, Chief Conservator of Forests and Director, Tamil Nadu Forest Academy, Coimbatore.
25. Shri M.L. Mal, Director, Indian Paper Mills Association.
26. Shri Narayan Moorthy, General Secretary, Indian Paper Mills Association.
27. Shri Saradha, Vice President, J.K. Paper Mills, Rayagad, Orissa.
28. Shri N.S. Atkoli, Chairman, Bamboo Society of India.
29. Dr. D.C. Uprety, National Fellow and Principal Scientist, ICAR.

MISCELLANEOUS

1. Quality seeds of *Eucalyptus camaldulensis*, *E. tereticornis*, *Casuarina equisetifolia* and *C. junghuhniana* were collected from orchards and supplied about 52 kg of seeds to farmers and other user agencies.
2. A reconnaissance survey was undertaken to the major eucalyptus growing areas of Tamil Nadu and Karnataka to assess the status and the incidence of stem and leaf gall in *Eucalyptus* caused by *Leptocybe invasa*.

INSTITUTE OF WOOD SCIENCE AND TECHNOLOGY, BANGALORE

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

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

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

		No. of projects completed in 2007-08	No. of ongoing projects in 2007-08	No. of projects initiated in 2007-08
IWST, Bangalore	Plan Projects	13	15	11
	Externally Aided Projects	7	20	6
FRC, Hyderabad	Plan Projects	5	1	—
	Externally Aided Projects	1	1	—
	Total	26	37	17

PROJECTS COMPLETED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Studies on gas permeability of secondary species of timbers [IWST/WSP/X-19/2003-08]

Findings: In transverse direction, the permeability of *Acacia auriculaeformis* and *Acacia mangium* was very low as compared to axial direction. However, permeability in *A. mangium* was relatively higher than that of *A. auriculiformis*.



Heartwood specimen of *Eucalyptus camaldulensis*, *E. grandis* and *E. tereticornis* did not indicate flow rates. On the other hand, considerably higher permeability was measured in sapwood specimens of *E. camaldulensis* and *E. tereticornis*. On the contrary, permeability in sapwood of *E. grandis* was found to be lower as compared to the other two species measured.

Project 2: Study the variability in growth stresses in clones of *Eucalyptus* [IWST/ WSP/ X-56/2006-08]

Findings: A total of 15 clones of *Eucalyptus tereticornis* of ITC, Bhadrachalam growing at Nagroor, near Bangalore and 10 clone from IFGTB Coimbatore were evaluated for the growth strain. It was observed that clone number 116 and 3 (about 400 micro strain) had lowest strain while clone number 10, 71 and 115 had maximum level of growth strain (about 1000 micro strain) from Bangalore region. Wood from clone with highest growth strains also exhibited highest volumetric shrinkage. From IFGTB Coimbatore, clone number 53 had minimum value (568 micro strain) while clone numbers 17 and 19 had maximum level of growth strain (1555 and 1546 micro strain respectively). It was observed that clones from Coimbatore had more strains than that of Bangalore region. Green density of the clones from Bangalore was found to be almost constant (about 1000 kg/m³) while the basic density varied from 550 to 750 kg/m³.

Project 3: Studies on chemical modification of wood by vapour phase treatments [IWST/ WSP/X-61/2006-08]

Findings: The chemical modification of sapwood portion of the four wood species under viz. Rubber wood (*Hevea brasillensis*), Radiata pine (*Pinus radiata*), Mango wood (*Mangifera indica*) and Chir pine (*Pinus roxburghii*) can be treated in vapour phase by benzoyl chloride at boiling temperature in the glass reaction vessel. The optimized condition i.e. with 4% lead acetate as catalyst, pyridine as swelling agent and time of treatment in vapour phase 6 hours gave the highest Weight Percent Gains (18-35 WPG).

Chemical modification of wood by vapour phase treatments are most effective in Mango wood (*Mangifera indica*) followed by Rubber wood (*Hevea brasillensis*), Chir pine (*Pinus roxburghii*) and Radiata pine (*Pinus radiata*). Modified wood shows high Anti swelling efficiency and resistance against Termites.

Project 4: Extraction and separation of chemical constituents of *Dysoxylum malabaricum* Bedd. wood [IWST/CFP/X-52/2005-08]

Findings: Hydro distillation of powdered *Dysoxylum malabaricum* wood yielded an essential oil = 0.6% W/W. GC-MS analysis of the essential oil showed the presence of 28 important chemical compounds. Ethyl acetate extract of *Dysoxylum malabaricum* wood having pleasant odour gave positive tests for terpenoids and flavonoids. Ethyl acetate extract of *D. malabaricum* wood at 0.5% concentration showed strong inhibition against wood decaying fungi namely *Polyporus meliae* (Brown rot) and *Thyromycis hirsutus* (White rot) Among various experiments conducted to reduce mortality of *D. malabaricum* seedlings and increase survival percentage, adding of locally available mulch around seedlings increased survival percentage to a great extent.

Project 5: Development of methods for detection of adulterants and evaluation of quality parameters for assessing purity of Jigat [IWSST/CFP/XI-71/2007-08]

Findings: Binding property of the Jigat has been standardized by measuring its viscosity. This property of Jigat raw material is very useful to prevent peel off of finished bathis. A simple laboratory method has been developed to determine quantity of Jigat in adulterated samples by UV-spectroscopic method. The developed method will help to meet the needs of end users/stake holders. FTIR spectra were taken to differentiate functional groups of pure and adulterated samples of Jigat. Samples received from agarbathi industries/ Jigat traders for its authentication were used to study the percentage of Jigat in the adulterated mixture.

Project 6: Development of methods for detection of adulterants and determining purity of sandal oil [IWSST/CFP/XI-72/2007-08]

Findings: A simple method using UV-spectroscopy has been developed for estimation of sandalwood oil in adulterated mixture. The developed method will help to meet the needs of end users/stakeholders. Solubility test using 70 % ethyl alcohol for different adulterated mixture has been studied. This will give preliminary idea of type of adulterant in the mixture. Refractive index study, optical rotation study for pure sandal oil and different adulterated mixture has been studied which also gives idea about possible adulterant in the mixture. Samples received from end users for its authentication were used to study the percentage of sandal oil in the adulterated mixture.

Project 7: Investigations on the resistance of commercially available bamboo species in Karnataka against insect borer and termite [IWSST/WBD/X-45/2004-08]

Findings: The major borer identified to cause damage to commercial bamboo was *Dinoderus minutus* and the minor borers were *Lyctus africanus* and *Heterobostrychus aequalis*. The annual loss of revenue caused by insect borers in bamboo depots is around 25%. The bottom portion of the culm was found on an average to be more durable against borers and fungal attack. Bamboo from wet zone and dry zone were evaluated separately against termites and fungi. Commercially available bamboo *D. strictus* was found to be more durable against termites and fungi than *B. bambos*. Project is completed as on 31st March 2008. Project completion report is under preparation.

Project 8: Clonal test trials on *Casuarina equisetifolia* L. in north coastal Andhra region [IWSST/WBD-Marine/X-004/2003-08]

Findings: Ten clones of *Casuarina equisetifolia* L. procured from Regional Forest Research Centre, Rajahmundry and planted in Chippada VSS as per Randomized Row Planting Design. Soil samples were collected and analyzed for nutrient status which revealed that the soils are devoid of any nutrients. Survival percentage of the plantation revealed that 3 clones performed well with survival over 50% as compared to other clones. Growth parameters in terms of height, basal stem diameter and average branching pattern at ground level were recorded for all the clones. Growth performance in terms of height of all the clones is good. Basal stem diameter above ground of all the clones showed good girth. The trials with the clones revealed that the clone CP4202-M is the most suitable for plantation on degraded soils.



Project 9: Periodical income generation for communities involved in coastal plantation (Old title: Community involvement in coastal forestry through periodical returns by value added produce) [IWST/WBD-Marine/X-24/2003-08]

Findings: Seeds of *Eucalyptus citriodora* Hook. were procured and nursery raised in Chippada VSS area in Visakhapatnam district. Two hectares were planted with *E. citriodora* interspersed with *Casuarina equisetifolia* L. in Quinquinox Design and one hectare was planted with only *E. citriodora*. The spacing adopted in two hectares was 3 x 3 m and 2.5x 2.5 m and in one hectare it was 2 m x 2 m. Soil was analyzed for nutrient status and it was found that it was devoid of any nutrient. The average growth in terms of height of *C. equisetifolia* was 15 m which generally is useful for different end uses. Growth in terms of average girth was 38.50 cm which yields good amount of timber. Herbage of *E. citriodora* was harvested at quarterly intervals and essential oil distilled. On an average, the oil yield was 2.866 kg per hectare. The oil quality was assessed by Chemistry of Forest Products Division, IWST, Bangalore. The studies revealed that the *E. citriodora* plantation along with traditional *C. equisetifolia* will be beneficial for coastal communities in poor quality soils as in Chippada VSS. Trials on NTFP species, i.e., *Aloe vera* (L.) Burm. f., *Gymnema sylvestre* (Retz.) R. Br. ex Schultes and *Asparagus racemosus* Willd. revealed that the soil and weather conditions were not congenial for the species and mortality was recorded. Perhaps, these species can not be adapted for plantation in coastal localities.

Project 10: Environmental impact of leachates from Copper-Chrome-Arsenic (CCA) wood preservative under marine condition [IWST/WBD-Marine/X-23/2003-08]

Findings: A total of 200 mango stakes of 40 x 5 x 2.5 cm size were prepared, trimmed, planed, air dried and treated with CCA preservative. Treated stakes were converted into 600 test panels and 400 reference pieces. Macro grain pattern of all 600 panels was analyzed based on the nature of grain. "End penetration test" performed on all panels and preservative distribution recorded. Additionally, 120 untreated mango panels were prepared to serve as controls. Wood boring samples from all panels were obtained for chemical analyses. All treated panels were end sealed with suitable paint(s) to arrest preservative leaching. All treated panels were sorted into four CCA retention groups. Panels in triplicate of the 4 groups and controls were prepared into 200 test ladders. All the 200 test ladders were exposed to marine conditions at Visakhapatnam harbour. Test panel sets were retrieved at cumulative intervals and analyzed for preservative contents. Copper and chromium contents were found to have reduced in all treated mango timber panels exposed for different periods of time. Leaching rate of the two metals gradually decreased with progressing durations of panel exposure. As regards the impact of CCA leachates on colonization of biofoulers, it was found that these animals got abundantly recruited on all treated panels. Impact of copper and chrome leachates was also negligible on the biota growing in the test vicinity. However, the leaching metals were found to have proved lethal to the settling wood borer larvae.

Project 11: Studies on recruitment and metamorphosis of marine woodborer larvae [IWST/WBD-Marine/X-22/2003-08]

Findings: Teredinid wood borers trapped in the field were brought to the laboratory and *Lyrodus pedicellatus* and *Teredo parksii* maintained for generations by infesting fresh test coupons to serve

as stock of larvae. Inocula of two species of algae, i.e. *Isochrysis* sp. and *Chaetoceros* sp. were procured and tested for their preference as food for the larvae. It was found that there was not much difference in recruitment and metamorphosis of larvae under the influence of the algal feed. Test coupons were immersed in the harbour for facilitating formation of primary film. Different bacteria were isolated from the primary film, maintained as pure cultures and identified through biochemical tests. Wafers of pine wood were coated with individual bacteria and tested against teredinid larvae for their recruitment response.

Project 12: Studies on seed source variation, determination of age of the trees and establishment of germplasm bank in Sandal [IWSST/TIP/X-47/2005-08]

Findings: Variability was found in 20 different seed sources collected from States of Karnataka, Tamil Nadu and Kerala with reference to seed and seedling traits. An *ex situ* seedling germplasm bank has been established at Gottipura, Hoskote, Bangalore. Study on core sample revealed that, it is difficult to predict age of sandal tree because of high variability in number of rings. It has also been found that sandal trees above 30 cms girth is nearly absent in natural populations of Karnataka and Tamil Nadu States.

Project 13: Carbonisation of selected fuelwood species [IWSST-34/WE-1/2004-June 2007]

Findings: The yield and other properties (Calorific value, proximate and elemental analysis) of charcoal prepared from *Casuarina equisetifolia*, *Eucalyptus* hybrid, *Acacia nilotica*, and *Acacia auriculaeformis* at different experimental conditions (carbonisation temperature, soaking time, heating rate etc.) were evaluated. The carbonization was carried out at 300, 400, 500, 600, and 800°C at 1 to 3 h soaking time and three different heating rates of 4°C/min, 8°C/min and 12°C/min. In all the species studied in this work, the char yield decreases significantly with the increase in the carbonization temperature. Fixed carbon content, ultimate carbon and ash content increases with the increase in carbonization temperature, whereas the volatile content and ultimate hydrogen was found to be decreasing with the temperature. There was a slight decrease in the yield and a marginal increase in the fixed carbon content with increase in the soaking time from 1 to 3 h. The yield of charcoal prepared at 12°C min⁻¹ was slightly less as compared to its value at 4°C min⁻¹. However, the change in heating rate of the wood has marginal effect on the yield and chemical composition of the chars. Calorific values of the wood chars found to increase with increase in the carbonization temperature. The yield of charcoal was different for the different wood species under similar carbonization temperature. Wood species have different anatomical properties. Porosity of wood also determines the yield and chemical composition of char. The presence of extractives also affects the final yield of charcoal.

A detailed study of variation of fuelwood properties (proximate and elemental analysis) of *C. equisetifolia*, *E. hybrid* and *A. auriculaeformis* with age and height of tree has been carried out. The fuel properties of *E. hybrid* and *A. auriculaeformis* are not significantly affected by the harvesting age. Therefore, it can be recommended that plantations should aim towards increasing the biomass yield by adopting proper silvicultural methods, when they are grown for bio-energy purposes. The results of this study also suggest that the fuel properties of *C. equisetifolia* are better in mature tree as compared to lower age trees.



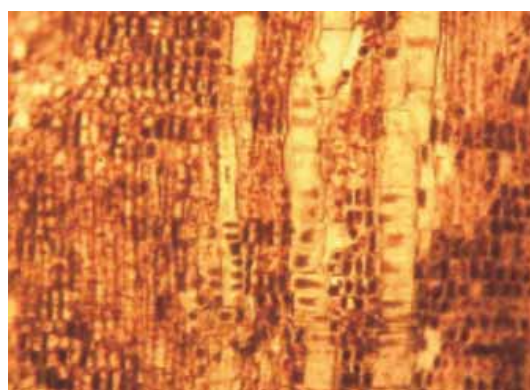
EXTERNALLY AIDED PROJECTS

Project 1: Studies on the properties of coffee wood as indicators of white stem borer resistance (Funded by Central Coffee Research Institute) [2005-08]

Findings: The project was basically consisted of training in-service officials of CCRI in histo-chemistry. As per the agreement, a number of clones (selections) were collected at regular intervals of different locations of coffee growing areas which were affected by stem borer alongwith healthy (immune) and inoculated ones. Histo-chemical tests like presence of starch, proteins and lipids were made on these samples for finding any relationships. Histo-chemical studies were also made on the presence of tannins. Studies have indicated that the presence of these food reserves in different stages of phenology have no direct relevance to borer attack. However, the presence of sclerotic cells in the bark of immune variety compared to the susceptible one is an indication of their resistance offered against the borer attack.



Sarchimor Immune Bark, Tannin, 2006



Sarchimor Susceptible Bark, Tannin, 2006

Project 2: Investigations on lesser known aspects of mangrove biodiversity and ecology in the States of Goa, Karnataka and Andhra Pradesh (Funding Agency: Ministry of Environment and Forests) [2004-08]

Findings: Survey and inventory of mangrove floral diversity in selected areas along Goa, Karnataka and Andhra Pradesh coast was carried out. Twenty two lesser known mangrove wetlands were reported for the first time from Andhra Pradesh. A total of 885 plant specimens were collected and all the specimens were made into herbarium and identified. Ecological data were also collected. *Brownlowia tersa* (L.) Kosterm. was collected and reported for the first time from Southern India. *Ruppia maritima* L. – a marshy plant was reported as new distributional record from Andhra Pradesh. Three rare mangrove species, namely, *Aegialites rotundifolia* Roxb., *Ceriops tagal* (Per.) C. B. Rob. and *Scyphiphora hydrophyllacea* Gaertn. were recorded from Andhra coast. Collected insects, foulers and borers from mangrove areas along Goa, Karnataka and Andhra Pradesh coasts and identified. Anatomical studies of selected mangrove trees were completed. Phytochemical studies on selected species, namely, *Rhizophora mucronata* Poir., *Xylocarpus granatum* Koenig, *X. mekongensis* Pierre and *Excoecaria agallocha* L. were carried out. Selected mangrove species were screened for wood energy values. A workshop on mangroves was conducted at IWST, Bangalore during February 2008.

Project 3: Community ecology of a detritus systems. Insects and fungi associated with fallen trees in the Nilgiri Biosphere Reserve (Funding Agency : MoEF, Govt. of India) [2004-07]

Findings: Different landscape elements were selected in Rajeev Gandhi National Park for assessing the role of fallen logs in biodiversity conservation. Various sampling methods, including black light traps were used to collect the insects from fallen logs. Specially designed traps for collection of emerging insects from fallen logs were fixed to each log. A weather recorder was installed for studying the effect of seasonal variation in insect and fungal biodiversity. About 300 species of xylophagous insects were recorded from fallen logs at Nagarhole national park. The insects are being identified. Twenty species of fungi and 42 species of mycophagous insects were recorded from fungi inhabiting fallen logs. Chemical characterization of different stages of fallen logs of 10 species is completed and was correlated with the community structure of insects and fungi. The role and interactions of insect and fungal communities in the fallen log system was assessed. Final technical report is prepared and submitted to MoEF.

Project 4: Studies on the Entomofaunal diversity and their interactions in selected provenances of sandal (Funding Agency: Ministry of Environment and Forests) [2004-May 2007]

Findings: The project was completed on 31st May 2007 and the completion report is submitted.

Project 5: Development of protocols for rapid and mass clonal propagation of *Bambusa pallida* Munro and *Phyllostachys bambusoides* Sieb. et Jucc. (Funding Agency: Department of Bio-technology) [2004-07]

Findings: Developed protocols for micropropagation of *Bambusa pallida* and *Phyllostachys bambusoides* from nodal shoot segments of mature clumps. High frequency (>95%) multiple shoot induction (4-6 shoots/explant) obtained in liquid MS medium with NAA 0.25 mg/l + BAP 2.5 mg/l in *B. pallida*. *P. bambusoides* MS liquid medium with NAA 0.25 mg/l; + TDZ (0.5-1.0 mg/l) proved most suitable for multiple shoot induction (3-4 shoots/explants). Shoot multiplication rate was high (3-4 fold) in *B. pallida* as compared to *P. bambusoides* (2.5 fold in 4 weeks period). Low nutrient medium (MS/2 and MS/4 basal salts) with NAA/IBA (1.0-2.0 mg/l) favoured rooting in both the species. Shoot clumps (2-3 shoots per clump) proved better than single shoot for rooting. In case of *P. bambusoides*, macro-propagation using nodal branch cutting was also standardized for high rate of rooting (>80%). Attempts were also made for *in vitro* propagation through somatic embryogenesis but results were not encouraging.

Project 6: Studies on assessing growth performance of *Guadua angustifolia* Kunth under different management schedules. (Funding Agency: National Mission for Bamboo Application) [2005-08]

Status: Established field trials for assessing growth performance of *Guadua angustifolia* Kunth at two spacing (5m x 5m and 5m x 9m) and fertilizer trials consisting seven treatments at two sites



viz; Yelwala near Mysore and Gottipura near Bangalore in 1.3 ha each. Intercropping has been done continuously with horse gram since 2005. Evaluated survival rate and growth performance of the exotic bamboo *Guadua angustifolia*. Survival rate varied from 60 – 90% initially, which decreased to 45-60% in 2007 mainly due to termite infestation. Initial results suggest that *Guadua angustifolia* may not be a suitable species for semi-arid areas.

Project 7: Bamboo location trials (Funding Agency: National Mission for Bamboo Application) [2005-08]

Status: Trials were established in respect of 8 bamboo species viz; *Bambusa bambos*, *B. balcooa*, *B. nutans*, *B. tulda*, *Dendrocalamus asper*, *D. hamiltonii*, *D. giganteus* and *D. stocksii* (in Bangalore) and *Guadua angustifolia* in place of *D. stocksii* in FRC, Hyderabad) during July-Sept. 2005 and maintained at Nallal, Bangalore and Dulapally, Hyderabad. Maximum survival (100%) was in *B. balcooa* and minimum (about 50%) in *D. asper*. Based on the growth performance, *D. hamiltonii* proved the most promising species whereas, *D. asper* and *G. angustifolia* were found unsuitable in semi-arid conditions of Bangalore and Hyderabad.

PROJECTS ONGOING DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Processing and evaluation of plantation grown *Simarouba glauca* DC from Orissa [IWS/WPU/X-59/2006-09]

Status: Completed studies on shrinkage behaviour of timber. Timber is found to be dimensionally stable (Radial: 3%, Tangential 5% and volumetric 9% whereas in teak it is 2, 4 and 6% respectively). Studied the bark properties keeping in view the importance of bark as medicinal value. The average bark thickness was found to be 0.8 cm and its percentage varied between 17-22. The average bark specific gravity was found to be 0.448. Studied pith to periphery variation of anatomical properties. Completed strength properties (compression, static bending, hardness, shear, tension, nail and screw holding power) as tested under green condition. The cellulose content of wood varied from 62-65%. The seeds contain 50-55% oil. Few prototype products like light furniture were made.



Light Furniture for sit outs

Project 2: Detection of natural and biological defects in timbers by non-destructive testing techniques [IWS/WPU/X-63/2006-10]

Status: Studied the effect of grain orientation on ultrasonic velocity of wood in *Grevillea robusta* and *Acacia mangium*. Studied the effect of defects (hollowness) on ultrasonic velocity of wood of *Grevillea robusta* and *Acacia mangium*. The main purpose of the findings is to find a relationship between hollowness and ultrasonic velocity.

Project 3: Study on utilization aspects of plantation grown *Acacia mangium* Willd. from Orissa [IWST/WPU/X-57/2006-10]

Status: Based on shrinkage studies, the timber is classified as steady timber and grouped along with *D. sissoo* and *Adina cordifolia*. The timber takes 47 days to reach 18% moisture content from initial moisture content of 80% after drying in dehumidifier drier. Studies on anatomical properties for 2 trees completed. Compression, Static bending, Hardness, Shear, Tension, Nail and Screw holding tests were completed in green condition. Installation of preservative samples at Nallal for durability study completed. Samples were prepared and subjected to product making.

Project 4: Studies on the durability of treated and untreated timbers of selected species [IWST/WSP/X-34/ 2004-09]

Status: One hundred ninety two poles of both *Eucalyptus tereticornis* and *Eucalyptus camaldulensis* (coppiced and non coppiced) were treated by non pressure and pressure methods. In non pressure method, they were treated by Sap displacement and Boucherie methods. It was observed that the ascent of preservative is quicker in the coppiced poles than in the non coppiced poles in the Boucherie method. In pressure method, the poles were dried to 20% moisture and treated by full cell by giving vacuum and pressure. Analysis of the poles for the preservative content at 3 different positions, bottom, middle and in top is in progress.

Test yard specimens of six timber species *Lophopetalum wightianum*, *Lagerstroemia lanceolata*, *Artocarpus heterophyllus*, *Spondias pinnata*, *Melia Azadirachta* and *Sterospermum personatum* were subjected to pressure treatment by adopting the Full Cell process using 3 different preservatives viz. Copper Chrome Arsenic (CCA) composition, Copper Chrome Boric (CCB) composition and Creosote and furnace oil 1:1 preservatives for 4 different levels of absorption. Twelve specimens for each set, a total of 936 specimens are undergoing durability tests along with controls in the Test Yard. The degree of destruction by termites and decay by fungi is being recorded at regular interval.

The observations showed that the natural durability of *Lagerstroemia lanceolata* is less than 12 months as all the control specimens were destroyed within 12 months whereas all the control specimens of *Lophopetalum wightianum* are all in sound condition even after 33 months of exposure. Further observation is in progress.



Ganesha Idol Chiseled from the wood

Project 5: Effect of particle size on properties of wood filled polypropylene composites [IWST/WSP/ X-53/2006-09]

Status: Polypropylene was compounded with natural fibres and injection moulded into standard specimens to study the effect of filler types (Bamboo and Wood), particle sizes (five different particle sizes each for bamboo and wood), filler concentration (five concentrations 10% - 50%) and concentration of coupling agent. Evaluation of Tensile, flexural, and elastic properties was completed. Evaluation of dynamic properties completed. A model to predict stiffness of the composites based on shear lag analysis was developed.



Project 6: Isolation and anti-fungal activities of the chemical compounds of *Baccaurea courtallensis* Muell. Arg. - a wild edible plant of Western Ghats [IWST/CFP/X-64/2006-09]

Status: Samples collected from Makut, Virajpet and Sampaje were processed and extracted with different solvents. Other products obtained in the extraction were analysed using UV, GC and IR. Developed field method for gender identification of the species.

Project 7: Investigations on chemical composition and utility of AESP oil from exhausted sandalwood powder [IWST/CFP/X-60/2006-09]

Status: Exhausted sandalwood powder in 2 sets was treated with different concentrations of acid and extraction was repeated thrice for confirmation of results. The products obtained in different treatments were steam distilled, processed to get AESP oil. Data from all the treatments are being analyzed. Spectral properties of AESP oil have been studied. The study will be repeated for confirmation of results.

Project 8: Analysis of active principles in *Gymnema sylvestre* and *Phyllanthus amarus* from the forest of southern India [IWST/CFP/X-46/2005-June 08]

Status: Collection of plant samples from Different MPCA is over. Plant samples of Goa, Karnataka and Tamil Nadu were analyzed. Analysis of samples in remaining area is in progress.

Project 9: Screening and evaluation of wild varieties of *Emblica officinalis* fruit in various agro-climatic zones of Western Ghats [IWST/CFP/X-48/2005-June 08]

Status: Samples were collected from different areas in Western Ghats. Samples were processed and extracted to get Vitamin C content. The results are being analyzed.

Project 10: Laboratory testing for the assessment of the durability of timbers against powder post beetles – standardization and evaluation [IWST/WBD/ X-55/2006–10]

Status: Test procedures using adult release and larval inoculation in different sizes of test wood is standardized. CNSL formulation and ACA treated specimen were tested by larva and adult release method. Longevity studies of adults released on treated 4 age groups of 5 plantation species completed. Copper boric formulation was treated on rubber and was tested against adults and larvae of *L. africanus*. The contact toxicity and residual toxicity of bifenthrin was tested by larva release method.

Project 11: Studies on age related durability of plantation grown timbers [IWST/WBD/ X-50/2005–09]

Status: *Acacia auriculiformis*, *A. mangium*, *Eucalyptus tereticornis*, *Grevillea robusta*, *Melia dubia*, of 4 age group of timbers (viz. 5, 10, 15 & 20 years) grown in low rainfall area were tested for their natural durability against decay fungi. It was found that resistance of timber increases with the age. *A. auriculiformis*, *A. mangium* and *Eucalyptus tereticornis* comes under durable class. However, even 5 years age class wood of these 3 species also comes under durability class -2.

Grevillea robusta and *Melia dubia* wood comes under highly perishable group. Further work with different treatment and resistance study against termites are being done.

Project 12: Productivity and interaction studies in *Acacia* hybrid based agroforestry practices in Karnataka [IWST/TIP/X-40/2004-09]

Status: Established *A.* hybrid trials (block plantation) and line planting field trials in Doddaballapur and Kolar (on-farm trials). Intercropping carried out for 3 successive years. Biometric observations recorded and tabulated.

Project 13: Comprehensive tree improvement program for *Gmelina arborea* in Karnataka – Phase I- Progeny trial [IWST/TIP/X-41/2004-09]

Status: Seed and seedlings have been collected from 16 sources in Karnataka and 11 from AP for the establishment of progeny trial. Established progeny trials of 27 families seedling of Karnataka and AP origin. Preliminary results on growth indicate that SGA 16 and AP 8 are two best performing families in the trial. SGA 5, SGA 6 and AP 3 are poor performing families as per survival and growth data.

Project 14: Assessment of seed quality in unimproved populations, seed production areas and seed orchards of *Tectona grandis* [IWST/TIP/X-48/2005-09]

Status: Seeds were collected from unimproved populations and SPA at Virnoli, Barchi, Baghwathi and Titimathi, from CSO at Titimathi and SSO at Tirupathi. Fruit, seed and seedling variability studies showed that overall Titimathi seed sources was better as compared to other seed sources. Morphological parameters, germination and seedling growth studies revealed improvement in quality of SPA seeds as compared to unimproved populations.

Project 15: Database Development of IWST Xylarium [IWST/IT/X-58/2006-09]

Status: Web page model of wood specimens collection was prepared for IFGTB Coimbatore GASS forest museum. Classification of GASS forest museum wood specimens is in progress. Visited IPIRTI Bangalore and primary information has been collected. The feasibility study of IPIRTI wood specimen collection has been completed. Based on the data, model of web database preparation is in progress and infrastructure requirements have been defined. One thousand eight hundred wood specimens arrangement of IWST Xylarium was completed. Arrangement of writing identification number on remaining wood specimens of IWST xylarium is in progress.

EXTERNALLY AIDED PROJECTS

Project 1: Establishment of Advanced Wood Working Training Centre at IWST (Funding Agency : Italian Trade Commission/ACIMALL) [2003-08]

Status: Advanced Woodworking Training Centre, an Indo-Italian joint project by IWST-ICE-ACIMALL entered into the sixth years of operation. The Memorandum of Understanding (MoU) was renewed between the Institute of Wood Science and Technology, Bangalore and Italian Trade Commission, Mumbai to continue the training centre for another five years starting from



21st August 2007. The centre is equipped with 21 advanced wood working machines. During the year 2007-08, the centre has imparted training to 466 trainees. About 95% of the unemployed trainees have been benefited for employment with this training. So far 75 Indian wood working industries have offered employment to the trainees. The AWTC also participated in the Biannual International Wood Exhibition "INDIA WOOD 2008" at Bangalore International Exhibition Centre, Bangalore.

Project 2: Investigation on Tree ring analysis of certain species in Western Ghats to monitor climate changes and its relevance to wood quality (Funding Agency: Ministry of Environment and Forests) [2006-09]

Status: Two JRFs have been recruited for the project work and basic training was provided to them at IWST, Bangalore and IITM, Pune. Assets like Stereo Zoom Microscope with Tree Ring Analysis System and Increment borer were purchased. Teak discs from Madikeri, Mundugod from Karnataka, Thane and Chandrapur from Maharashtra were collected. Meteorological data of these sites were also collected. Age of teak discs from Madikeri alongwith their growth rates and specific gravity was determined.

Project 3: Studies on acoustical behaviour of plantation timbers for musical instruments and wall paneling (Funding Agency: Council for Scientific and Industrial Research) [2006-09]

Status: Anatomical properties like fibre and vessel dimensions were determined. Evaluated strength properties like modulus of elasticity, modulus of rupture, and hardness. Determined sound absorption coefficient and effect of different wood parameters. Generated data on commercially available musical instruments like veena, violin and dholak. Visited Tanjore and Kumbakonam for exploring the possibility of making musical instruments from plantation species like *Acacia auriculaeformis*, *Artocarpus heterophyllus*, *Azadirachta indica*, *Eucalyptus tereticornis*, *Grevillea robusta* and *Melia composita* to find their suitability in place of Indian timbers based on acoustical properties.



Acoustic measurement unit to detect the sound waves of musical instruments

Project 4: Insect-plant relationships with special reference to herbivory in the mangroves of South India (Funding Agency: Ministry of Environment and Forests) [2005-08]

Status: The West Coast (Mangalore, Honnawar, Kundapur and Karwar) mangroves were surveyed monthly and insects were collected from solar light traps and also using other methods. Four

hundred species of insects including defoliators, fruit and propagule borers (115) were recorded and their parasites were collected and identified. Assessment was made using Leaf area metre software herbivory in 5 species of mangroves with reference to different areas and seasons. Impact of Frugivores on germination of 3 species was studied. Pollination studies on *Rhizophora* and *Sonneratia* at Kundapura and Karwar were initiated. Germination trials on pest infected propagules of *Rhizophora mucronata* at Kundapura were conducted.

Project 5: Investigations on the mechanisms of success of *Mytilopsis sallei* (Recluz) in managing toxic load arising out of biodeterioration control measures (Funding Agency: Department of Science and Technology) [2005-08]

Status: Test panels immersed at Visakhapatnam Port and Kakinada Canal for trapping of *Mytilopsis sallei* were retrieved at monthly intervals. Bacteria were isolated from the gut of *M. sallei* growing in 4 pollution zones at Visakhapatnam Port. Experiments on accumulation of leachates of CCA by *M. sallei* were conducted. Experiments on depuration of copper by *M. sallei* were conducted. Content of copper and total hydrocarbons in water samples and tissues of *M. sallei* were analyzed.

Project 6: Monitoring of biofouling at Visakhapatnam Port (Funding Agency: Ministry of Shipping, Road Transport and Highways through National Institute of Oceanography, Goa) [2006-09]

Status: Test panels were exposed at three test sites, i.e., Slipway Complex, Ore Berth and Marine Foreman Jetty in Visakhapatnam Port and retrieved at monthly/cumulative intervals. Observations on the composition, growth, surface spread and biomass of fouling organisms and incidence of wood borers were recorded. Voucher specimens of different forms were prepared and maintained.

Project 7: Testing the efficacy of TBTM-MMA preservative developed by NMRL in Visakhapatnam and Kochi ports (Funding Agency: Naval Materials Research Laboratory, DRDO, Ambernath, Mumbai) [2008-11]

Status: The project was initiated in March 2008. A meeting between Scientists of IWST and NMRL was held at NMRL, Ambernath, Mumbai during March 2008 and methodologies for exposure of panels, observation schedules, data to be collected, etc. finalized.

Project 8: Field performance of micro and macro propagated planting stock of selected five commercially important bamboo species (Collaborative project with KFRI & IFGTB) (Funding Agency: Department of Biotechnology) [2004-09]

Status: Field trials viz; mode of regeneration (seed, macro and micro-propagated plants) spacing (5m x 5m, 5m x 7m and 5m x 9m) and fertilizer (*Bambusa bambos* and *Dendrocalamus strictus*) established in 15 ha area during 2005 in Bangalore and Mysore were maintained. Six monthly data on survival and growth performance revealed that maximum survival (>90%) was in *D. asper*. *D. strictus* performed the best in terms of culm height in Bangalore, Mysore and Hyderabad, followed by *B. bambos* and *B. balcooa*. Though number of tillers were more in *D. asper*, but growth was stunted. It is revealed that micro-propagated plants performed better in most of the species as compared to seed and macro-propagated plants. *D. asper* growth was poor in micro and as well as macro-propagated plants and not suitable in semi-arid regions.



Project 9: Development of bamboo fibre reinforced thermoplastic composites (Funding Agency: National Mission for Bamboo Application) [2006-09]

Status: The research work on development of bamboo fibre filled thermoplastic composites completed under the project. Mechanical properties of the composites improved significantly when an isocyanate based coupling agent was used. The isocyanate based coupling agent proved much superior to the conventionally used coupling agent (MAPP). With the increasing filler content (from 10% to 50%), Tensile strength increased from 35 MPa to 45 MPa whereas no improvement was observed in composites prepared with MAPP as a coupling agent. Similar trends were observed for flexural strength and modulus of elasticity. The work on industrial trials was also completed. The study suggests that the product can conveniently be processed on standard industrial plastic processing machineries like extrude and injection moulding. The technology transfer to the industrial partner of the project is under progress.

Project 10: Investigations on the fungi and insects associated with fruits and seeds of selected endemic trees of Western Ghats (Funding Agency: Ministry of Environment and Forests) [2006-09]

Status: Forest areas in Gundya, Kudremukh, Makutta, Sirsi and B.R. hills were visited for the purpose of location of endemic species and collection of fruits and seeds. Insects were collected from the fruits and seeds and their biology is being studied. Fifty fungi isolated from the different fruit/seed samples were identified. Among these, 30 were potential plant pathogens, reported for their pathological effects in several other hosts. Among the isolates obtained, there are plant pathogens and also comes under field fungi category like *Paecilomyces variotii*, *Lasioidiplodia theobromae*, *Sporothrix schenckii*, *Fusarium oxysporum*, *F. solani*, *Cladosporium oxysporum*, *Alternaria* sp., *Rhizoctina* sp., *cylindrocladium*, *Acremonium strictum*, *A. kiliens*, *Phomopsis archeri* and *Colletotricum gleosporioides*. Isolates included storage fungi also. These fungi play a major role in causing the seed health problems like seed rotting, shrinkage, discolouration, and abortive and poor germination.

Project 11: Monitoring of biofouling at Visakhapatnam Port (Funding Agency: Ministry of Shipping, Road Transport and Highways, Government of India through the National Institute of Oceanography, Goa) [2006-09]

Status: Test panels were exposed at three test sites, i.e., Slipway Complex, Ore Berth and Marine Foreman Jetty in Visakhapatnam Port and retrieved at monthly/cumulative intervals. Observations on the composition, growth, surface spread and biomass of fouling organisms and incidence of wood borers were recorded. Voucher specimens of different forms were prepared and maintained.

Project 12: Need for conserving forest canopies: assessing the diversity of canopy insects in the Western Ghats (Funding Agency: Ministry of Environment and Forests (MoEF) [October 2006 to September 09]

Status: Canopies of *Vateria indica* suitable for sampling were identified, three types of passive insect collection traps – canopy pitfall traps, canopy light traps and canopy yellow pan traps were designed, fabricated and tested. Sampling using the traps has been commenced and collections processed.

Project 13: Development, Augmentation of efficacy and improvement of dissemination systems of *Metarhizium* based mycoinsecticide for the management of major pests in forest plantations and nurseries (Funding Agency : Department of Biotechnology) [2007–10]

Status: Seasonal surveys were conducted in the four South Indian States for studying the incidence of major pests on important forest tree species in nurseries and plantations in selected areas. *Metarhizium* infected pest insects from different locations in South India were collected. Nineteen isolates of *Metarhizium anisopliae* were collected and maintained. Studies on the pathogenicity are in progress. The defoliators of Teak, Pongamia and other trees and arboreal termites were found susceptible to some of the *Metarhizium* isolates.

Project 14: Investigations on Microsporidia affecting major Lepidopteran pests of important forest trees of South India and their prospects as bio-control agents (Funding Agency: Department of Science and Technology) [2007-10]

Status: Sixty five species of Lepidopterans including 14 pest species were screened for microsporidia and 22 species were found infected. For the first time, a Microsporidian pathogen is isolated from the teak defoliator, *Hyblaea puera*. Three species of pest insects were cultured in laboratory conditions for detailed studies. Pathogenicity and cross infectivity studies with *Paliga machoeralis* was undertaken.

Project 15: Bioecology, damage potential and management of Gall formers of *Pongamia pinnata* (L.) Pierre. (Funding Agency: Department of Science and Technology) [2006–09]

Status: The leaf gall inducer of *P. pinnata* has been confirmed as *Aceria pongamiae* and the ovary gall inducer has been confirmed as *Asphondylia pongamiae*. Many trees were observed with 100% infestation of ovary galls. So far 5 parasitoids were collected and identified on ovary gall inducers. The observation on population dynamics and biology of leaf and ovary gall inducers are in progress.

Project 16: Multilocal introduction-cum-demonstration trials and field evaluation of six important bamboo species viz., *Bambusa balcooa*, *B. nutans*, *Dendrocalamus asper*, *D. hamiltonii*, *Guadua angustifolia* and *Pseudoxytenanthera stocksii* in Andhra Pradesh, Karnataka and Goa (Funding Agency : Department of Biotechnology) [2006-09]

Status: During the year 2007-08, trials were established at two sites in Andhra Pradesh (Chintalapudi, 10 ha and Buggapadu 10 ha) and one site at Goa (Agalote, 5 ha). The trials comprised of species introduction-cum-mode of regeneration, spacing trial and nutrition management trials. Initial survival data shows that at all three sites, *B. balcooa* and *B. nutans* had survival ranging between 68-89%. Among various species, best growth in terms of height growth was found in *B. nutans* (TC) at Chintalapudi site (107.36 cm), followed by *B. nutans* (VP) with average height (85.85 cm). It is interesting to note that, although, overall survival rate was good at Agalote (Goa), subsequently growth of various species was poorest as compared to other sites.

Project 17: Conservation of Sandal (*Santalum album* L.) germplasm, production of quality planting stock and promotion of sandal cultivational practices. (Funding Agency : National Medicinal Plant Board) [2006-09]

Status: Sixty five thousand quality sandal seedlings were produced for distribution among various stakeholders like farmers, NGOs and SFD for field planting. A stakeholders training programme



was organized at Mehsana, Gujarat on sandal nursery technology and cultivation on 15th and 16th March 2007. Two on farm trials on sandal based agroforestry with grafted Amla, tamarind and mango as host plants were established in 3 ha each in Bevanahalli and Mudelahalli as demonstration plots.

Project 18: Cultivation of *Guadua angustifolia* Kunth and *Dendrocalamus asper* in Kerala and Karnataka (Funding Agency: National Mission for Bamboo Application) [2006-09]

Status: Established trial plots of 0.5 ha each of *Guadua angustifolia* Kunth and *Dendrocalamus asper* Backer in high rainfall tropical humid zones in Alwaye and Palakkad in Kerala and Thittimathi in Karnataka. Initial observations indicate that *Guadua* is best suited for silt loam soils near riverine areas like Alwaye. Growth of both the species has been impressive in the sites in Kerala and Karnataka with > 90% survival.

Project 19: Commercial cultivation of bamboo in Kodagu District: Raising of Quality Planting Material (QPM), Establishment of demonstration plots and bamboo based value addition facilities. (Funding Agency: National Mission for Bamboo Application) [2006-08]

Status: This is a multi institutional collaborative project involving College of Forestry (CoF) Ponnampet, (University of Agricultural Sciences, Bangalore), Kodagu Model Forest Trust (NGO) and IWST which is being coordinated by IWST. Entrepreneur's meet organized in Coorg involving farmers and various stakeholders to facilitate exposure to various value addition projects for bamboo. A vegetative propagation centre with capacity to produce 50,000 rooted cuttings of bamboo established in CoF, Ponnampet. 25 ha of *D. asper* (edible bamboo) plantations involving 77 farmers established in Coorg. Planting material supplied by IWST.

Project 20: Vegetative Propagation Centre (VPC) for the production of quality plants of *P. stocksii*, *D. brandisii* and *Guadua angustifolia* (Funding Agency: National Mission for Bamboo Application) [2006-09]

Status: Agroshaded net house with micro-sprinkler system has been established in an area of 17mt × 17mt. Twenty sand beds were made. Total 6500 plants of *Dendrocalamus stocksii*, *Guadua angustifolia* and *Dendrocalamus brandisii* have been raised. Two thousand plants of *G. angustifolia* and *D. stocksii* and 200 plants of *D. brandisii* have been supplied for planting in projects funded by NMBA and DBT.

NEW PROJECTS INITIATED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Evaluation of wood quality of *Eucalyptus* clones and plantation grown *Grevillea robusta* A. Cunn. based on spiral grain [IWST/WPU/XI-73/2007-09]

Status: Sixty poles of *Eucalyptus* clones have been procured from two different locations (Mandya and Kolar) and also 5 trees of *Grevillea robusta*. Specific gravity and shrinkage measurements were completed for 180 samples and data entry made.

Project 2: Development of methods for detection of adulterants and evaluation of quality parameters for assessing purity of Jigat [IWS/CFP/XI-71/2007-08]

Status: Project period was for one year only and completed during March 2008.

Project 3: Development of methods for detection of adulterants and determining purity of sandal oil [IWS/CFP/XI-72/2007-08]

Status: Project period was for one year only and completed during March 2008.

Project 4: Studies on influence of microwave treatment on drying characteristics and treatability of wood [IWS/WSP/XI-69/2007-09]

Status: Preliminary studies on drying rate of *Acacia auriculaeformis* and teak wood in a 800W domestic microwave was completed. The moisture loss rate was found to depend on the cross-section of the wooden sample. A MW drier system of 2.4 kw power intensity was designed and got fabricated. The system has provision of two magnetrons each of 1.2 kw power and the total power intensity can be varied from 180 watt to 2.4 kw. The system has a conveyor belt for feeding wood to microwaves, which moves bidirectional. Both conveyor belt speed and microwave time can be varied according to requirement. Standardization trial of MW drier system controls has been completed. Treatment of Silver Oak planks of varying thickness and at different MW time completed. Comparison of drying behaviour of microwave treated and untreated wood is in progress.

Project 5: Isolation and estimation of L-DOPA from *Mucuna prurines* Linn collected from South India [IWS/CFP/XI-66/2007-10]

Status: Identified plots in different parts of Karnataka for collection of seeds. Seeds were collected from different MPCA areas. Procedure for extraction of L-DOPA has been standardized. HPLC data for pure L-DOPA has been collected.

Project 6: Studies on the natural resistance of imported woods against insects and decay fungi in Indian environment [IWS/WBD/XI-74]

Status: Twenty different types of imported timber procured and they were seasoned and converted to required size with proper label. Field experiments were laid at Trivandrum, Bangalore, Visakhapatnam, Hyderabad, Jodhpur and Jabalpur. Third month observation on the natural durability of timbers were taken in Trivandrum, Bangalore, Visakhapatnam, Hyderabad and Jodhpur. Experiment to study the natural durability in the marine condition is initiated.

Project 7: Seed infestation by insects among the emergent rain forest canopies at Makutta, Western Ghats [IWS/WBD/XI-68/2007-10]

Status: A sample plot of 1 ha has been laid out and the species-abundance data on the emergent canopies has been drawn. Interception traps have been designed and 30 Nos. fabricated. Interception traps were set up in the one-hectare sample plot. Collections were made from 13 traps. Insect emergences and extent of seed predation have been recorded. Field and lab germination studies for *Dipterocarpus indicus* have been carried out.

**Project 8: Ethnobotanical studies of North-Eastern Ghats in Andhra Pradesh [IWST/WBD(M)/X-170/2007-11]**

Status: Literature related to ethnobotany of the region was collected. Four field tours to Patapatnam and Seethampeta tribal areas in Srikakulam district and Bhadragiri and Saluru areas in Vizianagaram district were conducted. Ethnobotanical data on wild genetic resources, edible, medicinal, material and social cultural aspects on 82 plant species from the tribes of Savaras, Khonds, Jatapus, Kondadoras, Nukadoras and Porjas were recorded. Seventy one species were collected, identified and preserved as herbarium. Ethnobotanical data from available literature was scrutinized and screened. A rare, endangered and threatened gymnosperm, namely, *Cycas spherica* Roxb. was collected for the first time from eastern ghats in Srikakulam District of Andhra Pradesh. The tender leaves and cotyledons of this species are vividly used as food by Jatapu and Savara tribes.

Project 9: Studies on genetic fidelity of the micropropagated plants of bamboo-*Bambusa bambos* and *Dendrocalamus stocksii* [IWST/TIP/XI-65/2007-10]

Status: Shoot multiplication cultures of *B. bambos* and *D. stocksii* from the plant material (explant) of the mature clump were established. Production of plants of both the species through axillary shoot proliferation was initiated. Callus cultures of both the species for raising plants through somatic embryogenesis were established.

Project 10: Genetic improvement of *Melia azadirach* and *Melia dubea* through plus tree selection assessment of genetic variation trial establishment (Phase I) [IWST/TIP/XI-67/2007-11]

Status: Survey work was conducted in Karnataka, Tamil Nadu and Andhra Pradesh and plus trees of *Melia azadirach* and *M. dubea* were collected. Seeds were collected from the plus trees of both the species and carried out variability studies based on morphological parameters. Seeds collected from plus trees of *M. azadirach* used for the raising seedlings with family identity for the establishment of progeny trial. In case of *M. dubea* seeds did not germinate.

Project 11: Fuel properties of important forest weeds [IWST/WE XI-75/2007-09]

Status: Samples of *Lantana camara* and *Eupatorium* spp. were procured. Basic density and calorific value of selected weeds was determined. Proximate analyses ash content, volatile content, moisture content and fixed carbon content of 24 samples were carried out.

EXTERNALLY AIDED PROJECTS

Project 1: Study of anatomy and properties of lesser known timbers of North -Eastern State of India with particular reference to Nagaland (Funded by Nagaland State Forest Department) [2007-08]

Status: Forty timber species have been selected for the study. Macroscopic and microscopic studies were completed for 20 species. Draft (Part-I) of 20 species was prepared for publication. Macroscopic study of additional 10 species under hand lens was completed.

Project 2: Utilization of alternative timber species for catamarans to conserve traditional tree species of Eastern Ghats (Funding Agency: Ministry of Environment and Forests) [2007-09]

Status: Activities undertaken so far under the project are (1) Recruitment of 1 no. Technical Assistant, (2) Procurement of timber of *Mesopsis emini*, *Albizia lebbek* and *Tetrameles nudiflora* for durability test (3) Procurement of *Bombax ceiba*, *Albizia lebbek* and *Tetrameles nudiflora* timber for 15 catamarans and (4) Fabrication of *Bombax ceiba*, *Albizia lebbek* and *Tetrameles nudiflora* for 15 catamarans (5 catamarans of each species).

Project 3: Development of Package of Practices for the management of powder post beetles in ITC timber yards (Funding Agency: Karnataka Forest Department) [2007-08]

Status: The project was started on 1st June 2007 as per letter of intent. Monthly visits were conducted to ITC timber depots at Bhadrachalam and Ongole. The incidence of pests was assessed. The beetles were identified and being cultured in the laboratory. Field experiments were conducted with selected chemicals and botanicals at ITC timber depots at Bhadrachalam.

Project 4: IWID: Indian Wood Insect Database – a Database on diversity of indigenous and exotic wood insects/pests in India. 18 months (Funding Agency: Department of Scientific and Industrial Research) [2007-08]

Status: The project was started on 1st July 2007. Software for database was developed with the help of professionals. Collection of information from various sources and data entry are under progress.

Project 5: Evaluation of phosphine as fumigant to control insect pests in logs, chips and sawn boards (Funding Agency: United Phosphorus Ltd.) [2007-08]

Status: The project started on 13th October 2007. Three species of beetles were cultured in the laboratory for testing against the fumigant, phosphine. One field trial of fumigation of infested subabul with phosphine was conducted at timber depots in A.P.

Project 6: An integrated approach of bamboo improvement propagation, agroforestry models, protection, processing and utilization (Funding Agency: National Bamboo Mission) [2007-10]

Status: Carried out studies on the effect of auxins (IAA, IBA, NAA and NOA) on rooting from rhizomatous cuttings of *Dendrocalamus asper* and *D. brandisii* cuttings treated with IBA proved the best followed by NAA in both the species. Established agroforestry trial of *B. balcooa*, *D. asper*, *D. brandisii*, *D. stocksii* and *Guadua angustifolia* in Devon coffee estate near Shimoga using piper and vanilla as intercropping. Conducted survey in nurseries and plantation of bamboo. Preliminary studies carried out on drying of bamboo using microwave technique. Conducted demonstration programme for the official of the State Forest Department Karnataka for bamboo (*D. stocksii*) propagation and preservative treatment to enhance life of bamboo.



TECHNOLOGY ASSESSED AND TRANSFERRED

The technology of manufacturing bamboo fibre filled thermoplastic composite is in process of transfer to the industrial partner under NMBA supported project “Development of bamboo fibre filled thermoplastic composites”.

EDUCATION AND TRAINING

Education

1. Two hundred forty students from different Universities visited the Institute from April 2007 to March 2008.
2. Thirty eight RFOs from SFS College, Coimbatore visited on 2nd April 2007. Lectures on Forestry and Wood Science were arranged.
3. A total of 38 IFS Probationers (2007-08 batch) visited the Institute on 3rd October 2007.
4. Thirty one trainees from SFS College, Dehradun visited the Institute on 8th January 2008.

Trainings

Conducted

1. Compulsory training course on Computer Application and Statistics for FRI University Research Scholars (Internal) was conducted during July-August 2007.
2. Short term training on “Wood Protection (Seasoning, Preservation and Biodegradation)” from 20th to 24th August 2007 for trainees from Govt./ Pvt. Sectors. Scientists from institute and outside gave lectures and conducted practicals to the trainees.
3. Training course on “Timber Joinery” to the in-service officials of Naval Dockyard, Visakhapatnam and from M/s Poonam Timbers, Bangalore from 26th to 30th November 2007.
4. Training course on “Classification and grading of timbers” to the in-service officials of Naval Dockyard, Visakhapatnam and O/o the PCCF, Andaman and Nicobar Islands from 3rd to 5th December 2007.
5. Demonstrated Treatment Technology of Bamboo at College of Forestry –Ponnampet-10th December 2007.
6. One week hands on training in plant tissue culture for BSc 3rd year biotechnology students (10 nos.) of Surana College, Bangalore University, Bangalore, from December 17th to 21st 2007.
7. One week hands on training in plant tissue culture for MSc Bio-technology students (8 Nos.) of Ramaiah College, Adarsha College, CMR College, Bangalore University, Bangalore from 24th to 28th December 2007.
8. Compulsory Training Course for IFS officers on “Biotechnology for Forest Conservation” was conducted from 7th to 11th January 2008.

9. Conducted Training course on “Field identification of important timbers” to the in-service officials of Naval Dockyard, Visakhapatnam and scientist from IPIRTI from 21st to 25th January 2008.
10. Short term training course on “Extraction/Purification techniques and Instrumental Analysis” was conducted from 23rd to 25th January 2008 (by CFP Division).
11. Short term training course on “Nursery Techniques” was conducted from 11th to 15th February 2008.
12. Specialized training on Histo-chemistry was given to the in-service officials of Central Coffee Research Institute, Coffee Research Station, Chikkamagalur, Karnataka as a component of the sponsored project entitled “Studies on the properties of coffee wood as indicators of white stem borer resistance”.
13. Demonstrated Treatment Technology of Bamboo-Bamboo workshop organized by Karnataka State Forest Department on 15th and 16th March 2008.
14. Demonstrated Treatment Techniques and Ammonia fumigation technology – Inaugural function of the Vana Vigyan Kendra at Kadugodi on 18th March 2008.

Exhibition

1. The Institute participated in the Krishi Mela at Suttur, Mysore from 4th to 8th February 2008.
2. The Institute participated in the India-Wood from 29th February to 4th March 2008.

LINKAGES AND COLLABORATION

National

1. Collaboration with CCRI, Chikkamagalur, University of Agricultural Sciences, Bangalore, Orissa State Forest Department, Grasim Fibres continued.
2. Collaborative Research work on “Aging of Wood and its Prevention” with Department of Forest Product Technology, Helsinki University of Technology, Finland.
3. Linkages developed with Karnataka Forest Department for laying out regeneration plots of *Dysoxylum malabaricum* at Soraba, Makut and Virajpet.
4. Andhra Pradesh Forest Department; Fisheries Department; Andhra University, Visakhapatnam; Central Marine Fisheries Research Institute, Visakhapatnam; Central Institute of Fisheries Technology, Visakhapatnam; National Institute of Oceanography, Visakhapatnam and Goa; Naval Materials Research Laboratory, Ambernath, Mumbai; State Institute of Fisheries Technology, Kakinada; Visakhapatnam Port Trust and Indian Navy, Visakhapatnam.
5. Scientists of W. B. Centre (Marine), Visakhapatnam developed collaborative research projects with National Institute of Oceanography (CSIR), Goa and Naval Materials Research Laboratory (DRDO), Ambernath, Mumbai.
6. Linkages with State Forest Department, Karnataka, Andhra Pradesh Forest Department, Goa Forest Department, Bangalore University, Bangalore, University of Agricultural Sciences, Bangalore, University of Agricultural Sciences, Dharwad and Indian Institute of Sciences, Bangalore.



7. One operational DBT project in collaboration with KFRI, Peechi and IFGTB, Coimbatore on “Field performance of micro and macro-propagated planting stock of selected five commercially important bamboo species”.
8. Institute has collaborated with State Forest Departments of Karnataka, Andhra Pradesh and Goa for establishment of Van Vigyan Kendra(VVK). It is proposed to transfer the recent technologies of ICFRE to end users through these VVKs.

- **VVK, Karnataka**

Van Vigyan Kendra, Karnataka was inaugurated on 18th March 2008 at Forest Technical and Administrative Training Institute (FTATI), Kadugodi, Bangalore by Shri A.K. Verma, PCCF, Karnataka Forest Department. Shri B.K. Singh, Additional PCCF (EWPR&T), Shri V. Rangaswamy, CCF (Training), Karnataka, Dr. U.V. Singh, Conservator of Forests, Bangalore Circle, Shri Suresh Gairola, Director and other senior scientists of IWST were present.

“Abstracts of the published research papers (1988-2007)” in English and Pamphlets in regional language (Kannada) on “Sandal” and “Simple techniques of treating poles, fence posts, tree guards and bamboo by wood preservatives were released by PCCF, Additional PCCF (EWPR&T) and CCF (Training), Karnataka.

An interactive meeting-cum-demonstration program on following technologies was organized on the occasion.

- a. Ammonia fumigation for imparting colour to different wood species
- b. Planting technique of sandal, casuarinas, eucalyptus and bamboo
- c. Sap displacement method to treat freshly felled bamboo and poles
- d. Use of alternative timber for different end users like handicrafts, furniture etc.

An MoU between Director, IWST and Additional Chief Conservator of Forests (EWPR&T) on behalf of Karnataka Forest Department has been signed during March 2008. Deputy Conservator of Forests (training), Kadugodi and Incharge (Extension), IWST have been nominated as Nodal Officers for this centre.

- **VVK, Andhra Pradesh**

Van Vigyan Kendra is being established at Dulapally in Hyderabad. A MoU between Director, IWST and PCCF on behalf of Government of Andhra Pradesh has been signed during March 2008. Chief Conservator of Forests (Research), Hyderabad and Incharge (Extension), IWST have been nominated as nodal officers for this centre.

- **VVK, Goa**

Van Vigyan Kendra is being established at Satpal, about 50 kms from Goa. An MoU between Director, IWST and CCF, Goa is being signed. Deputy Conservator of Forests (Research & Utilization), Margoa, Goa and Incharge (Extension), IWST have been nominated as nodal officers for this centre.

• Model Village

Institute of Wood Science and Technology, Bangalore has adopted Byranahalli village which is under the administrative control of T. Begur gram panchayat in Nelamangala Taluk of Bangalore Rural District. The village is about 45 kms. From the institute on National Highway No.4. There are around 486 households in the panchayat with a population of around 2268 with around 1159 males and 1109 females. The village Byranahalli along with a small hamlet called Kambaiahnapalya is having around 175 households with a population of about 1200 with around 601 males and 579 females approximately.

The model village was inaugurated on 28th Jan 2008 and MoU has been signed by Director, IWST and Village Panchayat Chief. An interactive meeting was organized with the villagers to make them aware about the purpose of establishing the model village. A demonstration program on forestry and wood science technologies was also organized.

PUBLICATIONS

Book

M.V. Rao, M. Balaji, V. Kuppusamy, K. Satyanarayana Rao and L. N. Santhakumaran, 2007. *Biodeterioration of timber and its prevention in Indian coastal waters: Third progress report 1982-2005*. Institute of Wood Science and Technology, Bangalore: 198 pp.

Brochure (English and Kannada)

1. Sandal Brochure

Pamphlets (English and Kannada)

1. Sandal
2. Nursery Practices
3. Portable Distillation Unit
4. Sap Displacement Technique (Simple techniques of treating poles, fence posts, tree guards and bamboo by wood preservatives)
5. Wood Seasoning
6. Wood Plasticization and Bent Wood Products from Coconut Wood
7. Value Addition of timber – Plantation grown and lesser known species

Technical Bulletin

1. Sap Displacement Techniques for treating small girth timber and bamboo -(English/ Kannada) compiled by D. Venmalar and Pankaj K. Aggarwal
2. Ammonia Plasticisation of coconut wood for value addition – compiled by S.K. Sharma, R. Vijendra Rao and S.R. Shukla.



3. Information Series I entitled "A guide to some Imported Timbers in South Indian markets"
4. Information booklet of IWST - English
5. Abstracts of the published research papers (1988-2007) - English
6. Short term training calendar for 2008-09
7. Proceedings: "Conservation, Improvement, Cultivation and Management of Sandal"

CONSULTANCIES

1. Analytical service was rendered to Police Department, Forest Department and public in analysis of essential oils from sandalwood samples. A number of technical inquiries on utilization of various non-wood forest products from Government Departments and public were attended to and advice given.
2. Preparation of Catchment Area Treatment Plan including microplanning and placement of suitable SMC works to prevent soil erosion for exploitation of bauxite in Jerrela Block in favour of Andhra Pradesh Mineral Development Corporation Limited, Hyderabad
3. Preparation of EIA/EMP for diversion of forest land for bauxite mining in Jerrela Block III of reserve forest in favour of Andhra Pradesh Mineral Development Corporation Limited, Hyderabad.
4. Preparation of EIA/EMP along with Catchment Area Treatment Plan for diversion of forest land for Iron Ore Mining in Ankua Iron Ore deposits in Jharkhand in favour of JSW Limited.
5. Attended several enquiries from Forest department officials and NGO's with respect to insect and pathological problems in nursery and plantations and timber-in-service and suitable remedial measures were suggested.
6. Efficacies of commercial preservatives against termites/ borers/ wood rotters were tested for various agencies.
7. Dr. O. K. Remadevi visited Madahally, Mysore on 28th November 2007 to investigate the gall problems in Eucalypts.

PATENT

A patent application on "An improved cellulose fibre product and a process for making the same by grafting vinyl monomer using Manganese ions" filed.

COMMERCIALIZATION OF TECHNOLOGY

A technology on Bamboo fibre filled polypropylene composites is being transferred to a polymer industry for commercialization.

CONFERENCE/MEETINGS/WORKSHOPS/SYMPOSIA/EXHIBITIONS

International

A one day international seminar on "Wood drying: Principles and Practices" (Indo-Italian seminar) at IWST, Bangalore on 19th November 2007.

National

1. National Seminar on “Conservation, improvement, cultivation and management of Sandal (*Santalum album* L.)” on 12th and 13th December 2007.
2. National workshop on “Mangroves in India Biodiversity, Protection and Environmental Services” during 7th and 8th February 2008.
3. A one day Regional workshop on Forestry statistics under the ITTO funded on “Establishment of a network to facilitate collection, processing and dissemination of statistics pertaining to tropical timber and other forestry parameters in India on 18th December 2007 at IWST Bangalore.

AWARDS

1. Mr. Pankaj Aggarwal and Mr. Suresh Gairola were awarded prestigious “Brandis Award” for the best research paper in Indian Forester.
2. Dr. O. K. Remadevi was awarded ITTO fellowship to attend the IUFRO all division 5 conference held at Taipei (29th October 2007 to 2nd November 2007).
3. Dr. R. Sundararaj has been awarded with travel fellowship by DST, Govt. of India and Centre for Cooperation in Science and Technology among the developing countries (CCTDAC) and Fellowship under Scientist Assistant Programme of IUFRO to attend the IUFRO all division 5 conference on Forest Products and Environment: a productive symbiosis held at Taipei, Taiwan from 29th October to 2nd November 2007.
4. The Institute was awarded 3rd Prize for Official Language Implementation in the function organized by Town Official Language Implementation Committee, Bangalore on 27th July 2007.

DISTINGUISHED VISITORS

1. Shri R.P.S. Katwal, Former DG, ICFRE visited the Institute and addressed the Scientists on 27th June 2007.
2. Shri S. Reghupathi, Ministry of State for Forests, Government of India visited the Institute on 31st July 2007.
3. Shri Jagdish Kishwan, IFS, Director General, ICFRE visited the Institute and reviewed the progress of the internal and external projects of IWST on 7th and 8th August 2007.
4. Ms. Meena Gupta, IAS, Secretary, MoEF visited the Institute on 7th September 2007. Director presented the Institute activities followed by lab visit.
5. Dr. Anand Sanadi, Scientist, Forest Products Laboratory, Madison, USA visited IWST for three days during 4th to 7th December 2007.



MISCELLANEOUS

1. Mid term evaluation of FDA in Karnataka (Chamrjnagar W/L, Chikmagalur) and Goa (North Goa) was carried out.
2. “Investigations on bacterial flora of the biofilms on timber in marine environment”. Project work done under the Supervision of M. V. Rao, Scientist-C by N. S. Rama Devi, Visakha Government College for Women in partial fulfillment of the requirement for the award of the degree of M. Sc. in Microbiology.
3. “Marine heterotrophic bacterial colonizers of wood at Visakhapatnam harbour” Project work done under the Supervision of Dr. M. Balaji, Scientist-C by S. Navya Sri, Visakha Government College for Women in partial fulfillment of the requirement for the award of the degree of M. Sc. in Microbiology.
4. “New strategies for timber preservation in marine environment: an approach via biocidal intervention”. Project work done under the Supervision of M.V. Rao, Scientist-C by P. V. Bhargavi, Dr. V. S. Krishna Government P. G. and Degree College in partial fulfillment of the requirement for the award of the Degree of M.Sc. in Bio-technology.
5. Design and Development of database for Project Completion Reports (PCR) of Institute of Wood Science and Technology, Bangalore.
6. Design and development of current website, Update and maintenance the institute website and all the tender advertisement is updated in the NIC web site.
7. Implementation and maintenance of Anti Virus software, MS office, Adobe reader, WinZip, etc for client systems.
8. Implementation and maintenance of databases of Indian Forester Information System, Winsprirs, Teak Defoliator, KFRI Research Reports 1-200, Libsys for the Library.
9. Implementation and maintenance of RDBMS server and FAS, PIS, RIS modules have implemented in the client systems.

FOREST RESEARCH CENTRE HYDERABAD

The Forest Research Centre (FRC), Hyderabad started functioning under the administrative control of Institute of Wood Science and Technology, Bangalore from July 1997. The Centre was established to cater research needs of the States of Andhra Pradesh, Karnataka and Goa in the field of forestry. It is situated 22 km away north of Secunderabad railway station. The campus is spread over 100 acres of area in Dulapally reserved forests facilitated with administrative buildings, laboratories, library, rest house, research nursery, experimental plots and a residential quarters for the office staff.

PROJECTS COMPLETED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Screening of natural populations of *Lagerstroemia* spp. for domestication [FRC-05/TI-02/2003-07]

Findings: Two species of *Lagerstroemia* prevalent in Andhra Pradesh and Karnataka were surveyed and several populations were identified. The processes of germplasm collection and multiplication by vegetative means have not been successful. The seed from different places is collected and planted from the better known populations.

Project 2: Natural variation studies in Rosewood (*Dalbergia latifolia* Roxb.) for tree improvement [FRC-04/TI-02/2003-07]

Findings: The number of plus trees were marked in various parts of the Andhra Pradesh and Karnataka. There is a total of 399 trees raised from 48 plus tree population from both Karnataka (100) and from Andhra Pradesh (299). Apart from this, a total of 30 root suckers survive in the field which was well maintained.

Project 3: Estimation of variability in *Pterocarpus marsupium* and germplasm collection [FRC-07/TI-04/2003-07]

Findings: The number of plus trees were marked in various parts of the Andhra Pradesh and Karnataka. A total of 400 seedlings were planted in FRC Campus from selected mother trees from different places.

Project 4: Studies on phenotypic variation in *Pterocarpus santalinus* and collection of germplasm [FRC-04/TI-01/2003-07]

Findings: Survey was conducted in AP in the districts of Kurnool, Cuddapah and Chittoor and identified prominent trees for collection of germplasm. Vegetative propagation technique has been standardized. Propagated 250 plants from different collections and maintained them well.

Project 5: Dynamics of insect populations in cotton based agroforestry systems of Andhra Pradesh [FRC-08/EB-04/2003-08]

Findings: An agroforestry system with six tree species and cotton as intercrop was established in an area of two ha in FRC, Hyderabad campus. The tree components are *Eucalyptus* sp., *Azadirachta*



indica, *Annona squamosa*, *Emblica officinalis*, *Moringa oleifera*, and *Dendrocalamus strictus*. Central idea of the project is to study the insect pest dynamics in diversified habitat conditions. Data on incidence of insect pests and their natural enemies were recorded on intercrop as well as tree components.

EXTERNALLY AIDED PROJECT

Project 1: Bioecology and Integrated Management of Insect Pests of Aonla, *Emblica officinalis* Gaertn.

Findings: Insect pest incidence and their seasonality in Aonla was recorded at Rajahmundry and Hyderabad locations. Aonla aphid, *Cerciaphis emblica*, stem gall insect, *Betuosa stylophora* and Bark eating caterpillar, *Inderbela* sp. followed by *Nipaecoccus viridis* were identified as key pests of Aonla. Five synthetic and one botanical insecticide viz., Dimethoate, Imidacloprid, Spinosad, Profenophos, Neem Seed Kernel Extract and Acetamipride were evaluated under field conditions at Hyderabad in the month of March 2008 against Aonla aphid, *Cerciaphis emblica* on the cultivar *Chakiya*. Dimethoate 30 EC, Confidor 17.8 SL, and Profenofos 50 EC were found highly effective at 0.06, 0.036, and 0.1 per cent concentration respectively. The project is funded by National Medicinal Plants Board, New Delhi.



Menochilus sexmaculatus a predator on Aonla aphid, *Cerciaphis emblica* on *Emblica officinalis*

PROJECTS ONGOING DURING THE YEAR 2007-2008

PLAN PROJECT

Project 1: Reclamation of Iron Ore Mine spoil Karnataka through afforestation [FRC-03/EB-02/2002-05]

Status: Field experiment is continued in Iron Ore Mine spoil at RMMPL, Hospet for selection of suitable tree species, and soil amendment for the Iron Ore Mine spoils.

EXTERNALLY AIDED PROJECT

Project 1: Development of multitier cropping models for medicinal plants in Andhra Pradesh

Status: Three crops of medicinal plants namely, *Andrographis paniculata*, *Oscimum sanctum* and *Withania somnifera* were raised in six ha area in combination with Teak + Sandal, Rosewood +

Sandal, Eucalyptus + Sandal trees and in combination with Teak and their respective sole crops. Rosewood + Sandal combination was found to be very suitable for the growth of all the three medicinal plants. *A. paniculata* followed by *O. sanctum* and *W. somnifera* are found to be better suited in that order. The germplasm of Asparagus was collected from Darwar, Vishakhapatnam, Ranga Reddy, Medak Dists, Mahabubnagar and Srisailam. Seed was harvested from *O. sanctum* and *A. paniculata*. The growth data of Teak trees reveal better growths in inter crop as compared to control.

A comprehensive training-cum-workshop was organized on 18th March 2008 for a group of 32 farmers with scientists from CRIDA, APAU and CIMAP during this project. A group of 30 farmers on extension training were exposed to multitier agroforestry models with medicinal plants on 25th March 2008. A group of corporate people were exposed to the multitier medicinal plants system in February. Three willing farmers were identified for on-farm trials in the forth coming year.

EDUCATION AND TRAINING

Dr. Y. Sridhar, Scientist-C attended training programme on 'Research Methodology' at Indian Agricultural Statistical Research Institute, ICAR, New Delhi from 7th to 19th January 2008.

LINKAGES AND COLLABORATION

National

FRC, Hyderabad presently has one ongoing projects in collaboration with NMPB, Hyderabad and Andhra Pradesh Forest Department.

CONSULTANCIES

1. Mid Term Monitoring and Evaluation of FDAs of Andhra Pradesh under NAP. Submitted to National Afforestation and Eco-development Board, New Delhi (Part of National Consultancy Project of ICFRE).
2. Biological Environment Report (for the proposed bauxite mining site of Chittamgondi, Galikonda, Raktakonda, Eastern Ghats, Visakhapatnam, Andhra Pradesh) submitted to Andhra Pradesh Mineral Development Corporation Limited, Hyderabad (part of National Consultancy Project of ICFRE).
3. Biological Environment Report (for the proposed bauxite mining site of Jerrela Eastern Ghats, Visakhapatnam, Andhra Pradesh) submitted to Andhra Pradesh Mineral Development Corporation Limited, Hyderabad (part of National Consultancy Project of ICFRE).



ICFRE

CONFERENCE/MEETINGS/WORKSHOPS/SYMPOSIA/EXHIBITIONS

1. Integrated Insect Pest Management in Forestry from 18th to 20th December 2007.
2. Extension Training on “Agroforestry Systems for Semi Arid Tropics of Andhra Pradesh.” on 25th March 2008.

TROPICAL FOREST RESEARCH INSTITUTE JABALPUR

Tropical Forest Research Institute (TFRI), Jabalpur is an Institution of Indian Council of Forestry Research and Education (ICFRE) and caters to the forestry research needs of four States of India, viz. Madhya Pradesh, Chhattisgarh, Maharashtra and Orissa. Thrust areas of research in the Institute relate to non-wood forest produce, rehabilitation of mined areas and other stress sites, development and demonstration in agroforestry models, planting stock improvement, sustainable forest managements, biodiversity conservation and control of forest diseases and pests. TFRI has established constant liaison with State Forest Departments, NGOs working in the field of forestry and allied areas, universities imparting education in forestry, and forest based industries. A number of scientists, officers and staff of the Institute participated in various scientific seminars and symposia both at state and national levels and were also actively involved in extension activities. This has helped the Institute in imbibing in its research programme ideas and concepts from various user groups.

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

		No. of projects completed in 2007-08	No. of ongoing projects in 2007-08	No. of projects initiated in 2007-08
TFRI, Jabalpur	Plan Projects	7	13	5
	Externally Aided Projects	1	17	8
CFRHRD, Chhindwara	Plan Projects	—	2	2
	Externally Aided Projects	—	1	—
	Total	8	33	15

PROJECTS COMPLETED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Eco-Rehabilitation of limestone mine of overburden in Madhya Pradesh [065/TFRI/2004/Ecol-1(6)]

Findings: *Acacia nilotica*, *Dalbergia sissoo*, *Leuciana leucocephala* and *Acacia catechu* among Nitrogen Fixing Tree species (NFTs) and *Jatropha curcus*, *Gmelina arborea*, *Eucalyptus* hybrid, *Simaruba glauca*, *Holoptellia integrifolia* and *A. indica* among non-NFT's were found best suited in overburden



dumps of limestone mine areas. Application of a combination of *Rhizobium*, VAM and phosphorous solubilizing bacteria helped attaining maximum height and collar diameter in *Albizia procera*. Shoot height and root weight of *A. procera* were found significant at 5% level. Among nitrogenous fertilizers, ammonium nitrate increased maximum height of *A. procera*. Mulching was found to have significant positive response in height increment of *Albizia procera*. Leaf litter followed by husk and grass mulches helped good shoot growth.

Project 2: Effect of microbial inoculants on growth and productivity of safed musli (*Chlorophytum borivillianum*) [082/TFRI-2005/Patho – 1(11)]

Findings: *Chlorophytum borivillianum* (Safed Musli), an important medicinal plant, is being widely cultivated by farmers as it requires marginal soil for growth and development and has good market for its produce. In the present study effect of VA mycorrhizae, *Azospirillum*, PSB in the establishment of Safed Musli was undertaken. On the basis of experimental results, it has been found that the growth and saponin contents were enhanced by application of VAM, *Azospirillum* and PSB treatment. This combined treatment of biofertilizers was found superior.

Project 3: Studies on the role of Actinomycetes in controlling root diseases of *Tectona grandis*, *Albizia procera*, *Dalbergia sissoo* and *Acacia nilotica* in nurseries [072/TFRI-2004/Patho–2(9)]

Findings: One actinomycete (*Streptomyces* sp.) and three bacteria were isolated from soil and was screened in the laboratory for antagonistic activity against pathogens of forest tree species viz. *Alternaria alternata*, *Curvularia lunata*, *Sarocladium oryzae*, *Fusarium oxysporum*, *Ganoderma lucidum* and *Macrophomina phaseolina*. The culture filtrate of these antagonistic organisms were also tried to control the seed microflora of *Albizia procera*, *Dalbergia sissoo* and *Acacia nilotica*. A formulation contains farmyard manure and chicken manure was selected after growing *Streptomyces* sp. in seventeen different substrates. *Streptomyces* sp. was also multiplied in bulk by using lab fermentor in liquid PDA medium. The inoculum was prepared in bulk by using farm yard manure as the carrier for field application. The bulk culture of bacteria was prepared in PDA broth as well as in lignite. Post-emergence damping-off disease of *A. procera*, *A. lebbek*, *D. sissoo* and *Acacia nilotica* were also controlled by using above formulation. The use of this bio-agent also safe guards the soil from pesticidal residue in nursery and plantations. It is self-multiplying in soil and appears a new species of *Streptomyces*. It is concluded that this *Streptomyces* sp. and antagonistic bacteria (T_1 , T_2 , T_3) can be used to control the different pathogens which are responsible for seed deterioration, causing seed borne infections, root rot and damping off diseases of above selected species in nursery.

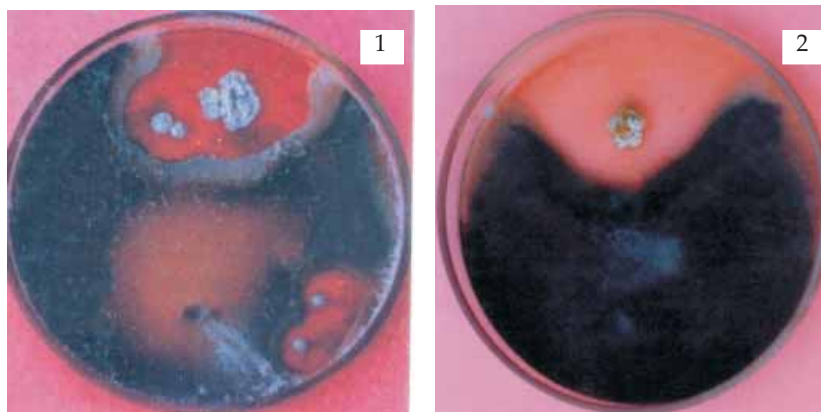


Fig. 1-2 Antagonistic effect of streptomyces
1. *Phytophthora*, 2. *Alternaria alternata*

Project 4: Standardization of the cultivation technique and utilization of laccate, stipitate species of *Ganodermataceae* (*G. lucidum*) [056/CFRHRD-2003/2(6)]

Findings: Field surveys were conducted in different agro-ecological zones of M.P., C.G. and M.S. Total 89 samples of *Ganoderma* were collected. Screening of *Ganoderma* strains were conducted by adopting cellulose degrading capability. Estimation and production of glucanase by four selected strains of *Ganoderma lucidum* was also carried out. Cellulolytic adequacy index capacity has been tested for 19 isolates of *G. lucidum* and two strains have been selected.



Medicinal mushroom of Central India

Project 5: Studies on inheritance pattern of selected wood traits in teak (*Tectona grandis* L.) [068/TFRI/2004/Gen-3 (9)]

Findings: Analysis of variance of growth and wood traits of the progenies of different parents in the trials at Lohara (Chandrapur) and Mohogata (Nagpur) showed significant variation at family level for all the traits except bark thickness. The important wood traits viz., specific gravity, heartwood percentage, sapwood percentage, fibre length, fibre diameter, fibre lumen diameter, vessel length and vessel diameter showed highly significant variation at family level.



The study also revealed moderate estimates of genetic gain for growth and wood traits from both the trials, which indicated that significant genetic gains can be realized through a moderately intensive selection programme. Some of the families showed good GCA for important growth and wood traits. The good general combiners identified in the present study can be used for establishment of advanced generation seed orchards and breeding arboreta for improvement of teak for specific or combination of above traits.

Project 6: Chemical investigations on biologically active chemicals of forest species and their utility for pest control [069/TFRI-2004/NWFP-1(9)]

Findings: *Jatropha curcas* seed oil was modified and different physico-chemical properties were assessed. *J. curcas* seeds were collected from different regions of India and estimated oil percentage and antinutritional constituents, saponins and phytates. Maximum oil percentage (kernel basis) 59.78 % was recorded in the seeds collected from Alirajpur, Jhabua (Madhya Pradesh) while oil percentage in different seed sources ranged from 37.88 to 59.78%. Toxic content phytates and saponin ranged from 4.35 to 9.10% and 0.52 to 2.52% respectively. There was no correlation between oil concentration and toxic content.

Biological activities of different oil component were assessed against Termite (*Odontotermes* spp.), Fungi (*Fusarium oxysporum* and *Alternaria alternata*), Bacteria (*Pseudomonas tectonae*) and Weed (*Parthenium hysterophorus*). 4.7% weight loss of wooden block was recorded in control while minimum weight loss (1.4%) was observed in 10% formulation of sulphated oil when tested against termites. Maximum fungal inhibition (75%) was recorded in diterpenoid fractions. Diterpenoid fraction showed potential efficacy against *A. alternata* and *P. tectonae*.

Herbicidal activity of *Jatropha* oil component was also assessed against a weed *Parthenium hysterophorus*. There was 100% root inhibition over the control.

Project 7: Evaluation of wild edible plants of central region for polysaccharides and other food [070/TFRI-2004/NWFP-2(10)]

Findings: Sal dominated forest areas of Mandla (Kalpi, Narayanganj, Bichiya, Anjanai and Mangli) of Madhya Pradesh were surveyed and wild edible fruits of Manhar (*Randia dumetorum*) and fruit bodies of edible fungi, Putpura (*Asterus hygrometricus*) were collected. Polysaccharide content (starch/carbohydrate) and other nutrient composition of fruit bodies of *A. hygrometricus* and *R. dumetorum* were estimated. Fruit bodies contain high carbohydrate (29.48% and 35.41%) in outer and inner part respectively and fruits of *R. dumetorum* contain high carbohydrate (18.93%). *A. hygrometricus* is the good source of protein. Water soluble vitamins (ascorbic acid and thiamine) were also present in both *R. dumetorum* and *A. hygrometricus*. Minerals viz., calcium, phosphorus and magnesium were also found in appreciable amount.

The rhizomes of *C. angustifolia*, *C. pseudomontana*, *C. speciosus*, *E. nuda* and *P. tuberosa* rhizomes /tubers are eaten raw or as vegetable in different parts of central region. Polysaccharide (starch) contents in tubers varied from 25.82-38.30%. Maximum content was estimated in the tubers of *P. tuberosa* followed by *C. angustifolia*, only 25.82% starch recorded in *E. nuda*. Physico-chemical properties of starch were also determined. Lipid/oil content was also estimated in species,

which contribute high energy value of tubers. 6.16% oil was found in *P. tuberosa* followed by *C. pseudomontana* (4.79%). Results showed that species are rich in mineral content. The percentage of potassium, magnesium, sodium ranged from 1.26 to 2.11%, 0.12 to 0.22% and 0.12 to 0.28% respectively. The amount of sodium and magnesium was comparatively low. Phenolic acids were also identified and quantified in species with the help of HPLC.

Diosgenin contents was estimated in *Costus speciosus* collected from different localities of central region. Maximum diosgenin content was found in the rhizomes collected from Kanker followed by Mandla samples. Durg (CG) contained 2.11% diosgenin, while Dhamtari samples possessed 1.37% diosgenin respectively. Anti nutritional contents, phenol was ranged from 0.24-1.09%. Maximum phenols was found in *P. tuberosa*. The tannin content of tubers varied from 0.03-0.34%. Level of oxalate in different tubers ranged from 0.02-0.09% which was considerably lower than those found in most other starchy staples. All the plant species contain high food value. Food energy provided by the edible parts of the species varied from 126 g calories to 336 g calories which is comparable with other commonly used edible species.

EXTERNALLY AIDED PROJECT

Project 1: Studies on refinement and scaling up of existing micro-propagation and macro-propagation technologies for *Bambusa nutans* and *Bambusa tulda* [063/TFRI-2004/Gen-1/DBT (7)]

Findings: A reproducible micro-propagation system for field grown culms of *B. nutans* and *B. tulda* was developed, which incorporates surface sterilization for 10 min with 0.1% aqueous mercuric chloride and establishment on 0.8% agarified MS semi-solid medium supplemented with 3% sucrose, 10 μ M BA and 0.1 μ M IAA through five subculture cycles each of 15 days. Supplementing MS liquid medium with 100 μ M glutamine, 0.1 μ M IAA and 12 μ M BA ensured a stable two fold shoots multiplication rate at a subculture cycle of 15 days and that with 40 μ M coumarin induced $\geq 98\%$ *in vitro* adventitious roots at one month after inoculation, regenerating plantlet production @ 1.96 fold per culture cycle of 45 days. The *in vitro* regenerated plantlets were hardened and field acclimatized with 90-100% survival.

Adventitious rhizogenesis was influenced much by season in *B. nutans* and by season, nature of cuttings and IBA treatment in *B. tulda*. Culm cuttings exhibited superiority over culm-branch cuttings for rooting in both species. However, rooting of culm-branch cuttings appeared to be a viable procedure for propagation in *B. nutans*. Thus, single node culm and culm-branch cuttings in *B. nutans* and only culm cuttings in *B. tulda* treated with 2 μ M IBA during the whole year and February to May, respectively can be employed for their clonal multiplication and production of planting stock. By both procedures, about 5000 hardened and acclimatized plantlets from nodal segments of field grown culms of *B. nutans* and *B. tulda* have been produced. Micro-propagation technologies for *B. nutans* and *B. tulda* and macro-propagation technology for *B. nutans* have been developed on conclusion of the project.



PROJECTS ONGOING DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Evaluation of medicinal plant based agroforestry (Silvi-Medicinal) system under existing teak plantations [105/TFRI/2006/Agro-1(14)]

Status: The project was initiated during 2006-07 with the aim of establishing medicinal plant based agroforestry system and to evaluate the performance of three medicinal plants, *Curcuma longa* L., *Costus speciosus* Koenig SM and *Gloriosa superba* L. under existing teak plantations. The medicinal crop was harvested and compilation of collected data is under progress. Results indicated that the growth performance of teak was better with various interculture operations. The system was demonstrated to the farmers of IFFDC (Indian Farm and Forestry Development Corporation), Sagar on 8th March 2008.

Project 2: Study on plant diversity in Sal – Teak ecotone zone as influenced by ecological and climatic changes [085/TFRI/2005/Biod-2(5)/2005–09]

Status: Two sites viz. Umariya (MP) and Jagadalspur (CG) have been selected for the study where sal and teak are growing together naturally. Quadrates have been laid out at both the ecotone area for floristic study.

Phenological observations of tree species were recorded from both the ecotone zone. Surface soil samples collected from the ecotone areas of Jagadalspur (24 samples) and Umariya (24 samples) were analyzed for soil micro-flora and chemical properties.

Project 3: Documentation of traditional knowledge on ethno-medicinal information from traditional herbal healers (vaidyas, ojhas, guniyas) in central Madhya Pradesh [TFRI-084/TFRI/2005/Biod-1(4)]

Status: The tribal rich pockets have been identified for survey work in Jabalpur, Sehor, Hoshangabad, Seoni, Chhindwara and Bhopal districts of Madhya Pradesh. The traditional knowledge on cure of various diseases is documented from traditional herbal healers of different tribal localities. The local names, scientific name, plant parts used, formulation, mode of preparation of drug and doses have been recorded along with number of traditional herbal healers contacted. Importance of sustainable use of herbal medicinal plants and their conservation have been brought to the knowledge of tribal communities and herbal healers during the field visits and at Van Mela at Jabalpur and Bhopal. Slogans showing importance of medicinal plants and their sustainable use and conservation were prepared for distribution in the above tribal pockets in the form of banner/pamphlets for creating awareness.



Van Singhara (*Eulophia nuda*)

Patal Kumda (*Pueraria tuberosa*)

Tribal herbal healer collecting medicinal plants from near
by forest for preparation of herbal medicine

Project 4: Studies on forest dwelling Braconids (Hymenoptera : Braconidae) from central India and their role in Biological control of important forest insect pests [081/TFRI/2005/Ento-2 (10); 2005-08]

Status: Survey of important localities of districts Umaria, Sidhi, Khandwa, Khargon, Ujjain, Ratlam, Jhabua, Dhar, Datia, Gwalior, Bhind, Morena, Raisen, Vidisha, Dewas, Shajapur and Rajgarh of Madhya Pradesh was carried out for the collection of braconids. Over all 181 samples of insects were collected by sweeping method; out of which 761 Braconids were isolated and preserved. Two hundred ten samples of leaf miners and defoliators of forest tree species (*Ailanthus excelsa*, *Butea monosperma*, *Pongamia pinnata*, *Dalbergia sissoo*, *Syzygium cumuni*, *Lagerstroemia parviflora* and *Ziziphus jujube*), teak leaf defoliator / skeletonizer and bamboo leaf roller were collected from surveyed localities of Madhya Pradesh. *Apanteles bambusae* was emerged from the larvae of Bamboo leaf roller: *Crypsitya coclesalis*; *Parahormius absonus* was reared from the larvae of *Albizia* defoliator: *Rhesala imparata*; *Chelonus deogiri* and *Hormius lamidae* were emerged from the leaf miner of *Pongamia pinnata* and *Parahormius deiphobus* was reared from Palas leaf blotch-miner. Twenty four species viz., *Apanteles hyblaeae*, *Apanteles agilis*, *Apanteles bambusae*, *Parahormius nr. jason*, *Parahormius absonus*, *Parahormius zonus*, *Parahormius rameshi*, *Hormius vitabilis*, *Hormius lamidae*, *Adialytus arvicola*, *Chelonus scutellatus*, *Chelonus gastrus*, *Chelonus chailini*, *Chelonus shyamus*, *Trioxys indicus*, *Trioxys soporensis*, *Apanteles attevae* sp.n., *Adialytus magnipalpus* sp.n., *Chelonus parascutellatus* sp.n., *Chelonus paragastrus* sp.n., *Hormius lorhaensis* sp.n., *Meteorus longiflagellata* sp.n., *Trioxys magnicorpa* sp. n. and *Agathirsia paratestacea* sp.n., were identified up to the species level.

Project 5: Studies on the efficacy of toxins of soil actinomycetes against major forest insect pests [103/TFRI/2006/Ento-2(13); 2006-09]

Status: One hundred fifty soil samples were collected from 20 forest localities of Madhya Pradesh and 10 and 5 localities of Maharashtra and Chhattisgarh respectively. Two actinomycetes were isolated on potato-dextrose agar plates following serial dilution technique and pour plate method. Extraction of toxins (antibiotics) of actinomycete, *Streptomyces* sp. were carried out. Nurseries, plantations and natural forests were surveyed for collection of insects damaging teak and *Albizia* sp. and their rearing were carried out in laboratory for experimental work. Toxicity tests of isolated antibiotics and bioproduct of a soil actinomycete were conducted against major insect pests of teak and *Albizia* spp. through larval and food treatment.

Project 6: Evaluation of biopesticidal products for the management of teak defoliator and skeletonizer in forest nursery [104/TFRI/2006/Ento-3(14)]

Status: Incidence of teak defoliator and skeletonizer was periodically monitored in teak nurseries and plantations. Periodical collection of teak defoliator and skeletonizer was made from plantation areas of Udaipur, Kalpi, Tikariya under Mandla Forest Division, Mandla (M.P.) and culture was maintained in laboratory. Sampling, isolation and identification of entomopathogenic fungi from insects collected from localities, such as, Belkund, Kundam, Seoni and Mandla in M.P. and Pauni,



Surewani, Deolapar in M.S. were carried out and culture maintained. Laboratory culture of the isolated microbes maintained and pathogenicity tested against the larvae. Laboratory culture of wax moth, *Galleria melonella*, was maintained round the year as host for Entomo-Pathogenic Nematode (EPN). Pathogenicity of the EPN was pioneered against the teak defoliator and skeletonizer. Compatibility of the EPN with that of chemical and biological insecticides evaluated. Eight concentrations each of 8 commercially available biopesticides were evaluated against the larvae of teak defoliator and skeletonizer. Anti-ovipositional effect due to prophylactic treatment of 2 botanical formulations was experimented against teak defoliator in nursery.

Project 7: Studies on bacterial and viral diseases of Teak, *Gmelina* and *Albizia* and their management [066/TFRI/2004/Patho-1(8)]

Status: Overall 250 bacterial/viral disease samples were collected from 27 forest nurseries of M.P., C.G. and M.S. Out of them 245 samples of teak and khmer were found to be infected with bacterial wilt and collar rot and 5 (*A. lebbek*, *A. procera*, *T. grandis* and *G. arborea*) with virus infection. 2-5% economic losses were recorded in different nurseries caused by bacteria and viruses. Total 9 bacterial isolates were purified and sensitivity test carried out to assess suitability of antibiotics for their application in nursery. An experiment has been laid out in nursery to control wilt and collar rot disease of teak, *A. procera*,



Leaf curl and stunting in teak

A. lebbek and *Gmelina arborea*. Incidence of *Xanthomonas* leaf curl and stunting in young teak plantations at Raipura, South Panna division noticed. Disease was successfully controlled with the application of streptocyclin 0.1% in combination with monocrotophas 0.036%.

Project 8: Evaluation, modification and value addition of starches of forest Origin [083/TFRI/2005/NWFP-2(13)]

Status: Fruit of *Carea arborea* from four localities of MP were surveyed and collected. Recorded morphological description of fruit and seeds. Analyzed chemical composition of seed. Extracted starch from seed and prepared syrup of 17 DE by acid hydrolysis of *C. arborea* starch. Surveyed potential area of *Curcuma aromatica* in Maharashtra, Madhya Pradesh, Orissa and Chhattisgarh. Collected rhizome from Baripada Forest Division (Orissa) and Palampur (HP). Extracted starch and analyzed chemical composition and physio- chemical properties including essential oil 0.6%, fibre 8.2%, protein 4.5%, phosphorus 0.37% and starch 25.3%.

Project 9: Evaluation of management systems and level of community participation under Joint Forest Management (JFM) [071/TFRI-2004/Silvi-1(6)]

Status: Vegetation survey for phyto-sociological studies was conducted by laying out sample plots in earlier selected sites at Udaipur Forests, Comptt. No. 561, 562, 563 in Maihar Forest Range, Satna Forest Division (Madhya Pradesh), Narwar (Comptt. No. RF-18), Nipnia (Comptt. No. RF-19), Aintajhar (Comptt. No. RF-12), Singpur Forests, (Comptt. No. RF-11), Sahdol Forest Range, South Sahdol Forest Division (Madhya Pradesh), Medha Lekha Forests (Comptt. No. RF-511),

Dhanwa Forest Range and Gadchiroli Forest Division (Maharashtra), Aoti Forests (Comptt. No.185) Satna Forest Range, East Nasik Forest Division (Maharashtra) for studying effect of Joint Forest Management programme on people and forests.

Regeneration, plant density, diversity index and species richness were better in forests having Joint Forest Management (JFM) programme as compared to non-protected forests having no JFM programme. The conditions of the forest got improved under JFM programme due to controlling of illicit felling / grazing, fire protection, settlement of encroachment etc. JFM programme has developed confidence of people on forests, forestry and forest departments. It has been observed that villagers of Medha Lekha Village are protecting Govt. forests on rotational basis without getting any help / remuneration from the Govt. by considering Govt. forests as their forests.

Implementation of JFM programme has positive effect on people due to introduction of income generating scheme like fishery, plantation of grafted mango seedlings, honey collection etc., ban on use of country liquor (Mahua Daru) by active involvement of women, increase in level of ground water. This has facilitated farming of horticulture / forestry / agriculture in the area.

Project 10: Sustainable management of medicinal plants in JFM areas in different agroclimatic zones of Madhya Pradesh [079/S.P.Tripathi/ Silviculture]

Status: For sustainable harvesting of Kalmegh in Satnur Forests area, Sawari Range, West Chhindwara Forest Division, sample plots were laid out in 2005 and harvesting was done at different intensity in 2005, 2006 and 2007. Sustainability with maximum productivity was found at 60% harvesting level. Additional sample plots have been laid out near Delakhadi Forest Rest House, Delakhadi Forest Range, West Chhindwara Forest Division and at Naunichhapar Village (Comptt. No. P-1286), Chhindwara Range in East Chhindwara Forest Division in 2006 and 2007 respectively for study of sustainable harvesting of Kalmegh.

Problem of natural regeneration and sustainable harvesting of Chironjee was reflected by West Chhindwara Forest Division and for this sample plots were laid out at Sitadongri Village (Comptt. No. P-155), Delakhadi Forest Range, West Chhindwara Forest Division and Khumbhadeo Forests (Comptt. No. P-1080), East Harrai Range, East Chhindwara Forest Division. Harvesting of mature fruits / seeds were done by having treatments namely T1 (90% No. of fruits), T2 (80% No. of fruits), T3 (70% No. of fruits) and T4 (60% No. of fruits). It has been observed that harvesting of only mature fruits / seeds and leaving 10% seeds bring regeneration of Chironjee which can be managed and protected by applying silvicultural practices. Sustainable harvesting exists at 90% of harvesting level. Site having rich population of Chironjee has also been selected at Ojhaldhana Village (Comptt. No. P-955). East Batkakhapa Range, East Chhindwara Forest Division for study of regeneration, following harvesting at different intensities and protection.

Sample plots have been laid out at compartment No. 321 and 292 in Katni Forest Division, and Dhawantri Park Takshkeswara, Bhanupura Range, Mandsaur Forest Division for studying of sustainable harvesting of Satawar.

**Project 11: Seed physiology of the tropical forest species with special reference to their maturity and storage [076/TFRI-2004/Silvi-2(7)]**

Status: Studies on germination of seeds have been carried out on *Schleichera trijuga*, *Terminalia arjuna* and *Hardwickia binnata*. Studies on desiccation tolerance and seed storage behavior have been conducted on *Schleichera trijuga*, *Terminalia arjuna*, *Sapindus laurifolia*, *Ablomoscus moscatus* and *Hardwickia binnata*. Seeds of *Schleichera trijuga*, *Moringa oleifera*, *Holoptelea integrifolia*, *Sapindus laurifolia* and *Terminalia chebula* were adjusted to three to five moisture contents and stored at four different temperatures i.e. -10°C, 5°C, 10°C and 45°C for evaluation of storage potential. Seeds of stored species were sampled for viability assessment. Seed maturation studies for determination of seed collection time have been continued on *Schleichera trijuga*, *Terminalia arjuna*, *Hardwickia binnata*, *Moringa oleifera*, *Holoptelea integrifolia*, *Sapindus laurifolia*, *Terminalia chebula* and *Ablomoscus moscatus*.

Project 12: Standardization of nursery techniques of *Strchnos nux-vomica* and *Strychnos potatorum* [080/TFRI/2005/Silvi-2(9)]

Status: Seed, roots and branches of *S. nux-vomica* were collected from Sahni Khar, Dhamtari Forest Division and seed, roots and branches of *S. potatorum* were collected from Khutama, South Chhindwara Forest Division for conducting seed germination and vegetation propagation experiments. Seeds of *S. nux-vomica* soaked in cow dung slurry for 72 hours before sowing gives 66% germination followed by seed soaked in poultry manure for 72 hours before sowing gives 54% germination and untreated seed gives only 3% germination. Seed of *S. potatorum* soaked in cow dung slurry for 72 hours before sowing gives 51% germination followed by seed soaked in poultry manure for 72 hours before sowing, gives 36% germination as compared to untreated seeds giving only 6% germination.

The maximum 66% germination in *S. nux-vomica* and 54% germination in *S. potatorum* was observed under 100 ppm IBM hormone followed by the maximum 42% germination in *S. nux-vomica* and 39% germination in *S. potatorum* was noted under 50 ppm IAA hormone. Under hormonal treatment no rooting in root and branch cuttings of *S. nux-vomica* and *S. potatorum* was observed.

Project 13: Development of nursery technique for *Terminalia chebula* Rext. (Harad) [107/TFRI/2006/Silvi-1(12)]

Status: Seed and branches of *Terminalia chebula* were collected from Chandrapur (Maharashtra), Bilagarh (Chhattisgarh), Tamia (Madhya Pradesh) and Sambalpur (Orissa) for conducting seed germination and vegetation propagation experiments. The seeds and branch cuttings were given different physical, chemical and hormonal treatments and laid out an experiment in silviculture nursery as per Randomized Block Design. Branch cuttings treated with different hormones with different concentrations of IAA, IBA and NAA. Maximum 90% sprouting was noted in the treatment of IBA -4000 ppm followed by IAA- 4000 ppm (70%). Best performance in inducing sprouting was observed in cuttings having diameter of 2-2.5 cms in comparison to other two groups (1-1.5 cms and 3-4 cms).

Under physical treatment for enhancing germination of seeds, 2 days drying after 7 days soaking in normal water showed best results.

EXTERNALLY AIDED PROJECTS

Project 1: Identification of species and ethnobotanical survey [088/TFRI/ 2005/ Biod-3 (CG, MFD) (6)/2005-08]

Status: Survey in 9 People Protect Areas (PPAs) of Chhattisgarh at Karpavan, Machkot, Guriya (Jagdalpur, Baster); Jabarra, Shankra (Dhamtari); Lamni, Marwahi (Bilaspur); Makadi (Kondagaon) and Antahgarh (Bhanupratappur) was conducted for vegetation study. Quadrat study has been conducted in 9 PPA sites for documenting floral wealth and increasing or decreasing trend of important forestry species in the area. Vegetation data of PPA (established during 2002-03, 2003-04, 2004-05, 2005-06 and 2006-07) for tree species with girth class, regeneration status of major tree species and medicinal plants available in the area were recorded during the study. The previous vegetation data available with forest department has also been recorded. The same has been tabulated for calculation and comparison of vegetation status. Plants observed in Karpavan, Machkot, Guriya, Jabarra, Shankra, Lamni, Marwahi, Makadi and Antahgarh PPA areas are identified with their local name, morphological character and available literature. The brief morphological description of the plants are being prepared. Some plant specimens have been collected to confirm the identity and their threatened status. The ethno-botanical uses of medicinal plants observed from above PPA sites are being documented. Common and medicinal uses of plants species found in the PPA site are recorded alongwith brief morphological description.

Project 2: To study utilization pattern of plants in ethno-medicinal uses prevalent in tribal pockets of Satpura plateau in Madhya Pradesh [101/TFRI/JBP/2006/Biod-1 (MPSBDB) (07) (2006-10)]

Status: 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. Existing utilization pattern of medicinal plant being utilized by traditional herbal healers against various common diseases of tribal pockets from Jabalpur, Mandla and Chhindwara districts of MP have been documented. Survey of Mandla, Jabalpur, Katni, Satna, Chhindwara, Bhopal and Sagar districts of MP have been carried out to document the channels involved in marketing of herbal plants. Market day of tribal villages of Mandla and Chhindwara districts have been recorded and visited where trading of raw and finished products takes place.

Awareness has been created through local contacts to the tribal/ rural people of above surveyed districts regarding sustainable uses of medicinal plants. Morphological description of medicinal plants recorded from above localities alongwith medicinal uses are being prepared. Some slogans have been prepared on uses and importance of medicinal plants for creating awareness among tribal communities.



Project 3: Identification of suitable tree species and other vegetation for biodrainage in Bargi Command Area (Jabalpur, M.P.) [087/TFRI/2005/Ecol-1 (MOWR)(7)]

Status: A plantation of about 10 ha area was raised along Left Bank Canal (LBC) of Bargi Command Area, Jabalpur. *Jatropha curcas* and *Agave americana* were planted surrounding the plantation sites for biofencing. Cattle Protection Trench (CPT) of standard size was also dug to protect the plantation sites from cattle. The species planted included *Pongamia pinnata*, *Acacia nilotica*, *Albizia lebbek*, *Albizia procera*, *Ailanthus excelsa*, *Eucalyptus* hybrid (Jabalpur), *Eucalyptus* hybrid (FRI-4 and FRI-5), *Terminalia arjuna* and *Dalbergia sissoo*. *Eucalyptus* hybrid and *Terminalia arjuna* were planted at Dabhola site; *Pongamia pinnata* and *Acacia nilotica* were planted at Jamuniya and *Albizia lebbek*, *Albizia procera*, *Ailanthus excelsa*, *Eucalyptus* hybrid (Jabalpur), *Eucalyptus* hybrid (FRI-4 and FRI-5), *Terminalia arjuna* and *Dalbergia sissoo* were planted at Somti site. *Ailanthus excelsa* did not perform well, hence partly replaced by *Albizia procera*. All species, except *Eucalyptus* hybrid (FRI-4 and FRI-5), were planted at 2 m x 2 m spacing. *Eucalyptus* hybrid (FRI-4 and FRI-5) were planted at both 2 m x 2 m and 1 m x 1 m spacing. Growth data of the planted seedlings was measured regularly at an interval of 3 months.

Observation wells were constructed as per standard design and installed at plantation sites and control site (where no plantation was there). The observation wells were installed in the manner so that the effect of plantation of each species could be observed separately. The depth of wells was set to be 10 feet. The evaporation rate was regularly measured on daily basis by open pan evaporimeter. Soil infiltration rate was measured at different grids along LBC of Bargi Command Area in different months. Under ground water table was regularly measured with the help of observation wells in different plantations.

Project 4: Lead Institution for Achanakmar-Amarkantak Biosphere Reserve, Chhattisgarh [102/TFRI/2006/Ento-1/MoEF (12)]

Status: Six visits to Achanakmar- Amarkantak, Biosphere Reserve (BR), Bilaspur were made to get information on area of buffer and transition zones, and listing of vegetations available in each zone of BR documented. Inventory list of crustaceans, insects, fishes, amphibians, reptiles, birds and mammals existing in BR updated. Two field surveys were conducted and work on documentation of different tribes, village wise population and economic status initiated. The work is in progress. One field visit was conducted in January 2008. The information on market survey of different NTFPs sold being documented. A workshop on research needs for Achanakmar-Amarkantak BR was organized on 30th April 2007. During discussion 8 gap areas in research in Achanakmar-Amarkantak BR identified. One meeting with Principal Chief Conservator of Forest level and two with Conservator of Forest and two at Dy. Conservator of Forest level, one with Superintendent of BR were made during the year 2007-08. The updated research based information presented in the workshop on Research needs for Achanakmar- Amarkantak Biosphere Reserve, held at Tropical Forest Research Institute, Jabalpur on 30th April 2007 published and widely circulated to BR managers, academicians and scientists. Biosphere Reserve Information Series (BRIS) volume 1, part 1 published and circulated to BR managers, Directors of Parks, Sanctuaries, academicians, scientists working on Achanakmar- Amarkantak BR.

Project 5: Screening of indigenous species of *Trichogramma* Westwood and *Trichogrammatoidea* Girault (Hymenoptera: Trichogrammatidae) from Central India and their utilization against important forest insect pests [077/TFRI/2005/Ento-(1) 9; 2005-08]

Status: Survey of important localities of selected districts of Maharashtra: (Amravati, Akola, Jalgaon, Dhule, Malegaon, Nashik, Thane, Pune, Raigad, Ahmad Nagar, Aurangabad, Jalna, Washim, Wardha, Yavatmal, Bhandara, Chandrapur, Solapur, Satara and Ratnagiri) and the districts of Orissa (Sundargarh, Koenjhar, Balasore, Bhadrak, Cuttack, Jagat Singhpur, Puri, Bhubaneshwar, Balangir, Sonapur, Sambalpur, Jharsuguda, Dhenkanal, Kalahandi, Nowrangpur, Koraput, Malkangiri and adjoining areas) was carried out for the collection of *Trichogramma* and *Trichogrammatoidea* species. Over all 1337 specimens belonging to the genera *Trichogramma* and *Trichogrammatoidea* were collected. Twenty three species of *Trichogramma* (*T. breviciliata*, *T. flandersi*, *T. fasciatum*, *T. higai*, *T. thalense*, *T. bezdenkovii*, *T. parkeri*, *T. brevicapillum*, *T. nomlaki*, *T. tshumakovae*, *T. fuentesi*, *T. ingricum*, *T. savalense*, *T. margianum*, *T. rossicum*, *T. ostrinae*, *T. artonae*, *T. clotho*, *T. lachesis*, *T. lenae*, *T. pretiosum*, *T. poliae* and *T. stampai*) and one species of *Trichogrammatoidea* (*T. fumata*) have been recorded as indigenous species, existing in Madhya Pradesh, Chhattisgarh and Maharashtra. Live culture of 5 indigenous species viz., *Trichogramma raoi*, *T. plasseyensis*, *T. latipennis*, *T. breviciliata* and *T. brevipflagellata* are being maintained. Culture of *Corcyra cephalonica* is being maintained for the use of their eggs as laboratory host for *Trichogramma* and *Trichogrammatoidea* species.

Project 6: Development of integrated insect pest and disease control system for major economically important forest tree species [112/TFRI-2006/Ento-4 (MPFD)(15)]

Status: Survey was conducted at Sonaghati, Neempani, Wamandehi, Balaghat and Hardi (Research Extension Circle, Betul, Seoni and Rewa), compartments at Balwara and Katkut ranges (Forest Division, Badwaha), Ghisi (Forest Protection Division, Barghat/Seoni), Kanchangaon and Belkund (Forest Project Divisions Mohagaon/Mandla and Jabalpur), Deogarh and Borgaon (South Forest Division, Chhindwara), Tendukheda (Forest Division, Damoh) and Mukki (Kanha), Sakriya and Raipur (N. Forest Division, Panna) for monitoring the insect pests and diseases of target species. Incidence of white grubs *Holotrichia* species, teak defoliator *Hyblaea puera*, skeletonizer *Eutectona machaeralis*, aonla shoot gall forming insect *Betousa stylophora*, leaf roller *Garcillaria acidula*, fruit sucker *Scutellera nobilis*, case worm *Acanthopsyche* species, heart wood borer *Hoplocerambyx spinicornis* and wilt/root rot/foliar diseases *Fusarium solani*, *Pseudomonas tectonae*, *Polyporus zonalis*, *Rigidoporous lineatus*, *Peniophora* species and *Olivea tectonae* were recorded. Experiments laid out on IPM of white grubs in teak nurseries at Kanchangaon and Belkund, teak defoliator *H. puera* and skeletonizer *E. machaeralis* in teak plantations at Kanchangaon and Ghisi. Biopesticides, insecticides/fungicides and bioagent were used against insect pests/diseases. Preliminary screening of seven varieties of *E. officinalis* (Chakaiya, Kanchan, Francis, NA6, NA7, NA10 and BSR1) against insect pests/diseases done.

Project 7: Varietal improvement of *Rauvolfia serpentina* and *Tinospora cordifolia* through germplasm selection, evaluation and breeding [100/TFRI/2006/ Gen-1 (MoHFW) (10)]

Status: Three States namely Chhattisgarh, Uttarakhand and J & K were visited and germplasm of both the species were collected. The collected materials were used for raising plantlets of both the species. The *in vitro* shoot multiplication rate and rooting was optimized in both the species.



In *R. serpentina* *ex vitro* rooting (100%) was also achieved. Two methods namely BP (British Pharmacopoea, 2000) and spectrophotometer (Singh *et al.*, 2004) were tested for estimation of total alkaloids in *R. serpentina*. In *R. serpentina* the anthesis period (4.00 am - 9.30 am) and peak time of anthesis (7.00 am - 8.00 am) were determined in May-June. Floral longevity (20 - 28 hours) was also standardized. Microscopic floral structure of *R. serpentina* and *T. cordifolia* was studied. The process of raising planting stock of both the species of at least 10-15 accessions is in progress for establishment on demonstration of multi location field trial of both the species.

Project 8: Studies on *in vitro* regeneration of plantlets and their genetic (molecular) fidelity in *Saraca indica* Linn., a vulnerable medicinal tree [111/TFRI-2006/Gen-2 (CSIR)(12)]

Status: Seedlings of about two to three years old were collected from J.N. Agricultural University, Jabalpur, Madhya Pradesh and Nagpur, Maharashtra. Nodal explants from these seedlings were subjected to five sources of cytokinin, viz., BA, kinetin, adenine hemisulphate, zeatin and 2-isopentyl at 20 μ M for *in vitro* culture initiation and bud break. BA and zeatin resulted in 60% sprouting of buds. Subsequently, six concentrations of BA (0, 0.01, 0.1, 1.0, 10.0 and 100 μ M) and 3 concentrations of NAA (0, 0.1 and 1 μ M) alone and in all possible combinations were tested for bud break in nodal segments of seedlings. The different concentrations of BA individually and its interactions with NAA had a significant effect on bud break (%). Maximum bud break was obtained with 100 μ M BA, which was statistically on par with 10 μ M BA supplemented medium. In another investigation, seeds were germinated under *in vitro* conditions on MS basal semisolid medium for harvesting of aseptic shoot explants. Four nutrient media (MS, B₅, WPM and Nitsch and Nitsch) along with five doses of BA (0, 2.2, 4.4, 8.8 and 17.8 μ M) alone and in all possible combinations were tried for bud sprouting and elongation of nodal segments. Nutrient medium B₅ supplemented with 2.2 μ M BA has been selected for sprouting and shoot elongation.

Five sources of cytokinin, viz., BA, kinetin, adenine hemisulphate, zeatin and 2-isopentyl at 20 μ M, along with different doses of 2, 4-D (0, 5 and 10 μ M) were screened for induction of callus on cotyledons. The effect of cytokinins individually and their interactions with 2, 4-D were found to be significant for callus induction. Maximum callus formation (100 %) was obtained on 20 μ M zeatin and 10 μ M 2, 4-D.

Project 9: Processing techniques of NWFP's of Chhattisgarh– *Madhuca latifolia*, *Shorea robusta*, *Schleichera oleosa*, *Pongamia pinnata* and *Buchanania lanzan* Chironjee) [91/TFRI/2005/NWFP-3 (CGMFD)(14)]

Status: Seeds/fruits of different TBOs i.e. Sal (*Shorea robusta*), Chironjee (*Buchanania lanzan*), *Pongamia pinnata* (Karanj), *Madhuca latifolia* (Mahua) and Kusum (*Schleichera oleosa*) from Bichiya (Mandla), Kota (Bilaspur) and Kundam, Barha, Tikariya (Jabalpur) during season. Seeds were decorticated manually and dried by different methods i.e. sun-drying, shade drying, hot air drying at 40° C, 60° C and 80° C, and stored in different containers i.e. jute bag, tin containers, plastic bag and air tight plastic containers. Chironjee seeds dried at 40, 60° C in oven and stored in plastic bag, glass bottles and plastic air tight containers, room temperature and freezer.

Fungal flora in different treatments in seeds of collected species were recorded in different intervals. Total 13 fungus belonging to 9 genera were recorded in different seeds - *Aspergillus flavus*, *A. fumigatus*, *A. niger*, *A. nidulans*, *A. teneus*, *Chaetomium globosum*, *Cladosporium herbarum*, *Collectotrichum gloeosporioides*, *Dothiorella indica*, *Fusarium oxysporum*, *Penicillium* sp. and *Rhizopus nigricans*. Fresh seeds showed 2-9% fungal infestation in different species. Fungal infestation increased with time but intensity varied in different containers i.e. 13 to 81% (Jute bags), 4 to 14% (plastic jars), 4 to 15% (poly bags), 8 to 38% (tin containers). Maximum deterioration was recorded in Jute bags.

Moisture percentage in different containers under different drying treatments increased with time. Oil concentration in different seeds decreased with time. Free fatty acid concentration and saponification value of seed oil of different species increased during storage due to the degradation of oil.

Project 10: Quality assessment of NWFP's from different regions of Chhattisgarh. Species- *Asparagus racemosus*, *Buchanania lanzan*, *Emblica officinalis*, *Embelia ribes* and *Andrographis paniculatus* [092/TFRI/2005/ NWFP-4 (CGMFD)(15)]

Status: Different regions of Chhattisgarh (Kawardha, Pendra Road, Durg, Bilaspur, Raipur, Raigarh, Mahasamund, Ambikapur, Dhurmjaigarh, Jashpur and Kanker) were surveyed and Satawar roots, Kalmegh (whole plant), Aonla (fruits), Vaibidang (fruits) and Chironjee (fruits) samples were collected during their respective seasons of collection. Physico-chemical properties to ascertain qualitative variations in samples from different regions were also assessed.

Ascorbic acid contents estimated in Aonla collected from different region of Chhattisgarh ranged from 64 – 257 mg/100 gm, minimum in Dondi, Durg (Mahamaya PPA) and maximum in Katghora (Bilaspur). Oil per cent ranged from 42.3- 63 in different localities. Maximum oil per cent was recorded in samples collected from Pandariya (Kawardha). Saponin glycosides and minerals (P, Na, K, Mg and Ca) were estimated in Satawar samples and ranged 0.4-9.9, 0.2-3.5, 2.3-12.5, mg/100 g, 0.048-0.096% and 0.08-0.4% respectively. Total saponin per cent ranged from 0.72% to 2.5%. Maximum saponin percent was found in Dondi (Durg). Andrographolide contents of in *Andrographis paniculata* estimated in different sample ranged from 0.27 to 0.38% with the help of HPLC. Maximum percentage was recorded in Kanker samples.

Project 11: Non-destructive harvesting practices for selective MFPs- *Buchanania lanzan* (Chironjee) [093/TFRI/2005/NWFP-5 (CGMFD)(16)]

Status: Different regions of Chhattisgarh (Bilaspur, Raipur, Raigarh, Mahasamund, Ambikapur, Kanker and Dhurmjaigarh) were surveyed for selection of sites. The fruits of Chironjee were collected in 3rd and 4th week of April and 1st and 2nd week of May from TFRI Campus, Jabalpur, Barha Experimental Field, Jabalpur, Bhilmadhi, Korba. Chironjee fruits were depulped and primarily quality of Chironjee was assessed on the basis of floatation test by counting the float and sunk seeds. Other physical properties of fruits/seeds - moisture%, colour of fruits, fruit weight, seed weight, kernel size, kernel fresh and dry weight were also recorded.



Bio-chemicals (oil per cent, carbohydrates, protein, free fatty acids, free amino-acids fibre, minerals, vitamins and phenolic acids) in fruits/seeds of Chironjee collected were estimated. Oil per cent in seeds increased with time (4.09-43-38%). Free Fatty Acid concentration was also increased in the seeds when collected in second week of May. Concentration of free amino-acids (FAA) decreased with time. However, protein concentration increased with time (7.4-19.30%). Similarly, fibre and mineral concentration were also increased with time. Quarterly observations on regeneration of Chironjee plants was undertaken.

Project 12: Standardization of non-destructive harvesting practices of Arjuna (*Terminalia arjuna*), Maida (*Litsea chinensis*) Bark and Salai (*Boswellia serrata*) oleoresin [96/TFRI/2005/NWFP-8(CGMFD)(19)]

Status : In Arjuna, the stage of bark recovery (re-growth) varied from tree to tree. After one year, the stripped trees exhibited an average of 42% recovery based on surface area covered with fresh bark. The trees in which the bark was harvested on December 2005 by putting blaze size (30 × 30 cm) showed almost complete bark recovery nearly after two years. However, few trees showed partial recovery of bark. The availability of Maida trees in the forest areas is very less. Thumb size collar diameter Maida trees were found harvested for bark. Minimum and maximum girth of Maida trees selected for study was 12 cm and 178 cm respectively. Mean thickness of bark varied from trees to trees. It is irrespective from the age/girth of tree. The tannin content ranged from 3.55 to 5.73 gm per 100 gms. In Maida trees the recovery of bark was faster. The regeneration of bark in young trees was fast in comparison to older trees and completed regeneration within one year. Various girth size *Boswellia serrata* (Salai) (age group) trees were selected for study. Different type of blazes having varied length, width and deep were laid out in December and March 2007 to optimize best blaze to harvest oleoresin from tree. In some trees the oleoresin oozes out but the yield was very less.

Project 13: Standardization of non-destructive harvesting practices of Baividang (*Embelia ribes*), Baheda (*Terminalia belerica*) and Aonla (*Emblica officinalis*) fruits [97/TFRI/2005/NWFP-8(CGMFD)(20)]

Status : The study revealed that the availability of Aonla fruits was affected by the existing destructive harvesting practices. Aonla fruits should be harvested in the proper season, at the proper maturity stage, in a non-destructive and sustainable manner. In protected areas where more than 5 fruited Aonla trees were available in (50 × 50 m), 90% harvest of Aonla fruits was found sufficient for regeneration. However, in unprotected areas less regeneration was observed even if 20% fruits were left for regeneration. For proper regeneration fruits should be harvested in December- January only after maturity.

Baividang fruits should be collected / harvested after maturity when they change their colour from green to pink or red. Fruits should be plucked by hand instead of cutting the branches. The amount of fruits to be harvested depends upon the population of Baividang. If the population of Baividang is more (20 fruited plants per 10x10m) then 5-10 % fruits are enough to maintain sustainability whereas in the areas where population is less (10 fruited plants per 10 × 10 m) more fruits (10-20%) should be left to maintain sustainability. If the population is very less

(5 plants per 10 x 10 m) more fruits 30-40% fruits should be left for regeneration in initial years. Embelin content varied from 2.21 to 4.77%. The immature fruits contain 2.25 % embelin whereas mature fruits contain 4.77% embelin. In Baheda 90% harvest was found suitable for its regeneration in protected areas. Variations were found in fruit size, fruit weight, tannin and gallic acid content in the fruit samples of Baheda collected from various locations. Fruits collected during mid December contained around 13% tannin and 15 mg/100 g of gallic acid. However, the fruits harvested in mid October had 8-9 % tannin and 18-20 mg/100 g gallic acid. It is therefore evident from the data that the Baheda fruits harvested during December are of superior quality in respect of tannin and gallic acid content.

Project 14: National network on integrated development of *Jatropha* and *Karanj* [73/TFRI-2004/NWFP-3(NOVOD)(11)]

Status : *Jatropha*: All experimental trials e.g. national, zonal, progeny and package of practices trials are being maintained at the Institute campus. Experimental area at Barah, Jabalpur and its centre at Chhindwara are performing well. In national trial accessions TFRI-2 and IGAU-3 performed best among all other accessions, whereas in regional trial TFRI-I and MPKV-I performed well among all other accessions received from different member institutions with respect to growth attributes as no sufficient fruiting was observed. Jogimuar, Chhindwara genotype performed best among all progenies with respect to growth characteristics. Pruning operations in *Jatropha* induced more number of branches which lead to more production/fruits.

***Karanja*:** National, zonal and progeny trials established at the institute campus, Barah experimental area and Bhandamuri, Balaghat are being maintained. In national trial accession number TNMP-4 received from TNAU, Mettupalayam, Tamil Nadu performed best among all other provenances, whereas in regional trial TFRI-2 collected from Madhya Pradesh performed best among all other provenances with respect to growth attributes. Progenies collected from Jabalpur and Lalpur, Satna-1 performed well among all other progenies in respect of growth attributes. Significant reduction in oil yield was obtained in the seeds stored for more than a year.

Project 15: Standardization of sustainable harvesting practices of *Terminalia arjuna* (Arjun) bark [78/TFRI/2005/NWFP-1(MPFED)(12)]

Status : Non-destructive harvesting technique to harvest Arjuna bark has been standardized. Only $\frac{1}{4}$ of the mature bark on total girth of the tree should be harvested. However, the length of the blaze can be varied (30, 45, 60, 75, and 90 cm) according to its GBH. Sustainable bark harvesting can be done after two years by removing opposing quarters of trunk bark rather than girdling the trees. The study shows that the technique of making of blaze on the tree also plays an important role in the recovery of bark. If the blaze is sharp the recovery is faster whereas if the blaze (cut) is not sharp the recovery is slow. The quality of the bark is directly dependent on harvesting technique and time. December to March was found best time to harvest Arjuna bark as it yielded quality bark in terms of major active ingredients.



Harvesting of bark by putting a blaze on the trunk



Terminalia arjuna tree showing regeneration of bark

Project 16: Sustainable yield assessment/harvesting of Non-Wood Forest Produce (NWFP) in People's Protected Areas (PPAs) of Chhattisgarh [098/TFRI/2005/Silvi-3 (CGMFD) (10)]

Status: The sustainable harvesting and regeneration studies of *Andrographis paniculata* (Kalmegh), *Asparagus racemosus* (Satawar), *Celastrus paniculata* (Malkagani) and *Aegle marmelos* (Bael) were carried out in PPA of 3 different agro-climatic zones i.e. Bilaspur, Raipur and Bastar of Chhattisgarh. The sample plots of standard size were laid out in randomized block design with 4 replication as per experimental design. There were four treatments i.e. T1=20%, T2=40%, T3= 60% and T4= 80% harvesting level for *Andrographis paniculata*, *Celastrus paniculata* and *Aegle marmelos*, however, there were 5 treatments i.e. T1=100% harvesting of roots without disturbance of parent disc, T2=20%, T3= 40%, T4=60% and T5= 80% harvesting of roots for *Asparagus racemosus*. The sample plots were laid out in Vasim, Belarbehra, Arjuni forest area in Sankara Forest Range, Dhamtari Forest Division, Tiriya, Machkote, Mohlai forest area in Bastar Forest Division and Bharosanga, Keochi forest area in Marwahi Forest Division for sustainable harvesting and regeneration studies of *Andrographis paniculata*, *Celastrus paniculata* and *Asparagus racemosus*, however, there were two sites i.e. Mohgoan forest area, Khairagarh Forest Division and Lellunga forest area, Dharmjaigarh Forest Division where sample plots were laid out for sustainable harvesting and regeneration studies of *Aegle marmelos*.

Sustainability for *Andrographis paniculata* and *Celastrus paniculata* with maximum productivity was found to be at 80% harvesting level and sustainability for *Asparagus racemosus* with maximum productivity was found to be at 60% harvesting level.

Project 17: Nursery technologies of mass multiplication of superior seedlings –Baividang, Sarpgandha, Chironjee, Arjun, Aonla and Bael in Chhattisgarh [099/TFRI/2005/Silvi-4 (CGMFD -11)]

Status: Literature for nursery technology of Sarpgandha, Chironjee, Arjuna, Aonla and Bael were collected from different sources. Seeds of these species collected from M.P. and Chhattisgarh were sown in the nursery of Silviculture Division, Tropical Forest Research Institute, Jabalpur. Germination of seeds was as per literature. The information of nursery technology of the species was documented and was submitted to M/s Federation of Minor Forest Produce, Chhattisgarh.

NEW PROJECTS INITIATED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Impact of pollutants on the growth of plants [115/TFRI-2007/Ecol-1 (8)/ 2007-09]

Status: The sites selected for the study are industrial areas of Raigarh, Chhattisgarh and Bhopal, Madhya Pradesh. More than 70 Sponge Iron Factories have been installed at Raigarh in last 20 years which do emit a lot of pollutants mainly in the forms of SO_2 , NO, NO_2 , N_2O_5 and Suspended Particulate Matters (SPM). SPM causes a huge loss to the vegetations. The factories are by default equipped with Electro-Static Precipitator (ESP) to precipitate the SPM, but found to be reluctant to use the ESP as they consume a lot of electricity. As a matter of fact, the factories do make their emission by late night to minimize the vigilance effect. Oxides of sulfur and nitrogen do form Acid Rain in atmosphere in reaction with water molecules. The average temperature got elevated in last 20 years; the average growth of the trees found to be stunted and deformed and the loss is higher after 0.5 to 1.0 km of the industry especially if there is barrier of hill and the plantation is on the foothill due to deposition effect in atmosphere.

Bhopal Industrial area at Mandideep includes the Lupin Pharmaceutical Factory and HEG Graphite Factory. A study in this area has just been started in the last quarter as a standard comparison scale to the results of Raigarh. The area is highly polluted too with an additional contribution of automobile exhausts. More than 12 species of tree are under study like *Tectona grandis*, *Gmelina arborea*, *Dendrocalamus strictus*, *Eucalyptus tereticornis*, *Dalbergia sissoo*, *Pongamia pinnata*, *Cassia siamea*, *Azadiracta indica*, *Embllica officinalis*, *Peltaforum ferrugina* and *Alstonia scholaris* etc. on a critical comparison with control data collected from least polluted areas. Physicochemical estimations in terms of pH, EC, organic matter, Available N, P, K, exchangeable cations (Na, K, Ca and Mg), CEC and biochemical estimations (Chlorophyll, Sugar, Ascorbic Acid and Phenol) of leaf and soil samples are on process.

Experiments have been made with the control set at the nursery of TFRI; seedlings of the tree species have been regularly subjected to Simulated Acid Rain (SAR) at pH 4.0 and 5.0. The soil has been treated with the SPM Slug collected from the industries. This is a model experiment which shall mimic the polluted condition and analyses of which along with growth data should tell us the magnitude of the loss or how much the plant is immune to pollution effects. The trend of laboratory analyses indicates that some tree species are moderately resistant to pollution when the others are vulnerable and sensitive.

Project 2: Chemical control of insect pests and diseases of *Buchanania lanzan* [114/TFRI-2007/Ento-2(17)]

Status: Survey was conducted at Batkakhapa (East Forest Division, Chhindwara), Padar (North Forest Division, Betul) M.P., Laripara (Forest Division, Bilaspur), Chichola (Forest Division, Rajnandgaon), C.G. and Mohghata (Forest Division, Bhandara), Dhadgaon (North Forest Division, Dhulia), M.S. for monitoring the insect pests and diseases. Incidence of stem borer, leaf gall forming



insect, defoliator, inflorescences sap sucker thrips and wilt and leaf blight diseases were recorded. Seven chemicals were tested against stem borer *Betousa stylophora* in natural stand of *B. lanzan*. Two fungicides were tested against wilt disease in nursery stage. Observations on mycoflora of storage seed were recorded.

Project 3: Screening of tropical forest tree species for their potential as carbon sink in Madhya Pradesh and Chhattisgarh [124/TFRI/2007/Ecol-2(9)]

Status: Surveyed and selected agroforestry systems in M.P. and Chhattisgarh with *Tectona grandis* and *Eucalyptus* hybrid as tree species and Wheat, Gram and Ashwagandha as agricultural crops. Regularly collected growth data of the selected species. Collected and analysed soil samples for organic carbon content. Developed agroforestry systems in TFRI campus with *Tectona grandis* as tree species and Wheat, Gram and Ashwagandha as agricultural crops.

Project 4: Application of growth promoting microbes and soil amendments to produce improved seedlings of forest trees [118/TFRI-2007/Patho-1(12)]

Status: Germplasm of growth promoting organisms were collected from Seoni, Bamandehi, Balaghat, Chhindwara and Tamia (M.P.). Different organic matter (leaves of sissoo, *Leucaena*, teak, grasses etc. were collected for conducting experiments. Sandal seeds of T-10 clone, FRC, Hyderabad obtained from IWS, Bangalore was sown in nursery beds for experiment. Seeds of *D. sissoo* were also collected locally for experiment. Fifteen growth promoting microbes were isolated from collected samples. Experiment on screening of growth promoting organisms for *D. sissoo* is in progress. Cultures of growth promoting organisms maintained in laboratory for further experimentation.

Project 5: Genetic variation for *in vitro* morphogenetic potential of *Dalbergia sissoo* Roxb. clones and evaluation of their field performance [117/TFRI-2007/Gen-1 9(13)]

Status: Four field visits were conducted for selection of promising individual and collection of planting materials was done from different progeny trials and mortality affected areas. The collected materials were treated with 100 ppm IAA overnight and planted in polythene bags for raising vegetative propagules. The vegetative propagules are being maintained in shadehouse/mist chamber. These propagules will be used for stock build up of clonal materials for *in vitro* propagation. The nodal segments of two clones were collected from newly coming branches of the propagules and sterilized with HgCl_2 for 304 minutes and inoculated on MS semi solid medium supplemented with $1\mu\text{M}$ BA. The newly coming microshoots were detached and transferred to MS semi solid medium and are being maintained as stock build for further experimentation.

EXTERNALLY AIDED PROJECTS

Project 1: Development of model for the management of white grubs in teak nursery, under the concept of Integrated Pest Management [113-2007/Ento-1(FDCM, MS)(16)]

Status: Monitoring of beetle emergence was made from the selected traps during the emergence period. Observations on field experiments were recorded. Beetles and their grubs were reared in

the laboratory in soil. Laboratory experiments were performed on effect of EPNs against white grubs. Observations were also recorded on the field experiment for evaluating EPNs against the grubs. Field-cum-lab experiments were laid out to evaluate six insecticides in range of concentrations against the beetles and their persistence in the field was evaluated. All the experiments were repeated minimum thrice to confirm the results. Rearing and feeding potential of a predator of white grubs was carried out in laboratory round the year. Maintenance of EPN culture was continued. Further work is in progress on development of model for the management of white grubs under the concept of IPM.

Project 2: Isolation, identification and evaluation of insecticidal phytochemicals from *Annona squamosa* L. (Annonaceae) against *Hyblaea puera* Cram and *Eutectona machaeralis* Walker, two major pests of teak (*Tectona grandis* Linn.) [122/2007/Ento-3(CSIR) (18)]

Status: Collection of plant material from the custard apple areas of Seoni, Chhapara and Behrai was done and prepared for initiating extraction process. The material was extracted in 5 organic solvents and water. Larvae of teak defoliator and teak skeletonizer were collected from teak plantation areas of Udaipur, Kalpi, Tikariya under Mandla Forest Division, Mandla for laboratory experiments and continuation of the laboratory rearing. The extracts in 5 organic solvents and water were subjected to bioassays for evaluating its biological activity for feeding inhibition and growth inhibitory activity against the larvae by leaf disc bioassay in laboratory. Bioassay directed separation of the fractions is in progress. For chemical analysis, the extracts were subjected to Thin Layer Chromatography, UV-Visual Spectroscopy, Infra Red Spectroscopy and Column Chromatography. Chemical analysis of compounds like PFT analysis was carried out by using analytical facilities available in other organizations in New Delhi. Further work in bioassay-directed separation is in progress.

Project 3: Studies on taxonomy of Braconid parasitoids (Hymenoptera: Braconidae) from central India [123/TFRI/2007/Ento-4 (CSIR)(19); 2007-10]

Status: Taxonomic survey of important forestry and adjoining agroforestry areas of Chhattisgarh, covering localities of districts Kawardha, Durg, Dhamtari, Kanker, Bastar, Dantewara, Raipur, Rajnand gaon, Koriya, Sarguja, Raigarh, Jashpur Nagar, Korba, Janjgeer Chanpa and Bilaspur were carried out for braconid collection. Over all 161 samples of insect fauna were collected by sweeping; out of which 576 braconids were sorted out and preserved. 110 samples of : leaf miners, defoliators, gall forming insects and larvae / pupae of insects were collected from *Pongamia pinnata*, *Dalbergia sissoo*, *Lagerstroemia parviflora*, *Butea monosperma*, *Syzygium cumuni*, *Ziziphus jujuba*, *Tectona grandis*, *Shorea robusta* and *Bambusa* sp. from different surveyed areas. By laboratory rearing of hosts/ insect pests, 3 species of *Apanteles* viz., *Apanteles tiracholae* emerged from the larvae of defoliator of *Lagerstroemia parviflora*; *Apanteles agilis* from leaf feeder of *Cassia* sp. and *Apanteles hyblaeae* emerged from blotch of *Pongamia pinnata* were recorded. As a whole twenty two species of braconids: *Alabagus stigma*, *Apanteles tiracholae*, *Apanteles agilis*, *Apanteles hyblaeae*, *Apanteles cajani*, *Chelonus deogiri*, *Chelonus gastrus*, *Cremnops desertor*, *Doryctobracon areolatus*, *Fopius arisanus*, *Helcon tardator*, *Hormius lamidae*, *Hormius orientalis*, *Meteorus dichomeridis*, *Parahormius absonus*, *Parahormius deiphobus*, *Parahormius jason*, *Parahormius stom*, *Parahormius*



zonus, *Phasmidiasta lia*, *Trioxys acalephae* and *Trioxys soporensis* were identified up to species level. *Parahormius longicarpus* sp.n. is being recorded as the species new to science.

Project 4: Studies on the natural enemies of teak pests, *Hyblaea puera* and *Eutectona machaeralis* and their role in suppressing the population of insects in Madhya Pradesh [127/TFRI/2008/Ento-1(MPCST) (20)]

Status: The project was initiated during January 2008. Nurseries were surveyed for teak leaf skeletonizer and diapausing larvae were collected. An unidentified ichneumonid parasite was obtained and preserved.

Project 5: Evaluation and prediction of oil bearing capacity of Sandal (*Santalum album* L.) germplasm using physio-morpho-molecular markers [120/TFRI/2007/ Gen-3/DSAE (15)]

Status: Two groups each of 30 trees of Sandal (*Santalum album*) were identified at TFRI campus and marked for conducting molecular and biochemical studies. Seven methods of DNA extraction were compared and that based on CTAB (Hexadecyl trimethyl ammonium bromide) was selected for extraction of DNA from leaves of sandal tree. Genomic DNA from leaves of Sandal trees was extracted. Twenty six Inter Simple Sequence Repeat (ISSR) primers were screened from 100 primers for amplification of genomic DNA of Sandal. Nitrate reductase and peroxidase activities in leaves of both groups of sandal trees in five replicates were measured and the data recorded.

Project 6: Development and use of Inter Simple Sequence Repeat (ISSR) markers for assessment of genetic diversity and DNA fingerprinting in *Gmelina arborea* Roxb. [121/TFRI-2007/Gen-2(CSIR)(14)]

Status: Ten natural populations of *Gmelina arborea* were collected from Andhra Pradesh, Assam, Karnataka and Kerala. Seedlings of the populations were raised and their individual identity maintained in the nursery. Four methods of DNA extraction were compared with the selection of Hexadecyl Trimethyl Ammonium Bromide (CTAB) protocol for extraction of genomic DNA free from impurities. Eighteen Inter Simple Sequence Repeat (ISSR) primers were screened from 100 primers for amplification of genomic DNA.

Project 7: Molecular characterization of *ex situ* conserved germplasm and identification of molecular markers associated with wood quality traits in *Tectona grandis* L.f. [125/TFRI/2007/Gen-4(DBT)(16)]

Status: Cuttings of >50 teak (*Tectona grandis*) plus trees and their ramets were collected from National Teak Germplasm Bank located at Chandrapur, Maharashtra. The cuttings were tagged for maintenance of their individual identities and planted in the polybags at the experimental area of Genetics and Plant Propagation Division for production of sprouts for DNA extraction and molecular marker studies. The data pertaining to sprouting pattern of teak plus trees were weekly recorded.

Project 8: Integrated development of bamboo for economic upliftment in central India [126/TFRI/2007/ (NBM)]

Sub-project (i) : Sustainable development of new Bamboo agroforestry techniques for increased income generation in the Central Indian States

Status: The project has been initiated.

Sub-project (ii): Bamboo species suitability for different degraded non-forest areas in Madhya Pradesh

Status: Geo-environmental survey and study of degraded lands were done at Dhuma, Damoh, Hoshangabad (Bagra), Bhopal (Ratapani), Katni (Kymore, SVIL Mines, Khitola) and Rewa (Sirmore). Data and samples were collected for nutrient study in the lab. The degraded lands are on Basalt and Sand stone as well as on Limestone. The water table is deep around 350' to 450'. The drainage is seasonal along shallow channels. The geomorphology varies from place to place, some areas belongs to rocky terrain with moderate slope whereas other areas belongs to plateau. The soil is generally shallow with dry to low moisture and nutrient content. To know the performance of bamboo on these degraded lands, the bamboo plantations of 2005-06, wherever located nearby to these degraded lands, have been studied for growth data and other details. To evaluate the nutrient status of the concerned soils, the samples are analysed in the lab.

Sub-project (iii): Insect and diseases of bamboo occurring in central India and their management

Status: Six localities of agro-climatic zones of M.P. and Chhattisgarh were visited and 22 samples of bamboos were collected. In all, two insect pests viz. sap sucker, *Ochrophara montana* and leaf feeder- *Cryptisia coclesalis* and 9 pathogenic fungi viz. *Desturella divina*, *Fusarium semitectum*, *Curvularia pallescens*, *Scytalidium vaccinii*, *Trichoderma viride*, *Paceilomyces varioti*, *Hymenochete patelliformis*, *Trichoderma atroviride* and *Trichoderma koningi*, identified. For the biological control of defoliator, multiplication of egg parasitoid, *Trichogramma raoi* was initiated in the laboratory. A field experiment was laid out at Korba in Chhattisgarh to prevent the attack of bamboo rhizome rot and fungal culm disease in *Dendrocalamus strictus*.

Sub-project (iv): Nutritive values and value addition of some bamboo species of central India

Status: Surveys were conducted to Madhya Pradesh and Chhattisgarh to select bamboo growing areas in the central India. The tribal communities of the region use young succulent shoots of various bamboo species as vegetable, pickles, salad, etc., from June to September every year. Collected bamboo shoots were analyzed for their nutritional and anti-nutritional parameters. Considering the market potentiality and suitability of young shoots, five species i.e., *Dendrocalamus strictus*, *Bamboosa bambos*, *Bamboosa nutans*, *Bamboosa tulda* and *Dendrocalamus asper* have been found as potential species.

TECHNOLOGY ASSESSED AND TRANSFERRED

1. Dust free collection and storage of mahua flowers were assessed and transferred to the user groups of Mandla, Dindori and Sidhi districts of Madhya Pradesh through trainings conducted at SFRI, Jabalpur and IIFM, Bhopal.
2. *B. nutans* and *B. tulda* micro-propagation technology ready to be transferred.
3. Sustainable harvesting limit of medicinal plants namely, Satawar, Kalmegh, Bael and Chironjee has been transferred to SFDs for onward application in the field.



EDUCATION AND TRAINING

1. Four training programmes on Nursery, plantation techniques, utilization and marketing of bamboos under Bamboo Technical Support Group of National Bamboo Mission for the farmers and field functionaries of SFDs of Gujrat, M.P. and Chhattisgarh State from November 2007 to February 2008.
2. One training on Management of production populations for the officials of M.P. Forest Department on 18th and 19th December 2007.
3. One training on Improving forest productivity through technological interventions for the field executives of Maharashtra Forest Department from 3rd to 7th March 2008.
4. The following officers imparted training: Drs. A.K. Mandal, A.K. Pandey, N. Berry, S. Agarawal, S.P. Tripathi, R.S. Pal, M. Kundu, K.K. Soni, R.K. Verma and K.C. Joshi.

LINKAGES AND COLLABORATION

National

- Developed linkages and collaboration with state forest departments, forest development corporations, universities, research institutes, NGOs in the region and Department of Science and Technology (DST), Department of Bio-technology (DBT), Council of Scientific and Industrial Research (CSIR), The Energy and Research Institute (TERI), New Delhi for implementation of research projects, field experimentation etc.

PUBLICATIONS

Brochures on medicinal plants including, Sarpagandha (*Rauvolfia serpentina*); Kalihari (*Gloriosa superba*); Kalmegh (*Andrographis paniculata*); Gudmar (*Gynema sylvestre*); Safed Siris (*Albizia procera*); Gamhar (*Gmelina arboria*) and Teak (*Tectona grandis*) and on agroforestry models on Paddy-babul; Bach- paddy and Agri-lac were published.

CONSULTANCIES

1. Evaluation of preservation plots for Maharashtra Forest Department, Nagpur during 2007-08 at a cost of Rs. 1.20 lakh.
2. Evaluation of Forest Department Agency (FDA) plantation of Madhya Pradesh during 2007-08 at a cost of Rs. 2.25 lakh.

PATENT

A patent has been granted entitled “A Protocol for Micropropagation of Bamboo from Explants” (Patent No. : 207870, date of Grant 29th June 2007).

CONFERENCE/MEETINGS/WORKSHOPS/SYMPOSIA/EXHIBITIONS

1. A National Symposium on Emerging Trends of Bio-inoculants in Forestry was organized jointly by Entomology and Pathology Division, TFRI on 26th and 27th April 2007.
2. National Workshop on Research Needs for Achanakmar-Amarkantak Biosphere Reserve organized by Entomology Division, TFRI on 30th April 2007.
3. A Workshop on Prioritisation of Research Areas for TFRI was organised 29th May 2007.
4. A regional Workshop on Forestry Statistics was organised on 17th October 2007.
5. A two days National Workshop on Sustainable Management of NTFPs was organized in collaboration with Regional Centre for Development Cooperation (RCDC) Bhubneswar on 18th and 19th January 2008 at Tropical Forest Research Institute, Jabalpur.
6. A National Conference on Bamboos : Management, Conservation, Value addition and Promotion was organized w.e.f. 12th to 14th March 2008.

AWARD

Dr. Nanita Berry was adjudged as the “Best Innovator” on the theme “grassroots initiatives for management and protection of natural resources” in India Development Market place 2007 competition organized by the World Bank held at New Delhi on 27th to 29th May 2007.

DISTINGUISHED VISITORS

1. Shri Brij Mohan Agrawal, Hon'ble Minister, Ministry of Forest and Environment Chhattisgarh State visited the institute on 9th October 2007 and interacted with the researchers.



Shri Brij Mohan Agrawal, Hon'ble Minister, Ministry of Forest and Environment Chhattisgarh State interacted with the researchers

2. Dr. D.N. Tiwari, Vice Chairman, State Planning Board Chhattisgarh visited this Institute on 13th March 2008 and interacted with the scientists and officers on various issues of National Bamboo Mission.



CENTRE FOR FORESTRY RESEARCH AND HUMAN RESOURCE DEVELOPMENT, CHHINDWARA

Centre for Forestry Research and Human Resource Development (CFRHRD), Chhindwara came into existence in March 1995. In January 1996 it was declared as Satellite Centre of Tropical Forest Research Institute (TFRI), Jabalpur under the Indian Council of Forestry Research and Education, Dehradun. The mandate of the Centre is to take up forestry research in the areas like Non-Wood Forest Produce, medicinal plants cultivation, nursery techniques. The centre has also been assigned mandate to develop human resource in forestry sector by imparting vocational training leading to poverty alleviation through self employment.

PROJECTS CONTINUED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Standardization of nursery technology and evaluation of various planting stocks of *Pterocarpus marsupium* [109/CFRHRD/2006-2(9)]

Status: Seeds of *Pterocarpus marsupium* collected and sown in polybags and root trainers of different sizes viz. 90, 150 and 250cc. with different proportions of soil : manure : sand (1:1:1, 1:0:1, 0:3:0, 1:2:0, 0:2:1 and 1:4:0) for assessing the germination. Experiments on effect of different dosages of chemical fertilizers were laid out in the nursery. The already laid out experiments on root trainer were maintained and data was recorded. Renovated older germination beds and seeds sown to study the germination variation and growth of *Pterocarpus marsupium* in different months of the year. Data on germination were collected and tabulated.

Experiments on effect of different doses i.e. 2, 4 and 6 gm of inorganic fertilizers on growth and development of 4 months old seedlings conducted. Urea, diammonium phosphate and murate of potash per plant was applied. Initially no effect of inorganic fertilizers on growth and development of seedlings was observed. Collected branch cuttings from mature tree in the month of February and March and experiment was laid out in mist chamber by treating the cuttings with different concentration of IBA 500, 1000, 1500 and 2000 ppm for 24 hours. Shoot formation was recorded but no root formation was observed. The experiment on root-shoot cuttings of *Pterocarpus marsupium* (bijasal) were laid out in mist chamber by treating with different concentration of IBA 100, 200, 300 and 400 ppm for 24 hours and 62, 76, 84 and 96% healthy plants were recorded.

Project 2: Studies on the seasonal variation in active chemical constituents of Hadjor, *Cissus quadrangularis* Linn. [108/CFRHRD/2006-1(8)]

Status: Fresh stem samples of *Cissus quadrangularis* Linn. were collected from the CFRHRD nursery, Chhindwara to study monthly variation in their active chemical constituents viz. total phytosterols and ascorbic acid content. Samples were also estimated for macro-elements (calcium, magnesium and potassium) and trace elements viz. copper, zinc, manganese and iron content. Soil samples collected from Bhopal, Jabalpur, Chhindwara (M.P.) and Akola (M.S.), where hadjor

growing, were analysed for pH, organic matter, organic carbon, nitrogen, phosphorus, available potassium and exchangeable calcium, magnesium, sodium and potassium. Active constituents viz. total phytosterols and ascorbic acid in *Cissus quadrangularis* fresh stem samples collected from Bhopal, Jabalpur, Piparia Chhindwara district (M.P.), Dabra (Janjgir Dist.), Raigarh (Chhattisgarh) and Akola and Nagpur (M.S.) were also analysed. Collection of *Cissus quadrangularis* were maintained. Further analysis work is under progress for confirmation of the results obtained.

EXTERNALLY AIDED PROJECT

Project 1: Field trial on agroforestry model in farmers field with medicinal trees and herbs in satpura plateau of Madhya Pradesh [110/CFRHRD/ 2006-3(NMPB)(10)]

Status: Seeds of *Moringa oleifera* (Munga) and *Emblica officinalis* (Aonla) were sown in polybags and of *Asparagus racemosus* (Satavar), *Andrographis paniculata* (Kalmegh), *Withania somnifera* (Ashwagandha) and *Rauvolfia serpentina* (Sarpagandha) in nursery beds. Maintained nursery of the above medicinal plants. Farmers from Kundalikala, Kundalikhurd, Sonagat and Umaria were contacted for establishing the agroforestry plantation of medicinal plants. Grafted plants of *Emblica officinalis* (Aonla) procured from Mansar nursery (M.S.) and distributed to the farmers including seedlings of *A. racemosus*, *R. serpentina* and *W. somnifera*. To make awareness among the people about the importance of medicinal plants and the cultivation of medicinal plants in their field and to get additional benefit both from top storey of medicinal plants and other agricultural crops one hundred people trained.

NEW PROJECTS INITIATED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Standardization of cultivation Protocol for *Asparagus racemosus* (Satavar) [119/CFRHRD/2007-2 (12)]

Status: Detailed literature survey on *Asparagus racemosus* (Satavar) were conducted. Site of open land was selected at TFRI, Jabalpur campus and near CFRHRD, Poama. Satavar tubers were collected from nearby places of Chhindwara including Tamia, Delakhari, Bichua and Betul.

Seeds were sown in nursery beds at 1.5×1.5 cm spacing. Farmyard manure and compost was applied. 70% germination was observed when the seeds were sown at the depth of 2 cm. Experiment was laid out to study the effect of different spacing viz. 45×45 , 60×45 , 60×60 and 45×30 cm and harvesting age of *Asparagus racemosus* on farmers field at Chhindwara and at Silviculture Nursery, TFRI, Jabalpur. Experiment was also laid out to study the effect of irrigation on growth of plants. The tubers from stress sites was found larger in size.

Soil testing of CFRHRD nursery, Chhindwara and farmers field was done. Maintained experimental plots. Data recorded on roots and growth of plants and samples of tubers collected for analysis.



Project 2: Genetic improvement of *Buchnania lanzan* [116/CFRHRD/2007- 1(11)]

Status: Survey carried out in Delakhari and Amarwada block of Chhindwara district, Madhya Pradesh. Selected 12 phenotypically superior candidate plus trees of *B. lanzan*. Out of 12 trees, seven were selected from Amarwada and five from Delakhari. Also preliminary survey has been conducted in Gondia and Shahada forest division of Maharashtra, and Kanker and Rajnandgaon forest division of Chhattisgarh for selection of phenotypically superior candidate plus trees of *B. lanzan*.

EDUCATION AND TRAINING

1. One day training programme on “Biofertilizer, Biopesticides and Agroforestry” was conducted at CFRHRD, Chhindwara on 2nd February 2008 for the farmers.
2. Centre conducted 10 training programmes. A total of 700 trainees participated in various training programmes. The target groups were SFD's, villagers, farmers, NGO's and herbal healers.

LINKAGES AND COLLABORATION

Linkages at national level were developed with State Forest Departments, Forest Development Corporation, Agriculture Research Station, Chhindwara for conducting research/training and Forest Survey of India, Nagpur for analysis of forest floor and soil samples.

AWARD

Shri H.S. Awasthi, Forester, CFRHRD, Chhindwara received award for his service on medicinal plants identification from World Wide Fund for Nature in October 2007.

RAIN FOREST RESEARCH INSTITUTE JORHAT

The Rain Forest Research Institute (RFRI), Jorhat, Assam, a constituent Institute of Indian Council of Forestry Research and Education (ICFRE), Dehradun (An autonomous Council) under Ministry of Environment and Forests, Govt. of India is mandated to cater the forestry related research needs of North-Eastern India. It has been pursuing research in the areas of shifting cultivation, ecology and biodiversity, propagation, cultivation and performance trial of important forest species, integrated management of pests and diseases, bio-prospecting of bio-resources, genetic improvement and biotechnology. The total human resource of the Institute is 132.

The Institute has an Advanced Research Centre for Bamboo and Rattan at Aizawl, Mizoram.

RFRI has a well stocked Library having a good collection of forestry and allied sciences related literature. RFRI is connected to other ICFRE Institutes through a Virtual Private Networking (VPN). A 256 Kbps internet service available through this network is also shared with all users at Institute level. Video phone and video conferencing services have also been commissioned recently. The RFRI is tuning its research, education, training and developmental efforts to contribute effectively to bring prosperity to the North-Eastern region.

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

	No. of projects completed in 2007-08	No. of ongoing projects in 2007-08	No. of projects initiated in 2007-08
Plan Projects	3	12	9
Externally Aided Projects	5	7	2
Total	8	19	11

PROJECTS COMPLETED DURING THE YEAR 2007–2008

PLAN PROJECTS

Project 1: Stability test of various clones and progenies for different characters in *Gmelina arborea* [RFRI/ TI-10/2003-06]

Findings: Progeny trial studies of selected families revealed better performance of progenies at Teliamura, Tripura (with 69% survival, 5.9 m height and 17.0 cm collar diameter) as compared to Imphal, Manipur (with 62% survival, height 3.4m and collar diameter 10.4 cm). Genetic and environment interaction was found significant at 0.001 level of significance both for height and



collar diameter. This shows that progenies differ significantly in their performance at these two different sites. Half-sib progenies of RRI/GA31 clone registered maximum germination per cent. The overall germination was recorded to be 26%. The tetrazolium test revealed 12 % partially viable and 1% non-viable seeds. Seeds of progeny number RFRI/GA/43 were found to be most (93%) viable compared to other progenies.

Project 2: Bioecological studies of seed insect pests of *Dipterocarpus retusus* [RFRI/FE-12/2005-08]

Findings: A total of 9 species with seven genera belong to the order Coleoptera and Lepidoptera was recorded as insect pests on the seeds of *D. retusus*. *Thamnurgides monoceros* Beeson (Coleoptera: Scolytidae) and *Enarmonia pulverulla* Meyrick (Lepidoptera: Tortricidae) were recorded 100% frequency, correspondingly the relative density was also recorded high values for *E. pulverulla* (38.68) followed by *T. monoceros* (25.79) during the survey periods. Damage loss of seeds due to seed insect pests of Dipterocarps was made. The percent insect infestation on seeds of *D. retusus* collected from forest floor ranges between 42.86 and 77.40%. However, only 37.5 to 58.18 % of insects' infestation was observed in aerial collection.

Project 3: Genetic improvement and clonal propagation of *Dipterocarpus retusus* [RFRI/TI-11/2004-07]

Findings: Among seventeen progenies and check planted in Seedling Seed Orchard (SSO) at RFRI campus the progenies DMP-9, DMP-2, and JKG-2 were found to be superior for traits viz. plant height (Ht), Diameter at Breast Height (DBH), height at first branching and Crown Diameter (CD). Under development of clonal propagation protocol 17-20% rooting was achieved in shoot cuttings of three genotypes of *D. retusus*. There is no report of rooting of the species. A follow up project on clonal propagation has been continued from 2007-10.

EXTERNALLY AIDED PROJECTS

Project 1: Conservation of productive land and promising flora of Majuli Island in Brahmaputra River [RFRI/EP-05/2003-08]

Findings: Planting of grasses with *Ipomea* spp. were found to be effective in checking sand deposition on productive lands. Banana also performed better with grasses. High density planting of flood tolerant nitrogen fixing leguminous species *Sesbania sesban* during May-June (Flood time) was found to enrich soil fertility status and its harvesting in October- November provided fuel wood and fibre for local use. Thereafter, farmers were advised to cultivate mustard, potato, vegetables and other crops to utilize the land resources properly. These reclaimed areas have shown very encouraging results when put under different agroforestry models. The local people have very much appreciated and adopted the method for replication in other nearby areas.

Project 2: Control of soil and river bank erosion in Majuli through bamboo based vegetative embankment [RFRI/EP-08/2004-07]

Findings: Zero zone plantation of *Ipomea* spp. and grasses gave good results in arresting soils from surface erosion. Bamboo mats provided shelter to sandy soil. First zone plantations of *Bambusa nana*, *Dalbergia sissoo*, *Bombax ceiba* and second zone plantation of *Bambusa bambos*, *B. nutans*, *B. tulda* and *Dendrocalamus hamiltonii* showed good performance. Bamboo treatment unit provided to Bamboo Co-operative Society, Majuli had motivated local people to a great extent and more than one hundred seventy people have used this facility.

Project 3: Study of the current market prices of timber in Nagaland [RFRI/EP-17/ 2007-08]

Findings: Current market price of different timbers was collected from Tizit, Mokokchang and Dimapur (Nagaland) timber markets and submitted to Resource Survey and Management Division, Forest Research Institute (FRI), Dehradun for further processing.

Project 4: Improvement of infrastructure facilities in Botanical Garden /Centres of *ex-situ* conservation at, Rain Forest Research Institute Jorhat, Assam [RFRI/EP/09/2003-06]

Findings: Introduced as many as 7 species each of bamboo and Rattan, more than 39 of orchid species, 24 commercially important tree species and 12 species of endangered and rare plants of North-East India in the botanical garden at RFRI campus.



Orchids in shade house



General view of RFRI Botanical garden

Project 5: Augmentation of entomopathogenic fungi for the management of *Calopepla leayana* on *Gmelina arborea*: an eco-friendly approach [RFRI/EP-10/2005-07]

Findings: Population dynamics of *Calopepla leayana* was monitored in the study areas. The population trends were correlated with abiotic factors (temperature, relative humidity, and rain fall) of the study site, which exhibited a significant dependence on the abiotic factors such as temperature, relative humidity, and rain fall. Regression equation was also arrived to predict population of *C. leayana* based on abiotic factors. Entomopathogenic fungi viz., *Beauveria bassiana* and *Metarhizium anisopliae* were isolated and identified as natural enemies of *Calopepla leayana* from different insect groups. It was found that both the fungi were effective against both larval and adult stages of *C. leayana*. Mass production of *B. bassiana* using different substrates was tried to harvest ample amount of spores. Bakery waste/desolate bread was identified as one of the suitable substrates for the mass production of *B. bassiana*. 72-93% mortality of targeted insect was observed in field condition. Isolates of *B. bassiana* was harmless to silkworm and all of them attained healthy pupa (cocoon).



PROJECTS ONGOING DURING THE YEAR 2007–2008

PLAN PROJECTS

Project 1: Development of Patchouli based viable agroforestry models for North-East region of India [RFRI/CFE-04/2005-08]

Status: Based on the ideas generated in reference to better management, through interactions with the farmers, the participating farmers were facilitated for implementation of on-farm experimentation. As observed and also reported by the farmers, weed management in patchouli is a major factor affecting the economics at higher degree. Trials on mulching of leaves of bamboos, areca nut, neem and paddy straw separately to compare their response to discourage weed growth. Paddy straw was found to be the effective material to suppress weeds and after decomposition, facilitates the patchouli branches to penetrate into the ground for better survival and growth.

Organized farmer visits to the on-farm trials for demonstration of the patchouli agroforestry practices. The willing farmers were registered for attending the training programme organized at two different sites. Training was imparted through lectures by the experts and technical know how was also provided by organizing practical sessions during field visits. The local entrepreneurs were also invited in the program to facilitate liaisoning with the farmers. The farmers were assured 30 % higher price by these entrepreneurs for the raw material (dry leaves) to be supplied to their industries with a purchase guarantee.

Under the technical guidance of RFRI, the farmers have already started growing patchouli in their tree gardens. Primary observations reveal that the practice will be highly beneficial on sustainable basis.

Project 2: Evaluation of different existing land use systems for development of viable economic models in North-East India [RFRI/ SC-06/2003-08]

Status: The activity calendar depicting schedule of different management practices pertaining to various Land Use Systems (LUSs) identified at different jhum areas in Assam, Nagaland and Meghalaya have been prepared and analyzed for their Benefit Cost Ratios. In Assam, *Trichosanthes dioca* cultivation (3.75) followed by *Anona comosus* plantation (3.23) is found to be the potential LUSs among other in the list, whereas in Meghalaya *Citrus* sp. plantation (6.09) followed by *A. comosus* plantation (4.8) as well accepted LUSs because of its prospective characteristics. The data collected from various LUSs in Nagaland revealed the *Areca catechu* plantation (11.4) followed by *Musa paradisiaca* plantation (10.78) as highly sustainable LUSs among other in the list.

Project 3: Development of nursery practices for production of quality planting stock of Bamboo in North-East region [RFRI/SM-06/2005-08]

Status: Observations on survival and growth parameters on bamboo seedlings raised in polybags with different media combinations were recorded and data analyzed. Among the substrate media, sand, soil, FYM and vermicasting (cultured) were found to be the best media combination. The bamboo seedlings were planted in the field and observation are being taken to evaluate their performance.

Project 4: Management of *Bambusa nutans* for enhancing the productivity of marketable culms through silvicultural practices [RFRI/ TI-13/2005-08]

Status: Necessary field works related to the project have been completed. The data generated has been analyzed and final report preparation is in progress.

Project 5: Comparative studies on natural resistance of bamboos to biodegradation in Assam [RFRI/FP-08/2005-08]

Status: Data on the effect of biodegradation of eleven bamboo species of north-eastern India are being collected from three different experimental sites located at RFRI campus, Jorhat; Salna in Nagaon District and Burnihat in Kamrup District.

Project 6: The potential role of bamboo species with reference to carbon sequestration in Assam and Mizoram [RFRI/EE-07/2005-08]

Status: Biomass estimation of 3 age groups (1, 2 and 3 years) of *Bambusa tulda* and *Dendrocalamus hamiltonii* was done in selected locations at Assam and Mizoram. Data on clump dynamics, above and below ground (woody), biomass production was recorded for carbon sequestration potential of bamboo species under study. The dry biomass was recorded to be 50% of the fresh weight in *D. hamiltonii* and was found to be fluctuating in *B. tulda*.

Project 7: Diversity and dynamics of arbuscular mycorrhizal fungi and their influence on biomass production of some medicinal and aromatic plants of Assam [RFRI/FP-10/2005-08]

Status: The plant samples (medicinal and aromatic plants) were collected from Sivasagar, Kamrup, Nalbari and Barpeta districts of Assam and analyzed for mycorrhizal association. Mycorrhizal spores were isolated from the collected samples and quantified (root infection percentage). It was found that AM fungi infect the plants with varying degree.

Project 8: Studies on structural formation of vegetation for the conservation of Biodiversity in Gibbon Wildlife Sanctuary Assam [RFRI/SC-08/2005-08]

Status: Ecological enumerations of vegetation were carried out and classified into three major plant communities. Total of 219 plant species were enumerated from the forest (91 tree species, 18 shrub species, 74 herb species and 36 species of climber/ scandant shrub). Dicotyledons comprised 177 species, amongst them family Euphorbiaceae, Lauraceae and Moraceae maintained highest position that occupied similar number of species in upper canopy level. Total 32 targeted species were recorded such as *Artocarpus chaplasha*, *Castanopsis indica*, *Ficus* sp. and *Dysoxylum procerum* etc. Diversity and phenological observation of targeted species were carried out. Due to biotic disturbances; the accessibility of gibbons to these food plants has decreased in the disturbed sites.

Project 9: Investigation on the formation of agarwood in *Aquillaria malaccensis* Lamk. [RFRI/FP-11/2006-09]

Status: Keys for field identification of infected agar trees have been developed. Dominant fungi were isolated and maintained as pure cultures for artificial inoculation. Larvae of borer, *Zeuzera conferia* Walker were collected from infected agar trees for artificial inoculation. Artificial inoculations of agar trees were carried out at selected sites and periodical observations were made for agar formation.

**Project 10: Investigation on propagation and cultivation of selected rattan species [RFRI/EE-10/2006-09]**

Status: Survey and collection of planting materials of rattans has been completed. Nursery of selected rattan species has been raised and plantation in 2.5 ha area has been established for further investigations.

Project 11: Improvement of degraded shifting cultivation lands through introduction of *Thysanolaena maxima* (Broom Grass) along with *Cajanas cajan* as N₂ fixing plant [RFRI/SC-09/2006-09]

Status: Plantation of *Thysanolaena maxima* (Broom Grass) was successfully done along with *Cajanas cajan* (Arhar) in degraded shifting cultivation areas of Assam. Soil samples from the experimental plots were collected at different stages and analyzed. Growth data were recorded at regular intervals and yield analysis were done at harvesting stage of Broom Grass. Soil fertility and productivity were found to be better when *Thysanolaena maxima* (Broom Grass) was planted with *Cajanas cajan* than *Thysanolaena maxima* as sole crop.

Project 12: Standardization of nursery practices of *Bambusa pallida* [RFRI/SM-07/2006-08]

Status: Two node culm cuttings of 15 different clones of *Bambusa pallida* were collected from the RFRI Gene bank. Culm cuttings were treated with IBA solution and planted in the raised nursery beds prepared by mixing sand, soil and FYM (1:1:1) along with control. The cuttings were irrigated regularly. Macro proliferation was carried out after 5 or 6 months, when rhizome and shoots from the nodes of the cuttings develop properly. Data on survival and growth parameters was recorded at regular interval.

EXTERNALLY AIDED PROJECTS

Project 1: Validation, testing and locational trial of micro/macro propagated planting stock of selected bamboo species in North-East India [RFRI/EP-08/ 2004-07]

Status: Maintained liaison with Nodal Officers of all the 8 Field Implementing Agencies (FIAs) of North-East States, TERI (Collaborating Organization) and NMBA (Supporting Agency). Expedited the supply of 24000 tissue culture plants of target Bamboo species from Growmore Biotech, Hosur to HPC Jagi Road and hardened plants to all the implementing states. Expedited establishment of Demo and Experimental Trail plantations of target *Bamboo* spp. covering 70 ha area out of the total target 160 ha in different North-East States. Technical support and guidance shall be extended to these FIAs for execution of plantation maintenance. Monitored the trail plantations established in different North-East States and recorded data as per monitoring and data recording schedule. Growth and performance of *B. balcooa* (Tissue cultured plants) is found to be much better than other two species at all the 8 sites. At the two sites of Assam and Arunachal Pradesh, *B. balcooa* is performing better than *B. nutans* and *D. hamiltonii*. At the sites of Arunachal Pradesh, Mizoram and Tripura, *B. balcooa* showed maximum culm height followed by *D. hamiltonii* whereas number of culm is higher in *D. hamiltonii* as compared to *B. balcooa*. *B. nutans* is also showing good results. In Nagaland, performance of *B. balcooa* and *D. hamiltonii* are at par. One and half year old plants

of the two species have attained height of 5-8 m and no. of culms 15-18 per clump. In Manipur, due to long dry spell during the growth period growth of plants becomes stunted. *B. balcooa* (Tissue cultured plants) showing better result than other species. Under experimental trial, the fertilizer combination FYM-NPK has been found to be producing better results as compared to other treatments.

Project 2: Sustained capacity enhancement of economically backward scheduled tribes of North-East Region through composite R & D technologies [RFRI/EP-11/2006-09]

Status: An intercropping trial of *Cajanus cajan* (Arhar) in between the rows of Bamboo - *G. arborea* plantation has been established in 3 ha area and ginger and turmeric in 1.5 ha in mixed plantation of bamboo and *G. arborea*. A training has also been organized for skill development of 5 artisan at Cane and Bamboo Technology Centre, Guwahati, Assam.

Project 3: Biological control of *Mimosa invisa*, a destructive alien weed threatening Kaziranga National Park (grasslands) [RFRI/EP-12/2006-09]

Status: Laboratory studies of collected biological agents were done. Survey of various *Mimosa* infested areas was done for association of bio-agents. Pot culture experiment was conducted to test the efficacy of the isolated fungi against *Mimosa*.

Project 4: Genetic improvement and conservation of genetic resources of some economically more important bamboo species of North-eastern India [RFRI/EP-13/2006-09]

Status: Bamboo growing areas in Deomali, Jeyrampur, Chessa and Itanagar area of Arunachal Pradesh, Sibsagar, Tinsukia, Titabor, Borhola, Makum, Doomdoo, Jeypur, Borhat, Digboi, Sonari Nalbari and Borpeta area of Assam, Amarapur and Kanchanpur area of Tripura, Garo Hills area of Meghalaya and Imphal, Thoubal, Bishnupur, Noney areas of Manipur have been surveyed and superior clumps of target bamboo spp. selected. Statistical Design and operational Guideline for Gene Bank to be established at the two sites have been prepared. *M. baccifera* growing area situated in Assam (Jorhat, Tinsukia, Sibsagar, North Cachar hill, Hailakandi and Silchar districts), Manipur (Imphal west and East and Tmenglong districts), Meghalaya (East, West Garo hills and west Jaintia Hills districts), Mizoram (Aizawl, Mamit, Thenzawl, Kolasib and Champhai districts), and Tripura (South, West, and North Tripura districts) surveyed and germplasm selected by using random sampling method. Seeds were collected as half sib progenies of selected individual bamboo culms. Clonal materials from the selected CPCs of bamboo have been collected from the surveyed area brought to RFRI. These clones have been multiplied and conserved in Gene Bank. Monitoring of survival, growth and performance of species cum clonal trial plantations established at all the 6 sites in different north-east states have been carried out and observation/data have been recorded. In general, performance trial plantation is better in Tripura. Nagaland and Assam (Kamrup) sites as compared to Hailakandi site of Assam and Aizawl sadar and Virengte sites of Mizoram. Among the species, survival of *B. balcooa* found to be highest at all the sites followed by *D. hamiltonii*. Overall growth found to be the best in Tripura (Teliamin) followed by Nagaland (Jalukie) and Assam (Kamrup). Among all species most vigorous growth was observed in *Bambusa balcooa* at all sites. Analysis and detailed interpretation of data is continued. Gene Bank plantation and conservation



trial of *M. baccifera* established in RFRI campus have been maintained. Weeding and cleaning were undertaken at regular interval. Three sites have been selected for field trial of *M. baccifera* for the purpose of conservation staggered flowering germplasms from various year seed produced. Staggering trial plantation of *M. baccifera* established on permanent plots in RFRI campus. Hundred per cent survival in all blocks of plantation raised from seeds collected in four different years has been recorded. A new block has been prepared for 2008 flowering, seeds of which are being collected. Observation for incidence of diseases, insects and pests were recorded in bamboo nursery at RFRI. No infection of insect was observed in any seedling stock of muli bamboo (*M. baccifera*). Few leaves were found brightened which subsequently defoliated. No termite infestation recorded in all targeted species. On-site meeting were organized with Nodal officers and his supporting officials of concerned Forest Divisions associated with species-cum-clonal trial at their respective sites for technical guidance and discussion on planting operation, management practices and monitoring and observations as per operational guidelines.

Project 5: Biodiversity studies of Orthoptera in Kaziranga National Park, Assam [RFRI/EP-14/2006-09]

Status: A total of 36 species of Orthoptera belonging to 30 genera, and 4 families were recorded in different habitats viz., forestlands, savannahs and grasslands of Kaziranga National Park (KNP). Host range studies of commonly available orthopteran species such as *Xenocatantops humilis* (Serv.), *Phlaeoba infumata* Brun. and *Conocephalus maculatus* (Le Gouillon), revealed that they feed on a few monocot plants. Observations revealed that most of them are herbivores, of which *C. maculatus* is carnivorous in habit. Population dynamics of Orthopteran species was monitored on different vegetation type forestland, grass land and savannahs. The population trends were correlated with abiotic factors of KNP which exhibited a significant dependence on the abiotic factors.

Project 6: Establishment of a network to facilitate collection, processing and dissemination of statistics pertaining to tropical timber and other forestry parameters in India [RFRI/EP-16/2006-08]

Status: Data on Forestry Statistics from North-Eastern States was collected for the year 2004-05 and 2005-06 from Assam, Meghalaya, Mizoram, Tripura, Nagaland and Arunachal Pradesh except Manipur and for the year 2006-07 from Sikkim and submitted to Directorate of Extension, Division of Statistics, ICFRE Dehradun.

Project 7: Mapping and quantitative assessment of geographic distribution and population status of plant resources of Eastern Himalayan region [RFRI/EF-15/2006-09]

Status: Standardization of methodology and reconnaissance survey of the study area (i.e. the nine districts of Upper Assam region) has been completed. Survey and sampling of about 40 (forty) numbers of sampling grid (of 3.75' x 3.75' size) have been completed. Data entry for these sampling grids has been completed. Integration of these spatial and attribute information in GIS environment is in progress. Plant specimen collection, preservation and maintenance of Herbarium sheets are in progress.

NEW PROJECTS INITIATED DURING THE YEAR 2007–2008

PLAN PROJECTS

Project 1: Improvement of agar/agarwood production in *Aquilaria malaccensis* [RFRI/BG-20/2007-10]

Sub-project 1a: *In vitro* induction of essential oil components of *Aquilaria malaccensis* [RFRI/BG-20-I/2007-10]

Status: A callus inducing medium has been standardized for leaf explants of *Aquilaria malaccensis*. Friable callus was transferred to liquid medium and cell growth observed in suspension.



Callus from leaf

Sub-project 1b: Survey and selection of desirable genotypes of *Aquilaria malaccensis* and establishment of their field genebank [RFRI/BG-20-II/2007-10]

Status: Survey for infected agar trees at Golaghat (Naharoni), Nagaon (Hojai) and Sibsagar (Amguri and Namti) districts of Assam State has been completed. A total of 26 infected agar trees were selected and branch cuttings were collected for rooting trial. Seeds were also collected from selected trees and tested for their germination potential. Nursery was raised to establish Seedling Seed Orchard (SSO) at RFRI campus.

Sub-project 1c: Clonal multiplication of *Aquilaria malaccensis* through *in vitro* culture including hardening and out planting [RFRI/BG-20-III/2007-10]

Status: Direct shoot regeneration was observed from node explants in three different media concentrations. Experiments continued for standardization of optimal shoot regeneration media. Callus regeneration was achieved for somatic embryogenesis.



Leaf callus regeneration for somatic embryogenesis

Sub-project 1d: Evaluation of insecticidal properties of some plants extracts against *Heortia vitessoides* Moore (Lep. Pyralidae) a major pest of *Aquilaria malaccensis* [RFRI/BG-20-IV/2007-10]

Status: Plant samples of *Azadirachta indica*, *Melia azadirach*, *Adhatoda vesica*, *Clerodendron viscosum* and *Acorus calamus* were collected and extracts prepared for bioassay test. Data collection on population dynamics of *H. vitessoides* from three selected sites at monthly interval is in progress.



Project 2: Documentation of baseline information and restoration of selected stress sites under shifting cultivation through agroforestry in North-East India [RFRI/ SC-11/2007-10]

Sub-project I: Documentation of baseline information on shifting cultivation in North-East India

Sub-project II: Restoration of jhum land through intercropping *Rhizobium* inoculated legume trees with agricultural crops in Assam

Status:

Sub-project I: Collection (1st phase) of available literature on shifting cultivation (viz. area under shifting cultivation, number and distribution of jhumia tribal communities, land tenure systems, traditional institutions and customary laws, existing shifting cultivation practices, social and cultural life of major jhumia communities and, their socio-economic status and indigenous knowledge associated with shifting cultivation) has been completed from study area (7 North-East States). Analysis for trends/dynamics in shifting cultivation has been completed. Compilation of information is in progress. Schedules/questionnaires for field data collection on existing shifting cultivation practices and socio-economic survey have been developed and tested in the field. Survey for selection of sites in study area (7 North-East States) has been completed. A total of 14 sites have been selected representing 12 major Jhumia tribal communities. Baseline survey for existing shifting cultivation practices (viz. activity calendar, tree-crop combinations, cropping schedule, cultural operations, harvesting methods schedules and uses) and socio-economic status of selected Jhumia communities is in progress.

Sub-project II: Selection of sites for agroforestry trial and appraisal for tree-crop combinations has been completed. Two experimental sites have been selected at Phumen Ingti village (Rongmongwae Block) and Asot Teron village (Nilip Block) in Karbi Anglong district of Assam for establishment of agroforestry trial. Two leguminous tree species (viz. *Albizia lucida* and *Indigofera erecta*) have been selected as tree component and hill paddy as crop component. *Rhizobium* strains have been isolated from the tree species under study and pure culture maintained. Five *Rhizobium* strains of *Albizia* and four *Rhizobium* strains of *Indigofera* have been found to be highly effective in screening studies. Nursery has been raised for *Rhizobium* inoculated and control seedlings of both the species under study for field plantation.

Project 3: Establishment of GIS laboratory for systematic creation, management and upgradation of GIS based forest-database of North-East India [RFRI/EE-13/2007-10]

Status: Collection of available spatial and non-spatial literature for North-East India has been completed. A total of 330 Survey of India Topographic sheets have been procured, scanned and geometrically rectified using appropriate projection parameters. The vector layer digitization of roads, drainage systems, habitats etc has already been completed. Digitization of protected area network (National Parks, Wild Life Sanctuaries, Reserved Forests etc) of North-East India is in progress. Soil Maps (10 nos.) of the entire North-East India have been procured, scanned and geometrically corrected. Digitization is in Progress. Training on Arc-GIS and ERDAS software packages have been completed as a part of Liveware (manpower) development at RFRI.

Project 4: Genetic improvement of *Acacia mangium* for growth characteristics, pulp and timber quality [RFRI/BG-15/2007-10]

Status: Sixteen Candidate Plus Trees (CPTs) of *Acacia mangium* have been selected from six provenances. Out of sixteen candidates plus trees, seven have been selected for progeny trial. Nursery has been raised from seeds of selected CPTs progeny trial. Vegetative propagation through cuttings has been also tried but with little success.

Project 5: Development of an efficient technique for *in-vitro* clonal propagation of superior or clone of *Bambusa tulda* [RFRI/BG-17/2007-10]

Status: An efficient shoot multiplication medium for superior clones of *Bambusa tulda* has been standardized. Experiments for standardization of rooting medium are in progress.



Multiple shoot proliferation in *B. tulda*

Project 6: Macro and micro propagation of selected germplasm (clones) of *Dipterocarpus retusus* Bl. (Syn *D. macrocarpus*) [RFRI/BG-21/ 2007-10]

Status: Axillary bud and shoot tip regeneration has been observed in rooting trial of shoot cuttings from 12 genotypes of *D. retusus* in green house conditions. Basal media for regeneration has been standardized and standardization of optimal media is in progress.



Growing shoot tip of *D. retusus*



Growing axillary buds of *D. retusus*



Project 7: Assessment of Rattan diversity and conservation strategy with reference to Assam [RFRI/EE-12/2007-10]

Status: Survey, collection and population studies of selected Rattans has been carried out in three protected areas i.e. Nambor-Doigrung Wildlife Sanctuary, Gibbon Wildlife Sanctuary and Kaziranga National Park in Assam state. Herbarium samples of six *Calamus* species have been collected and identified. The population of *C. nambareinsis*, *C. latifolius*, *C. gracilis* and *C. erectus* has been found to be depleting alarmingly in the study areas. Nursery of *Calamus latifolius* and *C. flagellum* has also been raised at RFRI campus.



Rattan Nursery

Project 8: Standardization of harvesting and post harvesting methods for optimum yield of therapeutic ingredients of *Phyllanthus niruri* Hook. [RFRI/BIK-01/2007-10]

Status: Survey of forest areas of Assam for natural distribution of target species has been completed. Experiments for standardization of growth stages for harvesting and post harvesting storage has been completed. Second phase of experiment is under progress.

Project 9: Study of reproductive biology and seed production in clonal seed orchard of *Gmelina arborea* [RFRI/BG-22/2007-10]

Status: Observations on floral phenology of 20 clones of *Gmelina arborea* have been recorded at plant and inflorescence level with reference to day-to-day flowering pattern. Exclusion studies have been carried out to assess the success of a class or classes of visitors in pollinating different clones of *Gmelina arborea*. Flower buds collected, fixed and preserved for further studies.

EXTERNALLY AIDED PROJECTS

Project 1: On-farm innovation in macro-proliferation techniques and preparation of commercial plantation of edible bamboo shoot [RFRI/EP-18/2008-10]

Status: Selection of sites for establishment of demonstration plots for edible shoot production has been completed. Two sites at Rongbong Ghat and Deoither villages under Nilip block of Karbi Anglong District, Assam have been selected and SHGs constituted in each village. A training programme has been organized to selected SHG members on bamboo macro-proliferation technique for mass multiplication. Mother planting material of *Bambusa balcooa* has been procured.

Project 2: Sustainable Development of quality bamboo resource for employment generation and socio economic development in North-East India [RFRI/EP-19/2008-11]

Sub-project I: Development of suitable agroforestry models for promoting bamboo cultivation outside forests in North-East region.

Sub-project II: Development of clump management practices for economically important bamboo species for enhanced production of quality culm and edible shoots.

Status:

Sub-project I: Seven sites have been selected after an extensive survey and discussion with the local SFDs authorities in Arunachal Pradesh, Assam and Nagaland. Preparations of land at four places have already been completed. Layout designs for two sites have already been finalized. Appraisals for potential and suitable crop components have been conducted at four sites.

Sub-project II: Initiated site selection process in three locations in Assam.

EDUCATION AND TRAINING

Education

Dr. Anoop Kumar Sarkar, Research Officer, Biotechnology and Genetic Division, RFRI, Jorhat, Assam was awarded Ph.D. Degree from Rani Durgawati University, Jabalpur, M.P. on September 2007.

Trainings Organized

1. Fifty days Industrial Training of Pre-Final Year B.Sc. students of North-East Regional Institute of Science and Technology (NERIST), Arunachal Pradesh was organized from 28th May 2007 to 16th July 2007.
2. A training programme on Creation of Bamboo Nursery and Commercial Cultivation of Bamboo to the representatives of Dholla Tea Estate, Tinsukia (Assam) was organized on 24th July 2007.
3. A farmer's training programme was organized on Scientific Management of Bamboos in Nursery, Plantation and Storage on 19th September 2007 under DST sponsored project.
4. A two days training programme on Bamboo Propagation and Cultivation for Range Officers of Forest Corporation, Govt. of Bhutan was organized on 24th November 2007.
5. A training programme was organized on Bamboo Cultivation and Management to officials from State Forest Department Nagaland and Joint Forest Management Council members on 28th to 30th January 2008.
6. A training programme was organized for Bamboo Cultivation and Management to officials from State Forest Department of Assam on 6th to 8th February 2008.
7. Two on-site Farmers' Training programmes were organized to 60 jhumia farmer on Awareness generation for promotion of viable land use system in jhum land were organized at Kakochang village (7th March 2008) and Men Teron village (10th March 2008) of Karbi Anglong, Assam.
8. Two on-site training programmes were organized to 90 farmers for extension of Patchouli based agroforestry practices at Koliabor (8th March 2008) and Biswanath Chariali (14th March 2008).
9. One on-site Farmers' Training on Vermi-composting was organized at Kakojan village of Karbi-Anglong District Assam.

LINKAGES AND COLLABORATION

The linkages were established with State Forest Departments of all north-eastern states, Central/ State Universities, other research organizations, NMBA, MoEF, NBM, NABARD, DBT, NEC and NGOs working in the field of forestry and forestry research. Multilocal trials of 3 bamboo species and clonal trials of 6 Bamboo species are being conducted in association with SFDs.



CONSULTANCIES

1. Consultancy awarded by Director General, Archaeological Survey of India, Govt. of India, New Delhi for preparation of report on "Biodiversity and Vegetation Pattern of the "Majuli Island" for compilation of the nomination dossier in respect of "Majuli Island for its World Heritage status".
2. Successfully completed the consultancy on Mid-term Evaluation of National Afforestation Programme of all seven North-East States sponsored by National Afforestation and Eco-development Board (NAEB), Ministry of Environment and Forests (Govt. of India) i.e. Assam, Arunachal Pradesh, Meghalaya, Mizoram, Manipur, Nagaland and Tripura.

CONFERENCE/MEETINGS/WORKSHOPS/SYMPOSIA/EXHIBITIONS

1. On-site Interactive Meetings were organized on Species-cum-Clonal Trail of Bamboo at Hailakandi (Assam) on 23rd July 2007 at Aizawl (Mizoram) on 25th July 2007; at Virengte (Mizoram) on 27th July 2007 and at Teliamura on 28th July 2007 for Nodal Officers and officials of Field Executing Agencies of the respective States.
2. A two days Expert Consultation Workshop on Shifting Cultivation was organized on 1st and 2nd August 2007.
3. The Project Formulation Meeting for All India Co-ordinated Project on Bamboo was organized on 22nd November 2007.
4. The Stakeholder's Meeting was organized on 26th November 2007.
5. Research Advisory Group (RAG) Meeting was organized at Rain Forest Research Institute, Jorhat (Assam) on 27th and 28th November 2007.
6. Regional Workshop on Forestry Statistics in India was organized on 11th December 2007.
7. A two days Regional Workshop on Bamboo Flowering: Status and Management Strategies was organized on 21st and 22nd February 2008 at RFRI campus.

DISTINGUISHED VISITORS

1. Dr. M. Islam, Professor of Life Science, Dibrugarh University visited RFRI, Jorhat during June 2007.
2. Shri Tarun Gogoi, Hon'ble Chief Minister of Assam visited RFRI on 7th February 2008.



Shri Tarun Gogoi, Hon'ble Chief Minister of Assam visiting RFRI Jorhat

3. Dr. Keshav Rao, Air Commandant, 5 Air Force, Jorhat, Assam visited RFRI on 19th March 2007.

MISCELLANEOUS

1. Adopted Model Village Koliapani in Teok Block of Jorhat District (Assam) and extending technologies to villagers.
2. Van Vigyan Kendras have been established in six states of North-East India.

ADVANCED RESEARCH CENTRE FOR BAMBOO AND RATTANS, AIZAWL

The Advanced Research Centre for Bamboo and Rattans (ARCBR) at Aizawl formally started in November 2004 as a unit of RFRI under ICFRE is in the establishment stage. The office of the Centre is presently running in a hired building located at Kulikawn, Aizawl. However, the building construction including office-cum-research complex, residential quarters and farmers' hostel, etc. are being done by CPWD at Bethlehem Vengthlang, Aizawl.

For establishment of Field Experimental Station, about 100 ha area was selected at Khamrang (Kawnpui) under Kolasib Forest Division and proposal for allotment was submitted to the Govt. of Mizoram through State Forest Department. The proposal has been approved recently by the Cabinet of Mizoram State and the handing/taking over formalities will be completed shortly.

RESEARCH

Following research components of some externally aided projects of RFRI have been implemented by ARCBR in Mizoram state:

1. Validation of Micro-propagated Bamboo through Multi-locational Trial

With the objective to test and validate the field performance of micro-propagated bamboo, locational trial and demo plantation of *in-vitro* propagated plants of three commercially important bamboo species viz., *Bambusa balcooa*, *B. nutans* and *Dandrocalamus hemiltonii* have been laid out at Tuiral, under Aizawl Forest Division covering 20 ha area under the DBT sponsored project.

2. Selection of superior clones of Bamboo for restocking of flowered area

Evaluation trials of clonal materials collected from selected plus clumps of five bamboo species viz., *Bambusa balcooa*, *B. nutans*, *B. pallida*, *B. tulda* and *Dandrocalamus hemiltonii* have been laid out at two places, i.e., Tuiral, Aizawl Sadar under Aizawl Forest Division and Kharjawl, Vairangte under Kolasib Forest Division in Mizoram State so as to select best clone in terms of optimum performance, high productivity and suitable end-use linked physicochemical traits.



3. Establishment of Gene pool Nursery and Gene bank

Superior clumps of some commercially important bamboos have been selected from different parts of the north-east and clonal materials have been collected. A Genepool Nursery has been established in the premoses of ARCBR at Bethlehem Vengthlang, Aizawl wherein the clonal materials are being raised and multiplied for production of quality planting stock.

Ground works for establishment of Gene bank in ARCBR premises at Bethlehem Vengthlang, Aizawl is completed. Plantation of superior germplasms of commercially important bamboos will be done during ensuing planting season.

Establishment of Van Vigyan Kendra

For establishment of Van Vigyan Kendra in Mizoram State, liaison has been establishment with Environment and Forest Department of Mizoram and Nodal Officer has been assigned. Activities like nursery establishment and other extension activities have been taken up by VVK recently.

ARID FOREST RESEARCH INSTITUTE

JODHPUR

Arid Forest Research Institute, Jodhpur (Rajasthan), is one of the eight Institutes under the Indian Council of Forestry Research and Education (ICFRE), an autonomous body of the Ministry of Environment and Forests, Govt. of India. The objectives of the Institute are to carry out scientific research in forestry and allied fields to enhance the productivity and vegetative cover, to conserve the biodiversity and to develop the technologies for the end-users, especially in the hot arid and semi-arid region of Rajasthan, Gujarat and Dadra and Nagar Haveli.

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 modeling, planting stock improvement, bio-fertilizers and bio-pesticides, agroforestry, JFM and extension, phytochemistry and non-timber forest products, integrated pest and disease management and forestry education. During 2007-08, thirty three projects were executed including thirteen externally funded projects from Rajasthan Forest Department, Gujarat Forest Department, Department of Bio-technology, Government of India, New Delhi; National Medicinal Plant Board, New Delhi and CSIR, New Delhi.

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

	No. of projects completed in 2007-08	No. of ongoing projects in 2007-08	No. of projects initiated in 2007-08
Plan Projects	—	13	7
Externally Aided Projects	4	11	2
Total	4	24	9

PROJECTS COMPLETED DURING THE YEAR 2007-2008

EXTERNALLY AIDED PROJECTS

Project 1: Integrated management for qualitative improvement and increased production of Rohida (*Tecomella undulata*) in Rajasthan [AFRI-65/FP/2005-08]

Component 1: Insect pests and disease studies

Findings: The entire IGNP area in Jaisalmer and Bikaner districts was surveyed and 21 sites were evaluated for the insect pests and disease studies. Subsequently, on the basis of infestation intensity,



six sites viz., were selected in IGNP area covering Jaiselmer and Bikaner districts. Three species of fungi belonging to the family imperfecti (*Phoma* sp., *Fomes* sp. and *Botryodiplodia theobromae*) are primarily responsible for canker-rots in *T. undulata* in IGNP area at Mohangarh. It was observed that no significant hollowness problem was encountered in the Rohida plantations raised in the IGNP area except in a few trees, which exhibited the initiation of canker formation in the main trunk.

Component II: Rohida Macro-propagation

Findings: Technology developed on macro-propagation of important tree of arid region known as Marwar Teak and locally called Rohida (*Tecomella undulata*). Studies carried out in last two years indicate that rooting response of Rohida stem cuttings is not only difficult influence by several factors such as donor trees health, physiological status of cuttings and the external environmental conditions. However, tree has the potential to root relative high frequency if tree is managed well before collecting the stem cuttings. Selection of cuttings from well managed selected tree and established in mist chamber at proper time period after treating proper fungicide, insecticide and antibiotic treatments can be rooted successfully.

Component III: Growth and Yield Studies on Rohida Plantations

Findings: Total wood volume equations have been constructed and validated which assume importance in projecting the total volume at different stages (thinning and final harvest) as the plantations mature. Volume equations proposed may be applied on any population/sample of these species available in the study area as these equations have been validated for independent data set. The site index equation has been developed that may be used for assessing productive capacity of site and to select sites suitable for the particular species. These are also useful in estimating site index at a base age given height at some other age as well as estimating height at some desired age given site index. Generalized diameter height models have been developed which are useful tools for forest inventory purposes.

Project 2: Studies on prediction of NTFP availability and potential for extraction in Aravalli region of Rajasthan

Findings: Significant quantities of NTFPs are gathered in three forest divisions of the Aravalli region and the annual estimated values of NTFPs realized per household are Rs. 2765.00, Rs.1794.00 and Rs. 478.00 in Udaipur (central), Pratapgarh and Banswara forest divisions respectively, ignoring fuel wood and fodder grasses collection. Taking removal of fuel wood and fodder grasses from the nearby forests into account, estimated annual financial values realized per household are Rs. 5965, Rs. 4994 and Rs. 3678 in Udaipur (central), Pratapgarh and Banswara forest divisions respectively. The financial value realized per ha or NTFP income generated from a hectare area of tropical dry deciduous forest of Aravali region was estimated as Rs.1442.00 in Udaipur (central) forest division followed by the Pratapgarh and Banswara forest divisions, yielding Rs.1006.00/ha and Rs. 392.00/ha. Such species include important commercial and medicinal plant species like *Acacia catechu* (Khair), *Boswellia serrata* (Salar or Salai), *Lannea coromandelica* (Godal), *Sapindus trifolatus* (Aritha), *Anogeissus latifolia* (Dhavra), *Madhuca latifolia* (Mahua), *Chlorophytum borivillianum* (Safed Musli), *Dendrocalamus strictus* (Bamboo) and *Embelica officinalis* (Aonla) etc.

Project 3: Efficacy and economics of water harvesting devices in controlling run-off losses and enhancing biomass productivity in Aravalli ranges [AFRI-39/FED/2002-08] (Note: Concluded from State Forest Department, Rajasthan but got extension of one year in ICFRE Plan fund in 2008-09)

Findings: Experiment was started in July 2005 with the financial assistance from Rajasthan Forest Department. Seventy five plots of about 700 m² area were laid in 0-10, 10-20% and >20% slope with five treatments (control, contour trench, gradonie, box trench and V-ditch rainwater harvesting structure) in five replicates. Growth and seedling survival were recorded in June and December 2007. Run-off was measured from July to September (8 times) and water samples were collected (2 times) for soil and nutrient loss. Vegetation and shrub/ tree diversity was monitored and diversity indices calculated. Vegetation productivity was also estimated.

Presence of coarse fragment in most of the plots of >20% slope facilitated the infiltration and subsurface drainage reducing surface loss and enhanced duration of soil water availability for vegetation. Preparation of RWH structures further enhanced water availability increasing vegetation production and soil organic carbon, a benefit of carbon sequestration. Highest run-off (11.43%) was from the Control and lowest was from V-ditch plots (9.33%). The losses in other treatments were 11.28% from Box trench, 10.89% from Gradonie and 10.82% from Contour trench plots. Thus adoption of rainwater harvesting devices reduced run-off losses as the water loss in V-ditch plots was reduced by 2.1% of the total rainfall when compared with the control.

Report prepared and submitted to funding agency i.e., State Forest Department, Rajasthan.

Project 4: Baseline survey study on biological diversity in Mangala, Sarswati and Rageswari areas of Rajasthan Hydrocarbon Project [AFRI-75/FED/2006-08] (Funded by CAIRNS Energy India Pvt. Ltd.)

Findings: An extensive survey was conducted in the Mangala, Sarswati and Rageswari areas of Rajasthan Hydrocarbon Project in Barmer district to study the biological diversity in the area. Sensitive areas like community lands (Oran and Gauchar) and forest areas were also studied in detail. Site wise map has been prepared. Final report submitted to the funding agency.

PROJECTS ONGOING DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Market survey on selected species in selected markets [AFRI-58/Silvi/ Continue]

Status: The data regarding prices of various forest produces viz., timber, fuelwood, bamboo were collected from the markets of Jaipur and Ahmedabad on quarterly basis. Data collected were compiled and submitted to the ADG (Stat.), ICFRE, Dehradun on prescribed format for publication of Timber and Bamboo Trade Bulletin.



Project 2: Screening of exotic and indigenous plant species for their performance on salt affected soil with different management project [AFRI-49/NWFP/1997-08]

Status: Experiment 8: For *C. mopane* 88% survival was observed in control compared to 94% on CDM after 48 months. However, for ber survival decreased by 6% (58.20%) on control and 13% on CDM (40.20%). Plants of *C. mopane* became leafless during summer; it gained growth after rain and micronutrient application. Flowering and seed setting was observed in 64.7 % plants of mopane compared to 56.8% plants in control.

Experiment 6: Field trial was laid in 2000 with three planting treatments (DRM, CDM and Control) and three halophytic plant species (*S. nudiflora*, *A. lentiformis* and *A. stocksii*). Effect of structures continued and after 84 months mean survival was CDM (59.7%), DRM (63.9%) and Control (21.1%). *S. nudiflora* was found as best species with 63, 80 and 55 % survival in DRM, CDM and Control. Total (above and below ground) biomass studies were done in *S. nudiflora* plantation at the age of seven years.

Project 3: Quantitative estimation of biologically active secondary metabolites in some of the arid zone medicinal plants to ascertain correct harvesting time [AFRI-50/NWFP/2002-07]

Status: The total mean alkaloid content in *Calotropis* flowers was maximum in summer season (4.0%) and minimum in monsoon season (2.54 %), total mean sterol content was maximum during winters (2.97%) and lowest in monsoon (2.38%). The mean flavonoid content was found maximum in winter season (75.8 mg CE/100g) and minimum during monsoon season (61.2 mg CE/100g). Flowers collected from all the nine agro-climatic zones of Rajasthan analysed for studying variation in secondary metabolites showed maximum sterol and alkaloid content from Jaisalmer region (ACZIA).

Project 4: Genetic Improvement of *Tecomella undulata* [AFRI- 44/FGTB/2002-06]

Status: Tree improvement work on Rohida (*Tecomella undulata*) was started on the request of the Rajasthan Forest Department. Thirty CPTs in unirrigated and thirty five CPTs in irrigated regions were selected. Seeds of these CPTs were collected for raising of progeny trial-cum-seedling seed orchard in Rajasthan and Gujarat. Seeds were given to the Gujarat Forest Department for raising the trial in Gujarat and for Rajasthan. An area has been selected in Beechiwal Range of Bikaner and AFRI experimental field at Jodhpur. Seedlings have been transferred to the Beechiwal Range for acclimatization and establishment in the nursery.

Project 5: Screening of high oil and Azadirachtin in Neem [AFRI-45/FGTB/2002-06]

Status: To assess the heritability pattern of Neem CPTs, twelve hectares of progeny trials of summer and winter flowering CPTs at AFRI, Jodhpur and high Azadirachtin and high oil CPTs at Govindpura Jaipur were laid out. These trials are being maintained periodically and phenological observations are recorded on the trial. The trials should have started flowering by now but due to frost and consistent drought conditions, flowering has not started so far.



Progeny trial at Jaipur



Flower buds at initiating stage

Project 6: Multilocal trial of *Eucalyptus camaldulensis* and *D. sissoo* clones [AFRI-41/FGTB/2002-06]

Status: Multilocal trials of *E. camaldulensis* and *D. sissoo* clones established in 2003 at four locations namely Deesa, Kheralu, Gandhinagar and Rajpipla of Gujarat State are being maintained. Preliminary data compilation and analysis reveals that there is a significant variation amongst clones of both species. Further analysis and estimation of genetic parameters is being done.

Project 7: Developing strategies and methodologies for extension of forestry research technologies in semi-arid and arid areas [AFRI-71/AFE/2005-09]

Status: AFRI brochures, pamphlets, achievements and expertise booklet being revised. Published 5000 leaflets and 3 banner slogans, coordinated the Ceremonial Planting and Shramdaan on "World Environment Day 2007" publicized 10,000 leaflets, 10 banner slogans, sticker, article and poem, participated in plantation programme on "International Day to Combat Desert and Desertification" and publicized 10,000 leaflets, 10 banner slogans, and participated in plantation programme on "Van Mahotsav, 2007 for mass awareness. Documentation of regional workshop on "Challenges in Forestry Research Extension" (18th and 19th October 2005) finalized for printing. Dissemination of forestry extension services rendered to the stakeholders by participating in State Level Independence Day Celebration held at Jodhpur from 12th to 16th August 2007. Mela/Exhibition held at Polo Ground, Jodhpur from 31st October to 6th November 2007 and Western Rajasthan Hastshilp Mela 2008 held at Rawan Ka Chabutra, Jodhpur from 5th to 14th January 2008.

Project 8: Relative resistance of Neem provenances to insect pests and mites and their bio management in arid areas [AFRI-73/FP/2006-09]

Status: Relative resistance of neem provenances to neem weevil, *Myllocerus tenuicornis*: An experiment has been conducted to study the resistance of 39 neem provenances to neem weevil, *M. tenuicornis*. The provenance from Palanpur and Jhansi exhibited the least preference for the larvae (0.65 and 0.69 cm sq.). The provenance from Mulag was found to be the most favoured or susceptible host as the leaf area consumed by larvae was 3.11 cm sq.

Microbial control agent of neem weevil: Infection of an entomopathogenic fungus, *Beauveria bassiana* has been observed in the adult population of neem weevil, *M. tenuicornis*. Efforts are being made to isolate and propagate the fungus for further lab study.



The fungus quickly spread on the body of the weevil and choked the respiratory system resulting death of the weevil. Efficacy of this entomopathogenic fungus has been studied. The weevil have been exposed with entomofungus in the outdoor cages of insectary.

Bioecology of neem defoliator: A complete life cycle under different generations took an average period of 39.75 which ranges from 29 to 47 days under different conditions of temperature and relative humidity.

Project 9: Management of potential insect pests and diseases of important medicinal plants grown in arid and semi-arid regions [AFRI- 72/FPD/2006-09]

Status: Severe infestation of a noctuid caterpillar species has been noticed on all mehndi, (*Lawsonia inermis*), growing areas at Sojat road (Pali). The caterpillars are the semiloopers brown to black in colour depending on the number of instars. The larvae are voracious feeders of foliage. Heavy termite infestation was recorded in the Guggal (*Commiphora wightii*) plantation at Kailana (Jodhpur) wherein about 1.50 cm thick stem of Guggal were found infected by stem rot as well as termite infestation resulting drying of the stem and shoots. Guggal plants at AFRI Model Nursery were noticed infested severely by a lepidopteron pest and white fly. Severe infestation of termites has also been noticed in the root system of mature Guggal plants at Herbal Guggal Farm, Mangaliavas near Ajmer.

Project 10: Assessment of Neem International Provenance Trial [AFRI-78/ FG TB/ 2006-09]

Status: Phenological observation in the selected trees was made from February 2007 to July 2007 in 20 trees of each provenances. All the trees of the introduced provenances and national provenances started flowering in the 1st week of March except in the Thai provenances which came to flowering at the end of November. Large amount of flowers and immature fruits were fallen due to heat wave which occurred during the month of June. Fruits were collected in the month of July and August. Only five provenances produced fruits, though all of them showed high intensity of flowering. One Tanzanian Provenance and 4 Indian provenances produced the fruits. The quantity of the fruit yield was also very minimum in 4 provenances (10g -40 g) and the maximum amount of seed (467 g) was only obtained from the Indian Provenance (Ghati Subramaniya).



Neem International Provenance Trial

Project 11: Demonstration trial of male and female *Ailanthus excelsa* plants raised through grafting and tissue culture [AFRI-79/FGTB/2006-09]

Status: Method of grafting was further refined to improve grafting success. Stocks for raising demonstration plantation with male, female grafted plants and controlled seedlings are ready for plantations in July 2008. One hectare site has been identified at AFRI experimental area for establishing demonstration trail of this fodder species.

Project 12: Development of economically viable and integrated agroforestry models for arid region [AFRI-55/Silvi/2004-09]

Status: Agroforestry model being maintained at farmer's field at village Harsh, Bilara. *Cordia mixa* plants obtained average maximum height 86 cm and followed by *Prosopis cineraria* (78 cm), *Colophospermum mopane* (75 cm) and *Ailanthus excelsa* (75 cm) respectively. The plant height was found higher in agroforestry plots as compared to the control (without crop). Similarly, collar diameter was found highest in *Ailanthus excelsa* (3.12 cm) and followed by *Cordia mixa* (2.89 cm), *Prosopis cineraria* (1.69 cm). The highest survival was observed in *Prosopis cineraria* (99%) followed by *Zyzyphus mauritiana* (97%), *Colophospermum mopane* (92%) and *Cordia mixa* (90%) species.

Project 13: Development of suitable models for Eco-restoration of degraded lands in Thar desert [AFRI-74/Silvi/2006-10]

Status: Project was initiated at village Ostra, district Jodhpur over community land in 2007 but due to resistance of local people, work was stopped. Efforts were made to locate alternate site at village Salawas, Jodhpur district and Gram Panchayat was requested for granting no objection.

EXTERNALLY AIDED PROJECTS

Project 1: Genetic improvement of *Jatropha curcas* for adaptability and oil yield [AFRI-66/Silvi/CSIR/2005-10]

Status: (i) Collection of *Jatropha* Elite and Native Accessions and field trials : Twenty three elite accessions and 160 native accessions were collected. The survival percentage ranged from 12.50% to 100%. Native accessions collected and exchanged with various partner institutes have been planted in July/August 2006 in RBD design with three replications having single plant per replication at 2.5 x 2.5m spacing. (ii) Agro-technology Trials: Various trials on spacing, pollarding, irrigation and fertilizer have been initiated as per the design agreed upon during meeting held on February 2007 at New Delhi. (iii) Spacing trial: Trial was initiated from the seedlings raised from seeds received from Bhav Nagar. Plants were planted in RBD design with 16 plants per treatment and in five replications in July 2007.

Project 2: Locational trials on Bamboos (NMBA) [AFRI-43/GTB/2005-08]

Status: The initial results in the six bamboo species trial at Banswara, Rajasthan indicated that *D. strictus* and *B. vulgaris* are performing well followed by *B. bambos*, *B. nutans* and *B. tulda*. *Dendrocalamus asper* is not suitable for the selected site as survival percentage of this species is almost nil (<2%). In another experiment on water management of *B. bambos* tissue culture plants did not show any significant difference. However this experiment is only one and half year old.

Project 3: Multiplication and field trial of Bamboos through tissue culture in Rajasthan and Gujarat [AFRI-68/GTB/2005-08]

Status: Initial data collected from all the trails after one month indicates that survival percentage was 100 in *Dendrocalamus strictus* and 99% in *Bambusa bambos* at Jhalod site in Gujarat, whereas survival percentage was relatively less in both the species (95% in *Dendrocalamus strictus* and 96% in *Bambusa bambos*) at Kushal Garh site in Rajasthan. Survival percentage further decreased after



one year and it was ranging from 97.2% to 100.0% for both the species in Gujarat and 67.6 % to 96.8% at Kushal Garh site in Rajasthan. Initial data also indicate the enhancement of growth of *B. bambos* tissue culture plants.

Project 4: Study of Characteristic features pertaining to Bio-drainage potential of some selected tree species [AFRI-38/FED/2004-08]

Status: This is an externally funded project that has been funded by the Ministry of Water Resources (MoWR), New Delhi. It was initiated in 2004 with two field experiments in Indira Gandhi Nahar Pariyojana (IGNP) and one in in-filled non weighing type of Lysimeters ($2 \times 2 \times 2 \text{ m}^3$) at Jodhpur. *Eucalyptus rudis* accumulated high biomass under waterlogged condition in IGNP area followed by *Corymbia tessellaris*, *Eucalyptus camaldulensis* and *Eucalyptus fastigata*. In all these species, root spread was mostly concentrated along the bunds. Rooting depth was restricted up to the ground water level which receded to a maximum level of 125 cm in *E. rudis* plantation within a period of four year. *E. rudis* and *C. tessellaris* maintained steady rate of transpiration and photosynthesis throughout the year. In the lysimeter experiment, high rate of transpiration was observed in *Acacia nilotica* plants compared to *E. camaldulensis* plants. Peak rate of transpiration was recorded at 12.00 hour during the month of January 2008 for both the species.

Project 5: Productive propagation of remunerative medicinal plants for establishment of Silva-Ayurveda demonstrative models in the arid and semi arid areas, their preservation for further improvement, research, extension, development and diversification [AFRI-70/AFE/2006-09]

Status: Silva-Ayurveda demonstrative models were planted in farmers' fields at Tibna and Jadan villages in Jodhpur and Pali districts of Rajasthan respectively. Fifteen field beneficiaries were selected at Tibna - two of one hectare and thirteen of one bigha area. Total area planted is 5.75 ha. at village Tibna. The species of Gunda, Karonda, Guggal, Ber, Khejeri, Rohida Sahjan, *Aloe vera* and Ashwagandha were planted after the advance works. At Jadan, species of Rohida, Khejeri, Gunda, Ber, Aonla, Guggal and Nimbu were planted over 2 ha. with 384 no. of plants. Field nursery has been established and maintained at Tibna. It contains about 40,000 seedlings of *Aloe vera*. Neem khali, Tabacoo dust, Vermicompost and Gomutra were distributed to the farmers for application in plants. Survival and growth observations were recorded (84%) in February 2008.

Project 6: Source variation, extraction and cultivation Practices for *Commiphora wightii* Arn. Bhandari

Status: Establishment of Performance Trial: Clonal Material collected from 25 Districts of Rajasthan was raised in the polyhouse and planted in RBD design with 4 replications and each replication has 8 plants per accession in September 2007. Clonal material collected from Baran, Bundi, Chittorgarh and Jhalawad districts have shown distinct characteristics and showed higher sprouting and rooting than other accessions.

Establishment of Agri-trial: For assessing proper growth requirement of Guggal plants under arid conditions, an agri-trial has been initiated with three level of irrigation frequency (Survival, 30 and 45 days) and seven levels of fertilizer.

Component –II: Forty eight Guggul trees were selected with the objective to enhance gum

production by non-destructive means. All trees were multi-branched having number of branches (> 2 cm dia.) from 2-12 per tree. Organic manure was applied in September 2007 as per the treatments prescribed. Irrigation at the interval of 20 and 30 days was given November 2007 to January 2008. Tapping experiments, with different doses of gum enhancer (ethephone- 0, 150, 300 and 450 mg / plant), were initiated in February 2008. Three semi-circular cuts/plant were made. First gum collection was done after fifteen days, however, gum exudation was not observed in all the trees. Thereafter, gum was collected every ten days and gum yield (4.20 g to 59.22 g), was recorded till March end from all the trees, though the yield was minimal under control conditions. All the trees were healthy up to 31st March 2008, even those branches did not dry where cuts were given.

Component –III: Tissue culture

- A. **Characterization of immature seeds for use as right explant:** Fruit length, weight and volume was measured for selecting appropriate size for getting immature seeds as explant. Seed size of 1cm , weight of 300 mg and volume of 0.23 cc was best.
- B. **Hormonal treatment:** Green embryos were supplemented with varying concentration of 2,4-D for 30 to 90 days and was observed that 0.5 mg/ml concentration of for incubation of 60 days were best for callus biomass and embryogenic potential.
- C. **Maturation of somatic embryoids:** Experiment was carried out by culturing somatic embryos clumps on modified MS media supplemented with 5 g/l Activated charcoal + 0.1 mg/l IBA + 0.25 mg/l BAP + 0.8 % Agar + 3 % Sucrose + pH-5.8.
- D. **Maintenance of somatic embryoids:** Somatic embryoids were maintained with or without hormonal supplementation.

Project 7: Enhancing productivity of saline wastelands in Kachchh through improved tree planting techniques and silvipastoral study

Status: In plantation trials at Kordha (Patan), only 33% plants of *A. ampliceps* (with wheat husk) survived from previous year trials, hence, new trials were laid in July 2007 on highly saline $EC_2(dSm^{-1})$ 7.8 to 20.7 black silty clay soil (medium), Soil depth: 40-75 cm. Plant species were *Acacia ampliceps* and *A. bivenosa*, *S. persica* and *Atriplex* spp. with control, WH (1/2 kg), FYM (5kg), WH + FYM, Bajara Husk (250g) and FYM + BH treatments in RBD with 3 replication for all the trials. Spacing adopted was 4 m x 4 m for *A. bivenosa* and *S. persica* and 3m x 3m for *A. ampliceps* and *Atriplex* spp. All the three tree species recorded appreciably high mean survival, *S. persica* (95%), *A. bivenosa* (88.8%) and *A. ampliceps* (82.9%), after eight months. Survival of *Atriplex* spp. was not good (max *A. amnicola* 18%). In silvipastoral trial (Bhuj), maximum overall plant survival was 99.3% in *D. annulatum* followed by *C. setigerus* 93.3% and *C. ciliaris* 91.6% after 19 months. However, species-wise maximum survival was in *P. cineraria* (99.4%) followed by *C. gharaf* (99.7%), *Z. mauritiana* (96.5%) and *C. mopane* (81.7%). While all other species nearly maintained the survival there is slight decrease in survival for *C. mopane*. After 14 months, effect of grass on tree growth was very pronounced in *C. setigerus* where control trees recorded 36.6 % and 38.9 % more height and crown diameter, respectively. Overall maximum mean tree height and crown diameter was



recorded with *D. annulatum*, followed by *C. ciliaris* and minimum with *C. setigerus*. Species-wise growth was in the order of *C. gharaf* > *Z. mauritiana* > *P. cineraria* > *C. mopane*.

NEW PROJECTS INITIATED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Survey selection, performance trial and estimation of yield potential of *Jatropha curcas* in Rajasthan and Gujarat [AFRI-88/Silvi/2007-12]

Status: *Jatropha* population in Banswara and Saira, Rajasthan was surveyed. Fifteen CPPs in Banswara and 5 CPPs in Saira were marked. Similarly, 5 CPPs in Gandhinagar and 15 in SFD trials at Rajpipla were selected. Total height, girth and crown width of the CPPs have been measured. The variations for these traits were 3.5-4.0 m, 0.28-0.30 m and 3.1-3.3 m, respectively. Seeds collected from the CPPs selected at Gandhinagar and Rajpipla. Seeds were also obtained from DCF (Res.), Gandhinagar for the 16 CPPs identified by them. Seed yield variation in the CPPs at Gandhinagar was from 474 gm to 730 gm. Oil yield was estimated and it varied from 12.7% to 36.0% on seed basis. A total of 46 CPTs were tested for seed weight, kernel weight, seed and kernel ratio and estimation of oil.

Project 2: Studies on seed traits of seeds collected from seed stands / SPAs / SSOs / CSOs of important species of Gujarat state [AFRI-80/Silvi/2007-12]

Status: Collection of seeds: Seeds from 8 seed stands of *Acacia nilotica*, four stands of *Acacia catechu*, 2 stand of *Terminalia chebula* and 18 stands of *Tectona grandis* have been collected.

Seed Testing: Hundred seeds weight of *Acacia nilotica*, *A. catechu* and 100 fruit weight of *T. grandis* and *Terminalia chebula* has been worked out. Hundred seeds weight of *Acacia nilotica* varied from 13.24g to 16.70g and *A. catechu* from 5.40 to g. 100 fruits weight of *Tectona grandis* and *Terminalia chebula* varied from 37.94g to 43.99g and respectively.

Seed Testing: Various seed lots of *Acacia nilotica* (8) and two seedlots of *Acacia catechu* were tested for germinability. Seed germination in various seed lots of *A. nilotica* varied from 80.5% in seedlot no. 2429 and 96% in seedlot no. 2432. Seed germination in *A. catechu* varied from 73% to 82.25%. Fruit weight of 100 fruits of *Terminalia chebula* varied from 382.63g to 438g and in *Tectona grandis* it varied from 37.94g to 43.99g. The number of seeds in 100 fruits varied from 84-200 and seed viability from 30-70%. 100 seed weight of *T. chebula* also varied from 123.25 to 153.38g.

Project 3: Characterization and classification of forest soils of Rajasthan [AFRI-85/FED/2007-12]

Status: The project has been initiated in September 2007 with the objective to characterize and classify the forest soils of Rajasthan following the USDA classification system. Soil profiles have been studied at 14 places in Jodhpur, Banswara and Pratapgarh districts covering three subgroup types of forests under Tropical Dry Deciduous Forests and Tropical Thorn Forests.

Project 4: *In vitro* mass propagation of *Jatropha curcas* L. and optimization of low cost options for economizing the technology [AFRI-83/FGTB/2007-2012]

Status: Surveyed nearby *Jatropha* plantations including AFRI nursery. Plants for explant collection identified. Germplasm brought from Barmer and Saira being used. *In vitro* seed germination and sterilization protocol optimized. Cultures from seedling explants initiated on MS medium. Explants used: (A) Mature tree and shrub – Nodal segments, apical buds, leaf discs and petiole. Hormones tried: alpha-Naphthaleneacetic Acid (NAA), 6 Benzyl aminopurine (BAP), Indole Butyric acid (IBA), Indole Acetic Acid (IAA) and 2,4-Dichlorophenoxy acetic acid (2,4-D). Bud break and micro-shoot multiplication has been achieved through nodal segment on MS media supplemented with different combination of BAP. Best response was observed on MS + 0.2 mg/l BAP and MS + 0.5 mg/l BAP. Apical buds when cultured on different combination of BAP and NAA supplemented MS medium gave 100% callus induction.

Project 5: Field efficacy of control measures for the management of khejri mortality in North-Western Districts of Rajasthan [AFRI-87/FPD/2007-10]

Status: A study site was selected at Triloki (Sikar) and design of the experiment was finalized. MOU has been signed. Infected Khejri trees were randomly marked for treatment as per the design. Data of the 'loong' production has been recorded from selected trees before treatment. Pre-treatment Observations were recorded on DBH, Root infection, Die-back, shoot borer attack and defoliation (%) etc. Root infection (60.90%) and shoot infection/borer attack (57.60%) was recorded before the treatment. The repeat treatment was conducted in the month of August 2007 and data has been recorded in the month of February 2008. After one year of the treatment, the root infection reduced from 60.9% to 57.4% whereas, borer attack reduced from 57.60 to 54.5%.

Project 6: Development of Web Portal for Forestry Research Extension [AFRI-82/IT CELL/2007-11]

Status: The process for the purchase of softwares was also started and the purchase orders have now been issued. The other activities were to decide the outline of the portal and to identify the fields of the database. Discussions were made with the Co-PI and the other scientists in order to decide the outline of the portal and to decide the fields of the database. The areas to be covered under the web portal have been decided and the fields of the database have also been noted down to a large extent. The format for the collection of the data is under progress. Process has been started to collect the information about the research being carried out by AFRI since its inception.

Project 7: Mycorrhizal Dependency and Productivity of Economic Important Medicinal Plants (Mehndi and Ashwagandha) of Arid Zones [AFRI/FPD/2007-10]

Status: Five genera were identified in the rhizosphere of these selected plant species. A high diversity of AMF was observed which varied between different host plant species. Among the five genera, *Glomus* occurred most frequently, with ten species, *Acaulospora* and *Scutellospora* were found with three species, respectively, while *Gigaspora* and *Paraglomus* were detected with one species each. *Glomus constrictum*, *Glomus fasciculatum*, *Glomus geosporum*, *Glomus intraradices*, *Glomus*



mosseae and *Glomus rubiforme* were the most dominant species. The spore density of AMF had a strong positive correlation with soil pH and organic carbon content and a negative correlation with Olsen's P content of the soil.

EXTERNALLY AIDED PROJECTS

Project 1: Establishment of a network to facilitate collection, processing and dissemination of statistics pertaining to tropical timber and other forestry parameters in India (ITTO sponsored ICFRE Coordinated project) [AFRI-86/Silvi/ITTO/2007-09]

Status: Field assistant engaged and formats for statistical data collection modified in view of the recommendations of the Stakeholder's meet organized at ICFRE during November 2006. Data regarding forestry statistics 2004-05 and 2005-06 collected from Rajasthan, Gujarat and Dadra and Nagar Haveli, compiled on various formats and sent to the ADG (Stat.), ICFRE. Regional workshop on Forestry Statistics organized at AFRI on 18th September 2007 and recommendations finalized.

Project 2: Establishment of multilocal clonal trial and seedling seed orchard of *Jatropha curcas* [AFRI-81/Silvi/DBT/2007-10]

Status: Site Selection and Soil Analysis: Site at Haldu Ki Ghati, Kewda Ki Naal in Udaipur has been selected. The mean minimum and mean maximum temperatures goes from 6° to 45°C and mean annual rainfall is 600mm. The soil analysis has been performed.

Establishment and Observations in Field Trial: PDKV, Akola, MSSRF, Chennai, Biotech Park, Lucknow, AFRI, Jodhpur, TERI, Guwhati, Garhwal University and Raipur University, Chhattisgarh will participate in network multilocal trial.

EDUCATION AND TRAINING

Imparted training on tissue culture to the students of different colleges and Universities in the Biotechnology laboratory of AFRI.

LINKAGES AND COLLABORATION

- Tata Energy Research Institute, New Delhi
- Central Arid Zone Research Institute, Jodhpur
- Jai Narayan Vyas University, Jodhpur
- Council of Scientific and Industrial Research, New Delhi.
- National Medicinal Plants Board, New Delhi.
- Department of Biotechnology, Govt. of India, New Delhi.
- National Mission on Bamboo Application, New Delhi
- Ministry of Water Resources, New Delhi.
- Rajasthan Forest Department
- Gujarat Forest Department.

PUBLICATIONS

Extension. Brochure/Pamphlets

1. Prepared Pamphlet on Programme at a Glance for UNESCO MAB International Workshop “Ensuring the future of Dry Lands: Towards Implementing the MAB Agenda for a Sustainable Future of Dry Lands.
2. AFRI Published a Brochure regarding the mandate, Research Highlights and Research Facilities of the Institute.

CONSULTANCY

The works were carried out under the consultancy project entitled “Identification of mycorrhizal and rhizobial association, establishing gene bank and technology transfer to farmers in field” funded by Gujarat State Biotechnology Mission. Imparted training on VAM technology to 35 participants (ACFs, RFOs, Foresters, JRFs and Progressive farmers at Training and Research Centre, Gandhinagar. Laboratory training was given time to time for identification to the JRFs working under the project at Basan nursery, Gandhinagar and AFRI, Jodhpur.

CONFERENCE/MEETINGS/WORKSHOPS/SYMPOSIA/EXHIBITIONS

1. A one day regional workshop on Forestry Statistics was organized at AFRI on 18th September 2007 under the ICFRE-ITTO project with the aim to sensitize the agencies and review the formats designed to collect forestry statistics data to make them more meaningful and at the same time to get the feedback from the SFDs regarding problems faced in collecting, compiling and sending the required data on these formats.
2. AFRI organized the workshop on Guggal cultivation, production and collection on 24th September 2007. The PCCFs from many states participated in the meeting.
3. AFRI and CAZRI in coordination organized a workshop “UNESCO-MAB International Workshop” on ‘Ensuring the future of drylands: Towards implementing the MAB agenda for a sustainable future of drylands’ from 11th to 15th November 2007. This workshop was a follow up of Tunis declaration, 2006.
4. An introductory workshop on E-governance was organized in conference hall of AFRI. The discussions were made with Dr. Harish Sharma, Scientist D, Incharge IT Cell FRI, Dehradun on 16th November 2007.
5. A National Symposium on “Integrated Pest and Disease Management (IPDM) in Arid and Semi-arid Areas” was organized by Forest Protection Division on 12th and 13th March 2008 at Arid Forest Research Institute, Jodhpur. The organizing secretary of this seminar was Dr. S.I. Ahmed, Scientist-F and Head, Forest Protection. The total no. of 79 research papers were received on above themes. About 102 delegates participated in the symposium from 13 various states viz., (Orissa, Karnataka, Tamil Nadu, Maharashtra, M.P., U.P., Uttarakhand, Haryana, Gujarat, Rajasthan, H.P, Delhi and Kerala) etc. There were 10 technical sessions during which 36 multi-media presentations on various aspects of IPDM delivered by renowned delegates. A part from these 39 posters were presented during the symposium.



Inauguration of symposium



Group photo of the participants

6. An exhibition “Sanskriti- Sarokar and Sankalp” was organized in Gaushala maidan, by Jodhpur district administration on the occasion of 60th Independence day celebrations in Jodhpur, from 13th to 16th August 2007. The exhibition was inaugurated on 13th August by Smt. Vasundhara Raje, the Hon’ble Chief Minister of Rajasthan. In this exhibition various institutes of art/culture/science/development/agriculture/mineral/dairy and Railway of Jodhpur, Jaisalmer, Barmer and Pali participated and displayed their items. Our Institute exhibited various research findings/works in the exhibition. Important medicinal plants viz. Ashwagandha, Guarpatha, Ratanjot, Sonamukhi and Guggul, were displayed in the stall along with their useful parts and processed products. Two models depicting the natural sand drift conditions and bio-drainage were displayed in the stall. Brochures on medicinal plants, food from forests etc. were distributed in the exhibition. The exhibits were well praised by the visitors.
7. AFRI participated in Swadeshi Mela, organized by district administration, Jodhpur at polo ground of Jodhpur from 31st October to 6th November 2007.
8. AFRI participated in Hastshilp Mela, organized by Marudhar Industries Association and district administration, Jodhpur at Rawan Ka Chabutra of Jodhpur from 5th to 14th January 2008.

AWARD

Third prize awarded for poster presentation to Dr. Meeta Sharma, Research officer, AFRI on the paper entitled “Integrated Pest Management of Marwar Teak Defoliator in Arid and Semi Arid Region” in “National Symposium on Integrated Pest and Disease Management in Arid and Semi-arid Areas” held on 12th and 13th March 2008 at AFRI, Jodhpur.

DISTINGUISHED VISITORS

1. Dr. (Smt.) Kiran Soni Gupta, I.A.S., Divisional Commissioner, Jodhpur Division visited the Institute on 4th April 2007 and interacted with the Scientists/Officers. She visited Extension and Interpretation Centre, model nursery, arboretum and Germ-plasm of medicinal plants developed by the institute. She appreciated the work done by AFRI.
2. Shri Ram Bhuj, Scientist from UNESCO came and discussed about the international workshop on “Ensuring the Future of Drylands-Towards Implementing the MAB Agenda for sustainable Future of Dry lands.” Jodhpur, Rajasthan, India, to be held on 12th to 15th November 2007.
3. Sh. G.S. Kang, IAS, former Chief Secretary, Bihar and Mrs. Kiran Soni Gupta, IAS, Divisional Commissioner Jodhpur Division, visited AFRI on 14th January 2008. They were briefed about the institute and related research activities by the Director, AFRI and other officers/scientists.

INSTITUTE OF FOREST PRODUCTIVITY RANCHI

The Institute came into existence in the year 1993 with the objective to formulate, organize, direct, manage and carryout forestry research and education in eastern region of the country, comprising the State of Bihar, Jharkhand, Sikkim and West Bengal. Encompassing the picturesque eastern Himalayas in Sikkim and North Bengal, the fertile alluvial expanse of indo-gangetic plains in Bihar and West Bengal, deltaic and coastal mangroves of the world famous Sunderbans, a pocket of Terai Sal forest in the north-west corner of Bihar and tropical deciduous forests of Kaimur and Chotanagpur plateau overlaying rich and enticing mineral resources within its jurisdiction, the Institute of Forest Productivity is a premier forestry research organization catering to the forestry research needs of eastern India. The Institute also functions as one of the research centres of FRI University. The library of this Institute has a rich collection of over 6209 scientific and technical books and journals. A project for comprehensive IT solutions for Indian Forestry Research Information System (IFRIS) is envisaged with the objective to translate the present working system to more responsive, transparent and efficient system. Forty five nos. of 'Computer Desktop Intel v Pro Configuration (with TFT)' were provided to the Institute by E-governance, MoEF, Govt. of India, New Delhi under the scheme of IT Infrastructure for implementing E-governance initiatives.

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

	No. of projects completed in 2007-08	No. of ongoing projects in 2007-08	No. of projects initiated in 2007-08
Plan Projects	2	5	5
Externally Aided Projects	1	1	0
Total	3	6	5

PROJECTS COMPLETED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Studies on variability of bamboo species, their performance, conservation and economics with reference to Bihar, Jharkhand and West Bengal [IFP-016/SLR-4/2002-08]

Findings: By conducting field survey, the number of species in different States encountered were 10 species (in Bihar), 11 species (in Jharkhand), 25 species (in North-West Bengal) and 8 species (in South-West Bengal). Two hundred eighty one soil samples were collected and analyzed for



correlation studies. For *ex-situ* conservation, plantation of 620 superior rhizomes of bamboos of the study sites at Udai Singh Joth, ERS, Sukna, Netaipur, Midnapore, FRC, Mandar and IFP, Ranchi are being maintained. Trials on bamboo vegetative propagation, time of nursery propagation and age of culm etc. were standardized. Nutrient cycling in bamboo stands were assessed.

Project 2: Creation of germplasm resource bank of threatened medicinal plants of Darjeeling Himalayas [IFP-018/EBC-1/2003-08]

Findings: *Ex-situ* medicinal plant garden was created with 11 species namely *Acorus calamus*, *Curculigo orchoides*, *Dioscorea deltoidea*, *Hedychium spicattum*, *Rauvolfia serpentine*, *Asparagus racemosus* Wild, *Embelica officinalis*, *Gloriosa superba*, *Ocimum sanctum*, *Tinospora cordifolia* and *Curcuma caesia*. Eighty five thousand no. of QPMs of medicinal plant were produced, of which 56000 nos. of planting materials were distributed to the farmers, NGOs and States Forest Department of Sikkim and West Bengal for cultivation / trail/ demonstration. Besides, trial plot was created at research plot at Udaising Joth for yield assessment and demonstration to the farmers and Foresters. Remaining 29000 planting materials are ready for distribution during the year 2008-09.



Germplasm Resource

EXTERNALLY AIDED PROJECT

Project 1: Identification, collection and genetic evaluation of important oil yielding trees of Jharkhand (NABARD funded project) [IFP-028/BGT-6/ NABARD /2005 – 08]

Findings: Investigation on variability studies, genetic analysis, association studies and genetic diversity analysis of field biometric traits (clones and progenies), pod and seed characters, seedling traits, biochemical traits of 24 CPTs of Karanj and 23 CPTs of Mahua revealed following findings:-

- Variability available among the selected CPTs for biometric traits, pod and seed traits, half-sib traits and biochemical traits were assessed and observed to have significant variation.
- Genetic estimates were worked out in second part to know the GCV, PCV, Heritability and genetic advances for all the traits under study. It was found that trait volume index, hundred seed weight, vigour index, acid value and total oil content can be improved by breeding.



Important oil yielding trees of Jharkhand

- Inter-relationship between characters by association studies (correlation and path analysis) were worked out. Studies revealed the collar diameter 2D surface area, shoot length and protein content may be considered for selection indenting hire volume index, germination, vigour index and total oil content respectively.
- Genetic diversity of the collected clones using biometric observation were analysed which expressed non conformity with geographical distribution of clones.

PROJECTS ONGOING DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Development of appropriate silvicultural systems for selected medicinal flora of Chotanagpur and Santhal Parganas [IFP-022/FMS-3/2003 – 08]

Status: Vegetative growth of *W. somnifera*, *A. recemosus* and *R. serpentine* is unaffected by shade conditions of Teak and Shisham. Fruit set is also on the higher side in open in *W. somnifera* and *R. serpentine*. Survival percentage is greater in shade. *G. superba* – shade lover, survives only in Agronet (LI-70%).

Project 2: Creation of seed database on economically important forestry species of Jharkhand, aiming at functioning of a forestry seed certification agency [IFP-030/FMS -5/2006–11]

Status: Literature was reviewed on various aspects of seed technology. Identification and selection of superior seed sources was carried out. Observations of physical parameters of seeds i.e. seed weight, length and width, volume, colour etc. were recorded.

Project 3: Vulnerability assessment of climate change and development of adaptation strategies to mitigate the impact on seed and biomass production in forest trees and herbs [IFP-029/FMS-4/2005–09]

Status: Two open-type gas chambers were constructed. Seedling growth measurements i.e. for estimation of plant biomass from Neem, Sissoo and Gamhar seedlings were carried out. Experiment was maintained in open field conditions.

Project 4: Standardization of macro-propagation techniques of *Schleichera oleosa* and their clonal fidelity studies [IFP-032/BGT-7/2006–09]

Status: From Orissa and West Bengal, 10 more superior trees were selected. Branch/scion were collected from different locations of Jharkhand and Orissa. Grafting, air layering have been initiated. Cutting experiment was done according to the season, size and tree age wise. For raising root stock, seedlings were procured from SFD, West Bengal.

Project 5: Species suitability and reclamation strategy for degraded forest soils of Chotonagpur Plateau, Jharkhand [IFP-031/SLR -7/2006–11]

Status: Materials were collected for nursery establishment and field trials from the selected sites under the project. Samples were collected for assessment of growth limiting factors and land



degradation in trial sites. Land preparation, laying out of plots and nursery trials were carried out for screening of species suitability for field trials. Periodic growth data was collected from pot and field trials. Data was analysed and documented.

EXTERNALLY AIDED PROJECT

Project 1: Documentation and inventorization of indigenous traditional medicinal knowledge in selected districts of Jharkhand (Funded by NMPB) [IFP-033/EBC-4/NMPB/2005-08]

Status: Surveys were conducted in the remotest area of Gumla and Simdega districts well known for militant and terrorist activists. Primitive tribe groups viz. Birhos, Kanwar, Korwa and Asurs were discovered. In Tango Parish in Chainpur Block of Gumla district a herbal practitioner was met who conducts training programmes on herbal medicine for interested people from all over India. He also undertakes *ex-situ* and *in-situ* conservation of medicinal plants and trees in his botanical garden. Video recording was carried out on the rare and endangered plant species preserved in his arboretum.



Documentation and inventorization of indigenous traditional medicinal knowledge in Jharkhand

NEW PROJECTS INITIATED DURING THE YEAR 2007-2008

PLAN PROJECTS

Project 1: Genetic evaluation and molecular characterization of *Jatropha Curcas* L. of Eastern India [IFP-038/BGT-10/2007-10]

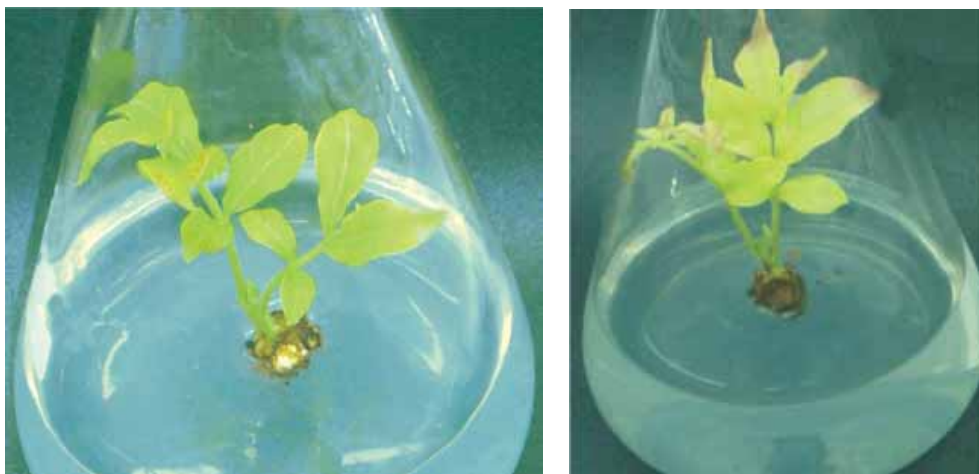
Status: Literature was surveyed. Survey, identification and selection of CPTs were carried out. Sixteen nos. of accessions were collected from Jharkhand. Field preparation and planting for 36 no. of accessions collected from different States of Eastern India were carried out. Scientific equipments, glassware and chemicals were procured.

Project 2: Study on floral biology, fruiting phenology and germination behaviour in *Schleichera oleosa* [IFP-037/BGT -9/2007-10]

Status: Seeds collected from Jharkhand and Orissa States were processed. Pre-treatments were applied on seeds for study of their germination. Procurement of equipments and chemicals was done.

Project 3: Rooting and acclimatization of *in vitro* shoots of *Schleichera oleosa* [IFP-036/BGT-8/2007-10]

Status: Shoot culture was initiated. More than 25 different media composition were prepared for experiment. Chemicals and equipment were procured.



In vitro shoot of *Schleicheria oleosa*

Project 4: Improvement of clonal propagation techniques of bamboos and enhancement in field survival [IFP-035/SLR -8/2007–11]

Status: Planting Materials were collected from South-West Bengal and Jharkhand. Nursery and propagation beds were developed for propagation and trials. Trials were taken up with 5 common species in nursery beds and in poly pots for sprouting and rooting as influenced by soil correction, GPSs etc. Tissue culture propagation of *D. asper* has been continued for different trials on hardening and field survival after planting. Shoot multiplication was carried out by sub-culturing existing cultures of *D. asper*.

Project 5: Assessment of the genetic diversity and development of species specific molecular markers in bamboos in Eastern India [IFP-039/BGT-11/2007–09]

Status: Relevant literature on genetic diversity / population structure of bamboos was reviewed. Marker systems were developed. Survey for identification and collection of *Dendrocalamus strictus*, *Bambusa bambos* and *B. tulda* was carried out in East and West Midnapore (WB). Fifteen species were also collected from BSI, Kolkata and preserved the plant materials at IFP, Ranchi.

TECHNOLOGY ASSESSED AND TRANSFERRED

Technology transferred

IFP has developed technologies related to improving forest productivity and environmental conservation / reclamation for transfer to user groups.

Technology assessed

- Propagation techniques of selected medicinal plants
- Macro-propagation of bamboos
- Laboratory analysis of soil and treatment for deficiencies
- Production of quality planting materials in hi-tech nurseries using root trainers



- Micro-propagation techniques of important forestry species
- Recycling of organic wastes by composting / vermicomposting
- Improved techniques for Lac cultivation
- Bio-reclamation of problem soils and mined over burdens

EDUCATION AND TRAINING

Education

1. Entrance Test Examination for M. Sc. and P. G. Diploma Courses on Forestry under FRI Deemed University, Dehradun was conducted by the Institute on 27th May 2007 at Ranchi Centre.
2. A pre-thesis submission seminar of Smt. Shampa Sahay, Ph.D. Scholar was conducted on 25th September 2007 at the Institute on the research work titled “Formulation of methodologies for reclamation of coal washery rejects in East-Bokaro coalfield belt: A case study” under Doctoral Programme of FRI University, Dehradun.

Training

The following training programmes were organized by the Institute on the national level:

- Jointly organized a field training and demonstration on bamboo propagation with Birsa Agricultural University, Kanke, Ranchi on 16th February 2008.
- Conducted a one day training programme on ‘Lac Cultivation’ at Tatisringari, Jonha, Jharkhand on 7th March 2008.
- Conducted five days training programme on ‘Modern Nursery Techniques’ during the period from 24th to 28th March 2008 attending by Asstt. Conservator of Forests of SFD, Jharkhand.
- Organized two days workshop at FRC, Mandar and ERS, Sukna on ‘Cultivation and Management of bamboos’ attending by progressive farmers, NGOs and SFD personnel during the year 2007 and 2008 respectively.



Workshop at FRC, Mandar and ERS, Sukna on ‘Cultivation and Management of Bamboos’

LINKAGE AND COLLABORATION

International

EWI, USA; DFID (U.K.) ; IDRC, UNDP

National

NABARD, NMPB, DBT, CCL, DVC, ILRI, ISM, HARP, BAU, FSI, SFDs (Jharkhand, W.B., Bihar), Planning Commission, GoI, MoEF, GoI.

PUBLICATIONS

- Annual Lac Bulletin
- IFP – A profile
- Proceedings of the ‘Regional Workshop on Forestry Extension Strategy Review’ held on 23rd March 2007.
- Booklets titled “Medicinal Plant Resources of North Bengal” on species (210 nos.) of useful medicinal plants.
- Souvenir and Abstracts for National Seminar on “Conservation and Management of Bamboo Resources” held on 29th and 30th November 2007 at IFP, Ranchi .

CONSULTANCIES

The following consultancies and other services have been provided to the Institute:

- (i) MoU signed between IFP and DVC for development of green belt at stress sites of ‘Chanderpura Thermal Power Station’.
- (ii) Estimation of organic carbon contents of forest soil samples and forest floor litters of various districts of Eastern Zone and evaluation of dry weight percentage at 65^oC of forest floor litters under MoU signed between ICFRE and FSI, Eastern Zone, Kolkata
- (iii) Bamboo Resource Survey of Jharkhand funded by Jharkhand State Forest Development Corporation Ltd.
- (iv) Collaboration of SEPC, Kolkata with IFP in the field of scientific cultivation of Lac, and for development of pilot broodlac farm and Lac finishing facilities in Purulia district, West Bengal.

CONFERENCE/MEETINGS/WORKSHOPS/SYMPOSIA/EXHIBITIONS

1. An Orientation Workshop for NGOs selected under “SASVPSY of Bihar State” held on 1st and 2nd May 2007 at IFP, Ranchi.
2. A Regional Workshop on Revision of National Forestry Plan: Research Priority Setting held on 29th June 2007 at IFP, Ranchi.
3. IX Research Advisory Group Meeting of the Institute conducted on 6th and 7th September 2007.
4. A National Seminar on “Conservation and Management of Bamboo Resources” organized by the Institute on 29th and 30th November 2007 at Ranchi under the aegis of Indian Council of Forestry Research and Education (ICFRE), Dehradun and National Mission on Bamboo Applications (NMBA), New Delhi.
5. A “Regional Workshop on Forestry Statistics” organized by the Institute on 7th December 2007 under project “Establishment of network to facilitate collection, processing and



dissemination of statistics pertaining to tropical timber and other forestry parameter in India” sponsored by International Tropical Timber Organization (ITTO).

6. An inception workshop on “Biodiversity Conservation through Community Based Natural Resource Management” organized at the Institute under the UNDP- GOI, CCF– II Project on 12th February 2008.

AWARD

During the Silver Jubilee Celebration of NABARD held on 11th August 2007 at Ranchi, His Excellency Shri Syed Sibtey Raza, Governor of Jharkhand awarded Certificate of Recognition to the Institute of Forest Productivity, Ranchi for undertaking NABARD supported research project on “Identification, Collection and Genetic Evaluation of Important Oil Yielding Trees of Jharkhand”. During the occasion His Excellency, Governor of Jharkhand also honoured the Director, IFP by presenting a shawl.

DISTINGUISHED VISITORS

Dr. S.A. Khan from Department of Agroforestry, CSA University of Agriculture and Technology, Kanpur visited the Institute as an expert from 10th to 12th May 2007 to evaluate the completed in-house research project “Development of Agro–techniques for *Gymmema sylvestre* and *Embelia ribes* medicinal plants of high marketing potential”.

MISCELLANEOUS

- “World day to combat desertification” was celebrated in the office on 18th June 2007 to draw everyone’s attention that desertification can only be tackled by ensuring community participation and co-operation at all levels.
- ‘Van Mahotsav’ was celebrated at the Institute on 17th July 2007. Tree planting was done in the campus to mark the occasion.

CHAPTER 4



AUDITED ANNUAL ACCOUNT

I.C. Sanghal | A.K. Jain
B.Com. (Hons.) L.L.B. FCA | B.Com. F.C.A.

I. C. Sanghal & Co.
Chartered Accountants

17, Rajpur Road, Dehradun - 248001
Ph: (0135) 2654607, 2653402, Fax : (0135) 2745502

AUDITOR'S REPORT

We have examined the attached Balance Sheet of **INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION, DEHRADUN**, as at 31st March 2008 and the annexed Income & Expenditure Account for the year ended on that date. These Financial Statements are the responsibility of the Council's Management. Our responsibility is to express an opinion on these financial statements based on our audit.

We have conducted our audit in accordance with the accounting standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material mis-statements. An audit includes examining on test basis evidence supporting the accounting and disclosures in the financial statements. An audit also includes assessing the accounting principles and significant estimates made by the management as well as evaluating the overall financial statements presentation. We believe that our audit provides a reasonable basis of our opinion.

In our opinion and to the best of our information and according to the explanations given to us the said accounts give a true and fair view :-

- i) In the case of the Balance Sheet of the State of Affairs of the above named Council as at 31st March 2008,
- ii) In the case of the Income & Expenditure Account, of the SURPLUS for the year ended on 31st March 2008.



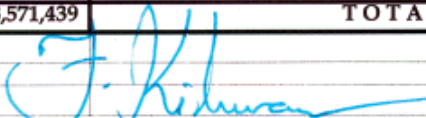
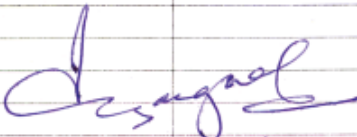
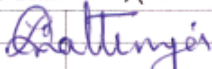
17-Rajpur Road, Dehradun
Dated : 29-08-2008

For I.C. Sanghal & Co.,
Chartered Accountants,

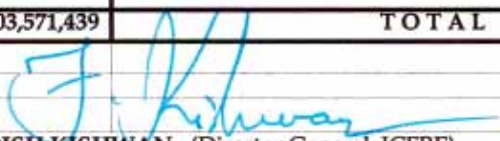
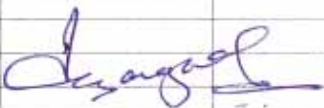
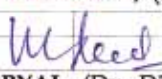
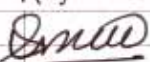
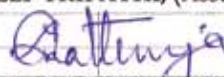
(I.C. SANGHAL)
Partner
M.No. 70242



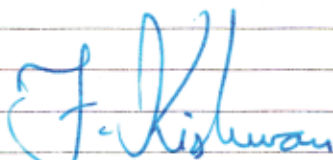
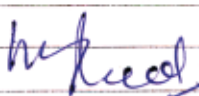
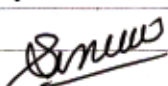
ICFRE

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN			
BALANCE SHEET AS ON 31ST MARCH, 2008			
PREVIOUS YEAR	LIABILITIES	AMOUNT	TOTAL AMOUNT
	CAPITAL FUND		
1,337,948,651	Opening balance	1,337,948,651	
	Add : Transferred from General Reserve	154,378,247	
	Less : Depreciation	104,697,783	1,387,629,115
275,913,955	GENERAL FUND (As Per Annexure 'A')		217,323,532
982,321,282	PENSION FUND / GPF / GSLIS (As Per Annexure 'B')		1,053,509,407
	CURRENT LIABILITIES & LOANS		
81,180	Amount Payable to Controller ICFRE (As Per Annexure 'C')		119,287
12,559	Amount Payable to PAO, New Delhi (As Per Annexure 'D')		25,999
166,124	Amount Payable to Other Units (As Per Annexure 'E')		158,084
3,835,107	Amount Payable to Others (As Per Annexure 'F')		4,297,421
96,842,252	Project Balances		141,375,969
6,450,329	EMD/Security (As Per Annexure 'G')		7,175,363
2,703,571,439	TOTAL		2,811,614,177
 JAGDISH KISHWAN, (Director General, ICFRE)		As per our Separate Report of even date.	
 M.S GARBYAL, (Dy. Director General, Admin., ICFRE)		 I.C. SANGHAL & CO. Chartered Accountants 17-Rajpur Road, Dehradun 29 AUG 2008	
 SANDEEP TRIPATHI, (Asstt. Director General, Admin., ICFRE)			
 D. CHATTOPADHYAY, (Fin. Adviser & Chief Accounts Officer, ICFRE)			

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN
BALANCE SHEET AS ON 31ST MARCH, 2008

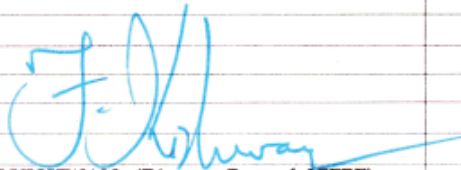
PREVIOUS YEAR	ASSETS	TOTAL AMOUNT
	<u>FIXED ASSETS</u>	
1,337,948,651	Fixed Assets (As per Annexure 'H')	1,387,629,115
39,938,000	Work In Progress	0
98,989,898	Advance for Capital Works (As per Annexure 'I')	83,528,410
	INVESTMENTS	0
	<u>CURRENT ASSETS, LOANS & ADVANCES</u>	
	<u>A. CURRENT ASSETS</u>	
1,189,539,560	CASH & BANK BALANCES (As per Annexure 'J')	1,295,860,983
	<u>B. LOANS & ADVANCES</u>	
21,795,427	Staff Advances (As per Annexure 'K')	28,499,945
10,303,344	Recoverable from Controller ICFRE (As per Annexure 'L')	6,663,663
4,737,733	Recoverable from PAO, New Delhi (As per Annexure 'M')	7,660,835
318,826	Recoverable from Other Units (As per Annexure 'N')	1,771,226
2,703,571,439	TOTAL	2,811,614,177
 JAGDISH KISHWAN , (Director General, ICFRE)		As per our Separate Report of even date.  I.C. SANGHAL & CO. Chartered Accountants 17-Rajpur Road, Dehradun 29 AUG 2008
 M.S GARBYAL , (Dy. Director General, Admin., ICFRE)		
 SANDEEP TRIPATHI , (Asstt. Director General, Admin., ICFRE)		
 D. CHATTOPADHYAY , (Fin. Adviser & Chief Accounts Officer, ICFRE)		



INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN	
<u>DETAILS OF GENERAL FUND AS ON 31ST MARCH 2008</u>	
<u>ANNEXURE A</u>	TOTAL
<u>GENERAL FUND</u>	
Opening	275,913,955
Add : Excess Of Income Over Expenditure	97,408,844
Add : Received from other units	26,379,784
Less : Transferred to Revenue ICFRE	27,191,147
Less : Transferred to Pension Fund/GSLIS/GPF	809,657
Less : Transferred to Capital Fund	154,378,247
	217,323,532
 JAGDISH KISHWAN , (Director General, ICFRE)	
 M.S GARBYAL , (Dy. Director General, Admin., ICFRE)	
 SANDEEP TRIPATHI , (Asstt. Director General, Admin., ICFRE)	
 D. CHATTOPADHYAY , (Fin. Adviser & Chief Accounts Officer, ICFRE)	
	

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN
DETAILS OF PENSION FUND AS ON 31ST MARCH 2008

ANNEXURE B				
PENSION FUND / GPF / GSLIS	GPF	GSLIS	PENSION	TOTAL
Opening	216,390,807	189,082	765,741,393	982,321,282
Add : Excess Of Income Over Expenditure	3,869,288	5,350	98,128,261	102,002,899
Add : Tfd.from General Fund			900,000	900,000
Saving Fund under GSLIS		447,746		447,746
Death Claim		660,484		660,484
Received from PAO	469,675		3,930,093	4,399,768
Subscription/contribution	46,405,816	1,620,148	13,926,027	61,951,991
Received from Others/Departments			13,720	13,720
Refund of Excess Payment	22,836		957,139	979,975
	46,898,327	2,728,378	19,726,979	69,353,684
Less :				
Death Claim Paid		564,771		564,771
Saving Fund		414,686		414,686
Subscription to LIC		1,650,162		1,650,162
GPF Advance Reimbursement	19,386,388			19,386,388
GPF Part/Final Payment	21,552,988			21,552,988
GPF Final Payment	7,165,837			7,165,837
Pensionary Benefit paid			41,993,503	41,993,503
DCRG			7,349,780	7,349,780
Tfd.to General Fund	32,978	57,365		90,343
	48,138,191	2,686,984	49,343,283	100,168,458
	219,020,231	235,826	834,253,350	1,053,509,407


JAGDISH KISHWAN, (Director General, ICFRE)


M.S GARBYAL, (Dy. Director General, Admin., ICFRE)

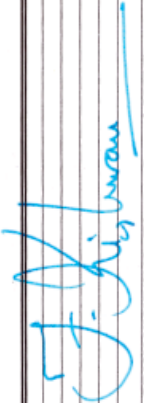

SANDEEP TRIPATHI, (Asstt. Director General, Admin., ICFRE)


D. CHATTOPADHYAY, (Fin. Adviser & Chief Accounts Officer, ICFRE)





ICFRE

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN RECEIPTS & PAYMENTS ACCOUNT FOR THE YEAR ENDING 31st March 2008				
RECEIPTS	AMOUNT	TOTAL AMOUNT	PAYMENTS	AMOUNT
To Project Receipts / Revenue Receipt		186,690,606	By Project Payments/Revenue	142,156,889
Amount Received by Controller ICFRE			Amount paid by Controller ICFRE	
Amount received from PAO (F) on account of GPF transfer	469,675		By GPF reimbursement to DDO's	19,386,388
Amount received from Various DDO's on account of GPF Subscription	46,405,816		By GPF Part Final payment	21,552,988
Amount received from Others on account of refund of excess GPF Payments	22,836		By GPF Final payment	7,165,837
Dividends on Govt. Securities Bank & FDR Interest	41,202,899		Death Claims paid	584,771
Amount received on account of Saving Funds under GSLIS	447,746		Saving Fund paid	414,686
Amount received on account of Death Claim under GSLIS	660,484		Amount of premium to LIC for GSLIS subscribers	1,650,162
Subscription from various DDOs Pro-rata Pensionary benefit received from PAO (F)	1,620,148		Pensionary benefit paid	41,983,503
Amount received from Various DDO's on account of Pension Contribution	3,930,083		Reimbursement of DCRG, Pension to Various DDO's	7,349,780
Amount received on account of excess payment of pension by bank	13,926,027			
Amount received from other Departments on account of Pensionary benefits	957,139			
Govt. Securities	13,720			
FDR Interest / SB Interest		109,656,583		
		2,568,153,337		2,568,153,337
 JAGDISH KISHWAN, (Director General, ICFRE)				
 M.S. GARBYAL, (Dy. Director General, Admin., ICFRE)				
 SANDEEP TRIPATHI, (Asstt. Director General, Admin., ICFRE)				
 D. CHATTOPADHYAY, (Fin. Adviser & Chief Accounts Officer, ICFRE)				





INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN					
RECEIPTS & PAYMENTS ACCOUNT FOR THE YEAR ENDING 31st March 2008					
RECEIPTS	AMOUNT	TOTAL AMOUNT	PAYMENTS	AMOUNT	TOTAL AMOUNT
OPENING BALANCE AS ON 1-4-2007			NON PLAN		
To Cash In Hand			By Salaries (Technical Staff)	82,290,997	
Name of Component			By Salaries (Non Technical Staff)	72,511,288	
Plan (Research)	785,970		By Salaries (Research KVS)	15,535,807	170,337,892
Non-Plan (GC)	962				
			Plan (General Components)		
To Cash at Bank			By Salaries (Technical Staff)	154,193,708	
A/c No. & Name of Component			By Salaries (Non Technical Staff)	69,112,840	
Plan (Research)	206,954,571		By T.E. (Technical Staff)	6,824,358	
Non-Plan (GC)	84,948		By T.E. (Non Technical Staff)	7,190,029	
To Earnest Money			By O.E. (Technical)	-	237,320,935
A/c No. & Name of Component			Maintenance of Vehicle		
Plan (Research)	1,345,101		- Fuel	6,522,130	
	1,025,502	209,410,122	- Repair	4,458,979	
To FDRs			- Road Taxes / Insurance	942,575	
A/c No. & Name of Component			Electricity Charges	21,835,145	
Plan (GC)	979,364,506		Telephone Charges	4,949,906	
			Maintenance of Equipments		
Grants-In-Aid			- Scientific	2,902,971	
To Plan (General Component)			- Office	3,353,024	
Less Paid to Centre	276,500,000		- I.T. Equipments / Services	153,480	
To Plan (Research)	263,500,000		Others		
Less Paid to Centre			- Water Charges	1,922,932	
To Non-Plan (General Component)	155,000,000		- Stationery	2,096,612	
To Non-Plan (KVS)	15,500,000		- Contingency Expenditure	18,801,921	
To North East	50,000,000	760,500,000	- Legal / Consultancy Charges	2,381,049	
			- Municipal Tax	1,200,893	
To Revenue Receipt From D.D.Os			- Medicines / X-ray	4,319,103	
To Revenue Receipt Payable to DGICFRE			- Livestock	272,170	
To Amount Received from DG ICFRE Revenue			- Postal / Stamp Charges	718,689	
			- Advertisement	932,953	
			- Seminar / Conference / HRD	5,171,446	
			- Newspaper Bill	453,718	
			- Extension	8,443,006	
			- Rent building / Equipment	461,880	92,294,382
			Plan (Research)		
			By Fellowship/Scholarship/cash Awards	254,931	
			Printings & Publication	2,180,259	
			Field Research Expenses	17,217,350	
			By M & M (Lab contingencies)	7,653,762	
			By Minor Works/Maintenance	54,657,710	
			Conveyance Advances	-	
			HBA	-	
			By Building & Roads	-	81,964,012
			By Equipments		
			Scientific Equipments	25,448,566	
			Office Equipments	10,651,074	
			I.T. Equipments/Services	122,655	
			Furniture & Fixture	200,680	
			Books & Journals	1,034,417	
			Vehicles	36,808	
			By Grants to Universities	49,975,770	87,469,970





ICFRE

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN				
RECEIPTS & PAYMENTS ACCOUNT FOR THE YEAR ENDING 31st March 2008				
RECEIPTS	AMOUNT	TOTAL AMOUNT	PAYMENTS	AMOUNT
				TOTAL AMOUNT
			North East Plan	
			Equipments / Furniture	14,460,483
			Minor Works/Maintenance	752,148
				15,212,631
			By Advance Payments	
			CCU	38,200,000
			RFRI-JOHRAT	-
				38,200,000
			By Advance Payments	
			Scientific Equipments	3,091,935
			Office Equipments	-
			IT Equipments	5,732,141
			Furniture & Fixture	-
			Books & Journals	-
				8,824,076
To Revenue Receipt Payable to own Revenue Account No.			To Revenue Receipt paid to own Revenue Account No.	
		7,373,903	By Revenue Receipt paid to D.G. ICFRE	7,223,596
			By Revenue Receipt paid to Controller ICFRE	27,191,147
			By EMD/Security Refunded	30,800,000
				4,180,048
To Securities / EMD Plan (GC)	4,890,082			
Plan (Res)	15,000	4,905,082		
To Reimbursement from PAO (F) New Delhi			By Payments made on Behalf of PAO (F) New Delhi	
GPF Advance	6,011,189		GPF Advance	8,695,523
CGEGIS	173,083		CGEGIS	174,523
DCRG	5,000		DCRG	242,328
Provisional Pension	-		Provisional Pension	-
GPF Part/Final Payments (Group'D')	-	6,189,272	GPF Part/Final Payments (Group'D')	-
				9,112,374
To Reimbursement from Controller, ICFRE			By Payments made on Behalf of the Controller, ICFRE	
GPF Advance	18,669,488		GPF Advance	16,833,801
DCRG	7,760,720		DCRG	5,958,381
Provisional Pension	750		Provisional Pension	-
GPF Part/Final Payments (Group'D')	442,905	26,873,863	GPF Part/Final Payments (Group'D')	442,000
				23,234,182
To Recoveries from Staff on behalf of PAO (F), New Delhi			By Payment made to PAO (F) on behalf of Staff	
GPF Subscription	5,375,512		GPF Subscription	5,363,512
Refund of GPF Advance	3,035,339		Refund of GPF Advance	3,035,339
CGEGIS	111,180		CGEGIS	109,740
House Building Advance	-		House Building Advance	-
Interest on House Building Advance	80,367		Interest on House Building Advance	80,367
Car Advance	26,000		Car Advance	26,000
Interest of Car Advance	-		Interest of Car Advance	-
Scooter Advance	722		Scooter Advance	722
Interest of Scooter Advance	-	8,629,120	Interest of Scooter Advance	-
				8,615,680





INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN					
RECEIPTS & PAYMENTS ACCOUNT FOR THE YEAR ENDING 31st March 2008					
RECEIPTS	AMOUNT	TOTAL AMOUNT	PAYMENTS	AMOUNT	TOTAL AMOUNT
To Receipt from Staff on behalf of other Offices			By Payments made to other offices on Behalf of Staff		
GPF Subscription / Refund	3,504,098		CPEGIS	3,510,708	
H B A	81,840		H B A	82,020	
Interest on House Building Advance	511,730		Interest on House Building Advance	509,750	
Car Advance	97,541		Car Advance	97,541	
Interest of Car Advance	153,777		Interest of Car Advance	153,777	
Scooter Advance	33,200		Scooter Advance	33,200	
Interest of Scooter Advance	31,206		Interest of Scooter Advance	34,456	
	-			-	
		4,413,392			4,421,482
To Recoveries from Staff on Behalf of Controller, ICFRE			By Payments to Controller, ICFRE on Behalf of the Staff		
GPF Subscription	33,718,404		GPF Subscription	33,719,904	
Refund of GPF Advance	12,116,938		Refund of GPF Advance	12,057,595	
GSLIS	1,611,619		GSLIS	1,611,449	
Pension Contribution	15,657,101		Pension Contribution	15,685,670	
New Pension Scheme	254,842		New Pension Scheme	246,179	
Employer's Share	197,627		Employer's Share	197,627	
		63,556,531			63,518,424
To Recoveries of Advances from Staff on Behalf of, ICFRE			By Advances paid to Staff		
Forest Advance	48,815,708		Forest Advance	49,960,830	
Festival Advance	1,398,300		Festival Advance	1,076,850	
Car advance	86,048		Car advance	2,645	
Interest Car Advance	40,868		Interest Car Advance	12,000	
Scooter Advance	1,302,374		Scooter Advance	3,373,230	
Interest Scooter Advance	46,164		Interest Scooter Advance	39,010	
Cycle Advance	80,500		Cycle Advance	106,600	
Interest Cycle Advance	-		Interest Cycle Advance	-	
House Building Advance (HBA)	1,426,617		House Building Advance (HBA)	2,486,750	
Interest House Building Advance	117,004		Interest House Building Advance	100,504	
TA Advance	17,484,358		TA Advance	19,079,645	
LTC Advance	2,414,925		LTC Advance	3,196,048	
TTA Advance	124,800		TTA Advance	208,000	
Medical Advance	2,546,046		Medical Advance	2,526,942	
Pay Advance	41,580		Pay Advance	144,175	
Computer Advance	-		Computer Advance	710,000	
Etc. (Please specify)	311,227		Etc. (Please specify)	308,978	
		76,236,499			83,332,207
To Recoveries from Staff on behalf of Others			By Payments made to other Offices on Behalf of Staff		
By Recoveries Income Tax (Salary)	10,327,904		By Recoveries Income Tax (Salary)	10,468,331	
TDS (Contractor/Firms, Service Tax)	3,130,086		TDS (Contractor/Firms, Service Tax)	2,961,909	
Professional Tax	314,521		Professional Tax	313,343	
PfP	99,660		PfP	99,660	
LIC	2,389,052		LIC	2,390,558	
EMD / Securities	-		EMD / Securities	-	
Court Attachment	-		Court Attachment	-	
Hindi Translation	-		Hindi Translation	-	
Quarter Rent	-		Quarter Rent	-	
Staff Association	6,660		Staff Association	6,660	
Etc. (Please specify)	19,739,676		Etc. (Please specify)	20,563,901	
		36,007,559			36,804,362



INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

PART OF ANNEXURE B :

PENSION-INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH 2008

INCOME	AMOUNT
GRANT IN AID	
Received through DDG(ADMIN)	30,000,000
Received from Revenue ICFRE	30,800,000
Interest	37,328,261
	98,128,261
EXPENDITURE	
Excess Of Income Over Expenditure	98,128,261
	98,128,261

GPF-INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH 2008

INCOME	AMOUNT
Interest & Dividend	3,869,288
	3,869,288
EXPENDITURE	
Excess Of Income Over Expenditure	3,869,288
	3,869,288

GSLIS-INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH 2008

INCOME	AMOUNT
Interest	5,350
	5,350
EXPENDITURE	
Excess Of Income Over Expenditure	5,350
	5,350



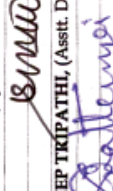
INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN	
Annexure forming part of the Balance Sheet as on 31st March 2008	
ANNEXURE C	TOTAL
Amount Payable to Controller ICFRE	
GPF Subscription / Refund	87,129
GSLIS	727
Pension Contribution	22,768
New Pension Scheme	8,663
	119,287
ANNEXURE D	TOTAL
Amount Payable to PAO New Delhi	
GPF Subscription/Refund	16,658
CGGEIS	6,595
Any Other Recovery	2,746
	25,999
ANNEXURE E	TOTAL
Amount Payable to Other Units	
Saving Fund	64,071
Death Claim	44,013
Advance Recovery	49,695
CGEIS	305
	158,084
ANNEXURE F	TOTAL
Amount Payable to Others	
LIC	712,266
T.D.S./Service Tax /Professional Tax	37,338
Payable to Conttroller ICFRE	2,247,145
Misc. Recoveries	1,300,672
	4,297,421





INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN	
Annexure forming part of the Balance Sheet as on 31st March 2008	
ANNEXURE 'G'	TOTAL
SECURITY/EMD	7,175,363
	7,175,363
ANNEXURE 'I'	TOTAL
Advance for Capital Works/Equipment	
CPWD	-
CCU	74,704,334
SCIENTIFIC EQUIPMENTS	3,091,935
I.T.EQUIPMENTS	5,732,141
	83,528,410
ANNEXURE 'J'	TOTAL
Cash In Hand	852,547
Cash at Bank	266,827,409
FDRs	1,026,812,445
EMD	1,368,582
	1,295,860,983



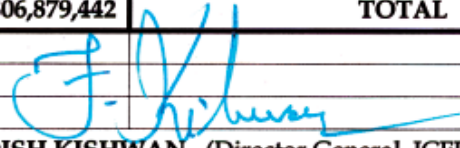
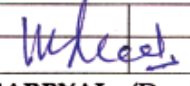
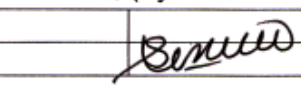
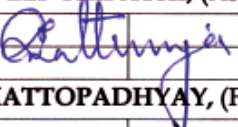
INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN						
ANNEXURE 'H'						
Details of Fixed Assets as on 31st March 2008						
	OPENING BALANCE AS ON 01/04/07	ADDITIONS	ADJUSTMENTS	GROSS BALANCE AS ON 31/03/08	DEPRECIATION	CLOSING BALANCE AS ON 31/03/08
PLAN ASSETS						
Land	5,072,750		-	5,072,750		5,072,750
Scientific Equipments	91,625,306	39,909,049	-	131,534,355	16,736,975	114,797,380
Furniture & Fixtures	13,028,009	200,680	-	13,228,689	1,312,835	11,915,854
Books & Journals	45,225,627	1,034,417	-	46,260,044	6,861,425	39,398,619
Vehicles	16,248,806	36,808	-	16,285,614	2,440,082	13,845,533
Building & Road	1,010,619,727	102,423,564	-	1,113,043,291	53,091,575	1,059,951,716
Office Equipments	143,842,189	10,651,074	-	154,493,263	22,375,159	132,118,104
Tools & Equipments	7,369,235	-	-	7,369,235	1,105,385	6,263,850
Electrical Fittings	4,917,002		-	4,917,002	737,550	4,179,452
IT Equipments		122,655	-	122,655	36,797	85,859
TOTAL	1,337,948,651	154,378,247	-	1,492,326,898	104,697,783	1,387,629,115
NOTE: Depreciation on additions has been charged for half year						
 JAGDISH KISHWAN, (Director General, ICFRE)						
 M.S. GARBHAL, (Dy. Director General, Admin., ICFRE)						
 SANDEEP TRIPATHI, (Asstt. Director General, Admin., ICFRE)						
 D. CHATTOPADHYAY, (Fin. Adviser & Chief Accounts Officer, ICFRE)						





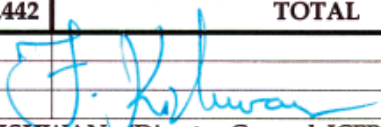
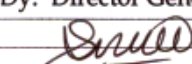
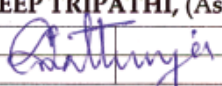
INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN	
Annexure forming part of the Balance Sheet as on 31st March 2008	
ANNEXURE K :	TOTAL
STAFF ADVANCES	
> Forest Advance	6,366,760
> Festival Advance	475,230
> Car Advance	193,168
> Scooter Advance	4,681,312
> Cycle Advance	105,446
> House Building Advance (HBA)	9,462,652
> TTA Advance	431,261
> LTC Advance	1,204,210
> Pay Advance	205,445
> Medical Advance	1,216,393
> Computer Advance	710,000
> TA Advance	1,204,117
> Other Advances	2,243,951
	28,499,945
ANNEXURE 'L'	TOTAL
Amount Recoverable from Controller ICFRE	
GPF Advance	1,875,016
DCGRG	3,026,758
Provisional Pension	188,130
GPFPart/ Final Payment	1,573,759
	6,663,663
ANNEXURE 'M'	TOTAL
Amount Recoverable from PAO, NEW DELHI	
GPF Advance	4,489,432
CGEGIS	963,856
DCRG	1,899,011
Provisional Pension	282,136
GPF Part/ Final Payment	26,400
	7,660,835
ANNEXURE 'N'	TOTAL
Amount Recoverable from Other Units	
DDOs (Premium for the month of March)	168,944
Deputation & Others	12,168
Service Tax	87,894
International Work Shop	1,500,000
GPF Subscription	2,220
	1,771,226



INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31-3-2008			
PREVIOUS YEAR	INCOME	AMOUNT	TOTAL AMOUNT
	<u>GRANT IN AID</u>		
	<u>PLAN</u>		
485,300,000	- GENERAL COMPONENT	276,500,000	
70,000,000	- RESEARCH	263,500,000	540,000,000
	<u>NON PLAN</u>		
140,000,000	- GENERAL COMPONENT	155,000,000	
18,500,000	- RESEARCH	15,500,000	170,500,000
	<u>PLAN</u>		
50,000,000	- NORTH EAST	50,000,000	50,000,000
43,079,442	Revenue Receipts & Others		30,401,583
806,879,442	TOTAL		790,901,583
 JAGDISH KISHWAN, (Director General, ICFRE)			
 M.S GARBYAL, (Dy. Director General, Admin., ICFRE)			
 SANDEEP TRIPATHI, (Asstt. Director General, Admin., ICFRE)			
 D. CHATTOPADHYAY, (Fin. Adviser & Chief Accounts Officer, ICFRE)			
			



ICFRE

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION			
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31-3-2008			
PREVIOUS YEAR	EXPENDITURE	AMOUNT	TOTAL AMOUNT
	NON PLAN (GENERAL COMPONENT)		
74,949,955	Salary Research	82,290,997	
66,720,344	Salary Non Research	72,511,288	154,802,285
	NON PLAN RESEARCH		
18,500,000	Payment to KVS	15,535,607	
-	Payment to KVS (from IGNFA)	-	15,535,607
	PLAN (GENERAL COMPONENT)		
	Salaries		
146,197,344	Research Staff	154,193,708	
68,828,362	Non Research Staff	69,112,840	223,306,548
	Travelling		
6,179,132	Research Staff	6,824,358	
5,941,409	Non Research Staff	7,190,029	14,014,387
88,756,596	O.E. (Research Staff)		109,814,263
	Plan (Research)		
1,308,838	Publication	2,180,259	
4,356,822	M & S (Lab. Contingencies)	7,653,762	
48,956,634	Minor Work / Maintenance	55,409,858	
3,267,260	Building & Roads	-	65,243,879
69,950,000	GRANT TO UNIVERSITIES		49,975,770
30,000,000	Grant to Pension Fund	30,000,000	
37,000,000	Revenue Paid to Pension Fund	30,800,000	60,800,000
135,966,746	Excess of Income Over Expenditure		97,408,844
806,879,442	TOTAL		790,901,583
 JAGDISH KISHWAN , (Director General, ICFRE)			
 M.S. GARBYAL , (Dy. Director General, Admin., ICFRE)			
 SANDEEP TRIPATHI , (Asstt. Director General, Admin., ICFRE)			
 D. CHATTOPADHYAY , (Fin. Adviser & Chief Accounts Officer, ICFRE)			



INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION - DEHRADUN
Annexure forming part of the Balance Sheet as on 31st March 2008

ACCOUNTING POLICIES & NOTES ON ACCOUNTS

1. **SYSTEM OF ACCOUNTING :**
The council follows cash system of accounting.
The Opening Balances of Units are subject to reconciliation.
2. **FIXED ASSETS :**
All Fixed Assets are stated at historical cost less depreciation.
3. **DEPRECIATION :**
Depreciation has been provided at the rates prescribed by the Income Tax Act 1961.
Depreciation on the additions made during the year has been provided for Six months only.
4. **RETIREMENT BENEFITS :**
No provision for gratuity & leave encashment liabilities is made.
5. **AMOUNT RECOVERABLE FROM CONTROLLER, PENSION CELL :**
The amount recoverable from Controller has been arrived at based on the data produced by the unit and after reconciling the same with the books of the controller, pension Cell.
6. **PROJECT BALANCES :**
Balance outstanding of various projects are subject to reconciliation.
7. **PENSION FUND :**
That the Council has been accounting interest on maturity of FDR's and the actual liability in respect of Pension has not determined by the actuary.
8. **PREVIOUS YEAR FIGURES :**
Previous year figures have been regrouped and recasted wherever necessary.



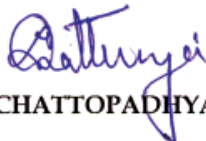
JAGDISH KISHWAN, (Director General, ICFRE)



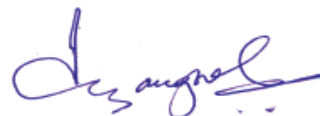
M.S. GARBYAL, (Dy. Director General Admin., ICFRE)



SANDEEP TRIPATHI, (Asstt. Director General, Admin, ICFRE)



D. CHATTOPADHYAY, (Fin. Adviser & Chief Accounts Officer, ICFRE)



I.C. SANGHAL & CO.
Chartered Accountants
17-Rajpur Road, Dehradun

29 AUG 2008

List of Abbreviations

A&R	Afforestation and Reforestation
ACA	Ammonical Copper Arsenic
AESP	Acidified Exhausted Sandal Powder
AFLP	Amplified Fragment Length Polymorphism
AFRI	Arid Forest Research Institute
AMF	Arbuscular Mycorrhizal Fungi
APFDC	Andhra Pradesh Forest Development Corporation
APFISN	Asia Pacific Forest Invasive Species Network
APMP	Alkaline Peroxide Mechanical Pulping
AWGLCA	Ad hoc Working Group on Long term Cooperative Action
AWTC	Advanced Wood Working Training Centre
AYUSH	Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy
BCC	Biodiversity and Climate Change
CATIE	Tropical Agricultural Research and Higher Education Centre
CBD	Convention on Biological Diversity
CCA	Copper Chrome Arsenic
CCB	Copper Chrome Boric
CDM	Clean Development Mechanism
CD-ROM	Compact Disc Read Only Memory
CFR&HRD	Centre for Forestry Research and Human Resource Development
CNSL	Cashew Nut Shell Liquid
CO ₂	Carbon Dioxide
COP	Conference of the Parties
CPT	Candidate Plus Tree
CSF&ER	Centre for Social Forestry Research and Eco-Rehabilitation
CSIR	Council of Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organization
CSO	Clonal Seed Orchard
CTG	Cassia Tora Gum



DBH	Diameter at Breast Height
DBT	Department of Bio-technology
DFO	Divisional Forest Officer
DG	Director General
DST	Department of Science and Technology
EB	Executive Board
ESF	Extension Support Fund
FIS	Forest Invasive Species
FRC	Forest Research Centre
FREE-P	Forestry Research Education and Extension Project
FRI	Forest Research Institute
FRLHT	Foundation for Revitalization of Local Health Tradition
FSI	Forest Survey of India
FT-IR	Fourier Transform Infrared
FYM	Farm Yard Manure
GACL	Gujarat Alkali and Chemicals Ltd.
GBPIHED	Govind Ballabh Pant Institute of Himalayan Environment and Development
GC-MS	Gas Chromatography-Mass Spectrometry
GEF	Global Environmental Facility
GHG	Green House Gas
GLC	Gas Liquid Chromatography
HFRI	Himalayan Forest Research Institute
HPLC	High Performance Liquid Chromatography
ICAR	Indian Council of Agricultural Research
ICFRE	Indian Council of Forestry Research and Education
IFFDC	Indian Farm Forestry Development Cooperative
IFGTB	Institute of Forest Genetics and Tree Breeding
IFS	Indian Forest Service
IGNP	Indira Gandhi Nahar Pariyojna
IHBT	Institute of Himalayan Bioresource Technology
IIRS	Indian Institute of Remote Sensing
IPIRTI	Indian Plywood Industries Research and Training Institute
IPM	Integrated Pest Management

IPMA	Indian Paper Manufacturers Association
IPT	International Provenance Trial
IR	Infra Red
ISO	International Organization for Standardization
ISSR	Inter Sample Sequence Repeat
ITTO	International Tropical Timber Organization
IWST	Institute of Wood Science and Technology
JRF	Junior Research Fellow
KFD	Kerala Forest Department
LAN	Local Area Network
L-DOPA	L-3,4-dihydroxyphenylalanine
LOSP	Light Organic Solvent Preservative
LULUCF	Land Use, Land Use Change, and Forestry
MoEF	Ministry of Environment and Forests
MoP	Meeting of the Parties
MoU	Memorandum of Understanding
MP	Madhya Pradesh
MPCA	Medicinal Plant Conservation Area
MPT	Multi Purpose Tree
MS	Maharashtra
MW	Microwave
NABARD	National Agricultural Bank for Agriculture and Rural Development
NAEB	National Afforestation and Eco-development Board
NATCOM	National Communication
NFLIC	National Forest Library and Information Centre
NFT	Nitrogen Fixing Trees
NGO	Non-Governmental Organization
NMBA	National Mission of Bamboo Applications
NMPB	National Medicinal Plants Board
NMR	Nuclear Magnetic Resonance
NOVOD	National Oilseed and Vegetable Oil Development



NRDC	National Research Development Corporation
NRSA	National Remote Sensing Agency
NTFP	Non Timber Forest Product
NWFP	Non-Wood Forest Produce
PCCF	Principal Chief Conservator of Forests
PCR	Polymerase Chain Reaction
PFM	Participatory Forest Management
PGD	Post Graduate Diploma
PSB	Phosphate Solubilizing Bacteria
PSIP	Planting Stock Improvement Programme
PT	Progeny Trial
PTG	Primitive Tribe Groups
QA	Quality Assurance
QC	Quality Control
RAPD	Randomly Amplified Polymorphic DNA
RBD	Randomized Block Design
RCBD	Randomized Complete Block Design
RDBMS	Research Data Base Management System
REDD	Reducing Emissions from Deforestation in Developing Countries
RFRI	Rain Forest Research Institute
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SFD	State Forest Department
SHG	Self Help Groups
SNC	Second National Communication
SP	Self Pruning
SPA	Seed Production Areas
SPM	Suspended Particulate Matter
SRF	Senior Research Fellow
SSO	Seedling Seed Orchard
SSPA	Seedling Seed Production Area
TEM	Transmission Electron Microscope
TFRI	Tropical Forest Research Institute

TKP	Tamarind Kernel Powder
TLC	Thin Layer Chromatography
TNFD	Tamil Nadu Forest Department
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USDA	United States Department of Agriculture
UV IR	Ultraviolet Infrared
UV	Ultraviolet
VAM	Vasicular Arbuscular Mycorrhiza
VMG	Vegetative Multiple Garden
WAN	Wide Area Network



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 - 248006	Shri Jagdish Kishwan, Director General Phone : 0135-2759382, 2224855 Fax : 0135-2755353 E-mail : jkishwan@icfre.org dg@icfre.org	Shri Sandeep Tripathi, Secretary, ICFRE, Phone : 0135-2758614, 2224867 (O) Fax : 0135-2750298 E-mail : sandeeptrip@icfre.org	All matters related to ICFRE Hqrs., Dehradun
Forest Research Institute, P.O. New Forest, Dehradun-248006	Dr. S.S. Negi, Director Phone: 0135-2755277, 2224444 (O) E-mail : negiss@icfre.org dir_fri@icfre.org	Shri A.S. Rawat, Group Coordinator (Res.), Phone: 0135-2752670, 2224316 (O) 0135-2752621, 2224580 (R) E-mail : rawatas@icfre.org	All Research and Account matters
		Shri T.C. Nautiyal, Registrar FRI University Phone : 0135-2751826, 2224439 (O) 0135-2752183, 2224585 (R) E-mail : nautiyaltc@icfre.org	University matters
		Shri R.K. Tiwari, Registrar, FRI Phone: 0135-2752678, 2224222 (O) 0135-2756160, 2224692 (R) E-mail: rajeevtiwari@icfre.org	Establishment, Administrative & all other matters
-do-	Head, Centre for Social Forestry and Eco- Rehabilitation, Allahabad	Shri A.S. Rawat, Group Coordinator (Res.), Phone: 0135-2752670, 2224316 (O) 0135-2752621, 2224580 (R)	All matters related to CSFER, Allahabad
Institute of Forest Genetics & Tree Breeding, Post Box. No.1061, Forest Campus, R.S. Puram, Coimbatore-641002.	Shri R Gunasekaran, Director Phone: 0422-2431942 Fax : 0422-2430549 E-mail: dir_ifgtb@icfre.org	Group Coordinator (Res.) Phone : 0422-2431540 (O)	All matters related to IFGTB Coimbatore
Institute of Wood Science and Technology, P.O. Malleswaram, Forest Research Lab. Bangalore- 560003 (Karnataka)	Shri S.C. Joshi, Director Phone : 080-23341731 (O) 080-23345965 (R) Fax : 080-23340529 E-mail: dir_iwst@icfre.org	Group Coordinator (Res.), Phone : 080-23340115 (O)	All matters related to IWST Bangalore
Head, Forest Research Centre Dulapally, Hakimpet (P.O.) Hyderabad-500 014	Head, Sh. Lokeshwar Rao Phone: 040-23095921 E-mail: head_frc@icfre.org	Sh. Lokeshwar Rao Phone : 040-23095921	All matters related to FRC, Hyderabad

Headquarters/ Institutes	Appellate Authorities	Public Information Officers	Subject matter(s) allocated
Tropical Forest Research Institute, P.O. – R.F.R.C, Mandla Road, Jabalpur – 482 021 (M.P)	Dr. A.K. Mandal, Director Phone: 0761-4044002, 2840483(O) 0761-4044011(R) Fax : 0761-4044002, 2840484 E-mail: dir_tfri@icfre.org	Dr. K.C. Joshi, Group Coordinator (Res.) Phone : 0761-4044003 (O)	All matters related to TFRI, Jabalpur
-do-	Head, Sh. Suneesh Buxy Centre for Forestry Research and Human Resource Development, Chhindwara E-mail: head_cfrhrd@icfre.org	Dr. K.C. Joshi, Group Coordinator (Res.) Phone : 0761-4044003 (O)	All matters related to CFRHRD, Chhindwara
Rain Forest Research Institute P. O Box # 136 Deovan, AT Road, RFRI, Jorhat - 785001 (Assam)	Sh. N.K. Vasu, Director Phone: 0376-2350273 (O) 0376-2350271 (R) Fax : 0376-2350274 E-mail : dir_rfri@icfre.org	Sh. Gautam Banerjee, DCF Public Information Officer (PIO) Phone : 0376-2350355 (O) Fax : 0376-2350274	All matters related to RFRI, Jorhat
-do-	Head, Advanced Research Centre for Bamboo and Rattans, Aizawl	Sh. Gautam Banerjee, DCF Public Information Officer (PIO) Phone: 0376-2350355 (O) Fax : 0376-2350274	All matters related to ARCB, Aizawl
Arid Forest Research Institute, P.O., Krishi Mandi, New Pali Road, Jodhpur - 342005	Dr. R. L. Srivastava, Director Phone : 0291-2722764 E-mail : dir_afri@icfre.org	Dr. Pradeep Chaudhary Head, Silviculture Division, Phone : 0291-2722764 Email: pradeepi@icfre.org	All matters related to AFRI, Jodhpur
Himalayan Forest Research Institute, Conifer Campus, Panthaghati, Shimla – 171 009 (Himachal Pradesh)	Sh. Mohinder Pal, Director Phone : 0177-2626778 (O) Fax : 0177-2626779 (O) : 0177-2624392 (R) E-mail : hfri@hotdak.net : dir_hfri@icfre.org	Dr. K.S. Kapoor Coordinator (Research) and Head, Division of Ecology & Biodiversity Conservation HFRI, Shimla – 171 009 Phone : 0177-2626801 (O) Fax : 0177-2626779 (O) E-mail : hfri@hotdak.net : kapoorks@icfre.org	All matters pertaining to HFRI, Shimla
Institute of Forest Productivity (ICFRE), Ranchi-Gumla N.H.- 23 P.O. Lalgutwa Ranchi – 935 303 (Jharkhand)	Sh. R. Krishnamurty Director Ph : 0651-2948505 (O) 0651-2546044 (R) Fax : 0651-2241457 E-mail : dir_ifp@icfre.org	Sh. Rameshwar Das Conservator of Forests Phone : 0651-3296974 (O)	All matters related to IFP, Ranchi



Addresses and e-mail of ICFRE and its Institutes :

Director General

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : jkishwan@icfre.org
dg@icfre.org
Phone : 0135-2759382

Deputy Director General (Administration)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : garbyalms@icfre.org
adg_amin@icfre.org
Phone : 0135-2758295

Director Research

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : rawatgs@icfre.org
dir_res@icfre.org
Phone : 0135-2756497

Deputy Director General (Education)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : ddg_edu@icfre.org
Phone : 0135-2758571

Deputy Director General (Research)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : rawatgs@icfre.org
ddg_res@icfre.org
Phone : 0135-2757775

Deputy Director General (Extension)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : rabindra@icfre.org
ddg_extn@icfre.org
Phone : 0135-2750693

Secretary ICFRE

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : sandeeptrip@icfre.org
sec@icfre.org
Phone : 0135-2758614

Assistant Director General (Administration)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : adg_admin@icfre.org
Phone : 0135-2750297

Assistant Director General (Education)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : dogrark@icfre.org
adg_edu@icfre.org
Phone : 0135-2758348

Assistant Director General (Environmental Impact Assessment)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : vermad@icfre.org
adg_eia@icfre.org
Phone : 0135-2753882

Assistant Director General (Research and Planning)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : sudhanshu@icfre.org
Phone : 0135-2753290

Assistant Director General (Policy Research)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : dogrark@icfre.org
adg_pr@icfre.org
Phone : 0135-2758348

Assistant Director General (Monitoring and Evaluation)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : balbir@icfre.org
adg_me@icfre.org
Phone : 0135-2758485

Head, (Biodiversity and Climate Change)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : renus@icfre.org
head_bcc@icfre.org
Phone : 0135-2750296

Assistant Director General (Project Formulation)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : pankaja@icfre.org
adg_pf@icfre.org
Phone : 0135-2754882

Assistant Director General (Statistical)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : sundriyals@icfre.org
adg_stat@icfre.org
Phone : 0135-2753882

Assistant Director General (Media and Publication)

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248006 (Uttarakhand)
E-Mail : adg_mp@icfre.org
Phone : 0135-2755221



Director

Forest Research Institute
P.O. New Forest,
Dehradun – 248006 (Uttarakhand)
Phone : 0135-2755277
E-Mail : negiss@icfre.org
dir_fri@icfre.org

Director,

Institute of Forest Genetics and Tree Breeding,
Forest Campus, P.B. No 1061
R.S. Puram, Coimbatore-641 002.
Phone : 0422-2431540, 2435541, 2450302,
Fax : 0422-2430549
E-mail : gunasekaran@icfre.org
dir_ifgtb@icfre.org

Director,

Institute of Wood Science and Technology,
P.O. Malleswaram, Bangalore-560 003
Phone : 080-23347131
080-23346811-14 (Gen)
Fax : 080-23340529
E-mail : dir_iwst@icfre.org

Director,

Tropical Forest Research Institute
P.O. – R.F.R.C, Mandla Road,
Jabalpur-482 021 (M.P)
Phone : 0761-4044002, 2840483(O)
0761-4044011(R)
Fax : 0761-4044002, 2840484
E-mail : mandalak@icfre.org
dir_tfri@yahoo.co.in
dir_tfri@icfre.org

Director,

Rain Forest Research Institute,
P. B. - 136, Deovan, Sotai,
Jorhat - 785001 (Assam)
Phone : 0376-2350273 (Director)
0376-2350355 (GCR)
Fax : 0376-2350274
E-mail : dir_rfri@icfre.org

Director,

Arid Forest Research Institute,
P.O., Krishi Mandi,
New Pali Road, Jodhpur-342005
Phone : 0291-2722549, 2729101
E-mail : dir_afri@icfre.org

Director,

Himaylan Forest Research Institute,
“Conifer Campus”
Panthaghati
Shimla-171009
Phone : 0177-2626778
E-mail : hfri@hotmail.net
dir_hfri@icfre.org

Director,

Institute of Forest Productivity
Ranchi – Gumla N.H.- 23 P.O. Lalgutwa,
Ranchi – 935 303 (Jharkhand)
Phone : 0651-2948505 (O)
0651-2546044 (R)
Fax : 0651-2241457
E-mail : dir_ifp@icfre.org

Head,

Centre for Social Forestry and Eco-rehabilitation,
3/1, Lajpat Rai Road, New Katra, Allahabad-2
Fax : 0532-2440795, 2622638
EPBAX : 0532-2440796
E-mail : csferald@yahoo.com
head_csfer@icfre.org

Head

Centre for Forestry Research & Human Resource Development
P.O. Kundalikala, Poama, Chhindwara (M.P.)- 480001
Phone : 07162-254473, 220354
Email : dir_cfrhrd@rediffmail.com
head_cfrhrd@icfre.org

Head

Forest Research Centre
P.O. Hakimpet, Dulapally,
Hyderabad – 500 014.
Phone : 040-23194188, 23095921
Fax : 040-23095926
E-mail : head_frc@icfre.org

NOTES

[illegible]

NOTES

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.