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Research



Environmental Research and Development

Introduction and Objective

Ministry has been funding research in multi-disciplinary aspects for environmental and ecosystems protection, conservation and management at various universities, institutions of higher learning, national research institutes and non-governmental organizations in identified thrust areas under its Research & Development (R&D) Programme. The Research & Development Scheme of the Ministry is a Central Plan Scheme for conservation and management of environment since 1985 and is looked after by Research & Ecoregeneration (RE) Division of the Ministry.

The objectives of the scheme are to generate information required to develop strategies, technologies and methodologies for better environmental management. It also aims at attempting solutions to the practical problems of resource management, conservation of natural resources and eco-regeneration of degraded areas. Further, the scheme also aims at strengthening infrastructure to facilitate research and scientific manpower development.

Progress of Various Activities

During the year Ministry brought out new guidelines for supporting research clearly indicating the order of priority and broad research themes to be supported in the identified thrust areas in the following three modes:-

- ◆ Suo-moto proposals, which can be submitted at any time of the year.
- ◆ Competitive invited proposals to be submitted when called for depending upon the specific needs of policy making including information required for international negotiations and implementation of plan schemes. Selection among the proposals received in response is made competitively on the basis of technical soundness.
- ◆ Non-competitive commissioned proposals to be invited directly from one or a network of research institutes depending on the specific needs of policy making etc. Thematic Expert

Groups are being setup to examine and recommend research proposals for funding by the Ministry.

The environmental research in RE Division of Ministry is being supported under various sub-schemes as given below:-

- ◆ Environment Research Programme (ERP) – Brown Agenda
- ◆ Ecosystem Research Scheme (ERS) – Green Agenda
- ◆ Research Programme for Eastern and Western Ghats – Location Specific
- ◆ Pitambar Pant National Environment Fellowship Award
- ◆ B.P. Pal National Environment Fellowship Award for Bio-diversity

Details about Pitambar Pant National Environment Fellowship Award and B.P. Pal National Environment Fellowship Award for Bio-diversity are given in Chapter 10 under "Fellowships and Awards".

Environment Research Programme (ERP)

Environment Research Programme (ERP) deals with problems related to pollution and development of suitable cost effective technologies for abatement of pollution. Emphasis is laid on development of eco-friendly biological and other interventions for prevention of pollution and development of strategies, technologies and instruments etc. for control of pollution. Projects are also encouraged for development of biodegradable plastics, epidemiological studies, ways and means to reduce impact of mining, chemical pollution of soils, and hazardous substances including pesticides, heavy metals etc. Projects related to waste recycling and resource recovery from waste along with the development of eco-friendly and cleaner technologies are given priority.

During the year, three meetings of the Environment Research Committee (ERC) were held to review / monitor the ongoing projects and to consider the new proposals. One hundred and

eight new projects were considered by the committee and based on the recommendations, 14 new projects have been sanctioned during the period. Progress of 90 ongoing projects was reviewed and monitored during the year. Twenty three projects have been completed under the programme during the period.

Ecosystem Research Scheme (ERS)

Ecosystem Research Scheme is an interdisciplinary programme of research which emphasizes ecological approach for studying the relationship between man and environment. The objective of the programme is to develop a basis within the field of natural and social sciences for rational use and conservation of resources for general improvement of the relationship between man and his environment. The programme seeks to provide a scientific basis to solve the practical problems of resource management. The programme also seeks to provide a scientific knowledge and trained personnel needed to manage the natural resources in a rational and sustainable manner. Ecosystem studies become even more important as the Earth's environmental ecosystems are increasingly being affected at all levels. Ecological understanding and research in this area offer tangible hope for addressing extremely complex and potentially devastating assaults on local, regional and global ecosystems. Under the scheme, emphasis is laid on multi-disciplinary aspects of environmental conservation with emphasis on ecosystem approach consistent with the identified thrust areas and orientation.

During the year, Expert Committee for Ecosystem Research Scheme (ERS) met four times to consider new proposals as well as to monitor the on-going projects. Eighty five new projects considered by the committee and based on the recommendations, 10 new projects have been sanctioned during the period. Progress of 41 ongoing projects was reviewed and monitored during the year. Thirteen projects have been completed under the programme during the period.

Eastern and Western Ghats Research Programme (E&WGRP)

The Eastern and Western Ghats Research

Programme addresses itself to location-specific problems of resource management in the Eastern and Western Ghats regions of the country. The region is suffering from destruction of habitats of its unique plant and animal life due to floods, siltation, deforestation etc. besides shortage of food, fodder and fuel for rural population and shortage of raw material for the industries. Under this programme, studies relating to bio-diversity, land use, impact of developmental activities etc. are taken up to restore the environmental quality of the region.

During the year, four meetings of the Expert Committee for Eastern and Western Ghats Research Programme (E&WGRP) were held to consider 67 new proposals as well as the monitoring of 26 ongoing proposals. Twelve new projects were initiated and 10 projects were completed. Three new Policy Research proposals were also sanctioned during the year.

Details of the projects sanctioned and completed under various schemes during the year are given in Annexure-III and Annexure-IV respectively.

Budget

The total allocation for R&D Scheme during 2006-07 is Rs. 4.2 crores. The entire amount is likely to be utilized for ongoing and new projects, based on the recommendations of the Expert Committees.

Summaries / Research finding of some of the Projects completed during the year

Technology development for the recovery of Nickel (Ni) and Cadmium (Cd) values from spent Ni-Cd batteries using an environmental friendly hydrometallurgical route

Batteries are daily used in many portable electronic devices such as cellular phones, computers, video recorders etc. Spent Ni-Cd batteries are considered hazardous due to the presence of toxic Cd. Objective of the project was to develop a hydrometallurgical flowsheet for the recovery of Cd, Cobalt (Co) and Ni from spent

Ni-Cd batteries on lab scale. For the first time, Cyanex 923 was used for the clear separation and recovery of Cd from chloride leach liquors of spent batteries containing Cd-Co-Ni. Separation and recovery of metals from sulphate leach liquors was carried out using P based extractants such as Cyanex 301, Cyanex 272 and TOPS 99. Cyanex 301 gave clear separation of Cd from others but stripping was difficult and it was possible with hydrochloric acid only. This was found to be the drawback of the route. Cd raffinate can be treated for Co separation by Cyanex 272 and Ni can be separated if we take up for Ni metal production by solvent extraction-stripping or simple crystallization/or precipitation to recover it as sulphate/hydroxide.

Treatment of effluent containing valuable/toxic metal ions and its recovery by electrodialysis

The project aimed at developing electrodialysis process with conducting spacers for the treatment of effluents containing valuable/toxic metal ion and its recovery by concentrating it about 10 times, while treated water (with TDS less than 100 ppm) recycled for further application. Interpolymer of polyethylene styrene-di-vinyl benzene copolymer based ion-exchange membranes and ion-conducting spacers were prepared and current voltage experiments were carried out in which ion-exchange membranes were kept in juxtaposition to similar type of conducting spacers(CS) in equilibrium with different electrolytic solutions. An electrodialysis(ED) unit with seven cell pairs of ion-exchange membranes and conducting spacers in treated compartments was fabricated and its performance was tested in NaCl , CuCl_2 and NiCl_2 solutions in order to explore the effect of CS on the energy efficiency. It was found that concentration polarization was suppressed, while limiting current improved with CS in comparison to non conducting spacer (NCS). ED with CS would found to be suitable process for the recovery of heavy metal ions, present in low concentration.

Adaptive research on improvement of natural grasslands in district Sirmour of Himachal Pradesh

The project was undertaken to carry out

adaptive research on improvement of natural grasslands. Types of grasslands existing in the district Sirmour were studied by recording observations on frequency of various grasses. In mid and high hills it was *Themeda-Arundinella* types of grasslands with species like *Heteropogon contortus* *Chrysopogon gryllus* and *Rottbaellia spp.* forming a major part of the grasslands. In low hill areas, it was *Dichanthium-Cenchrus-Lasiurus* type of grasslands which have degraded to *Dichanthium-Chrysopogon fulvus - Cynodon* type as these species form the major constituent of grass cover.

Studies lead to the conclusion that Napier-bajra hybrid (NB-37) can be successfully introduced in all the three environments. PSS 1 cultivar of *Setaria anceps* performed well in all three environments while, S-92 was good for mid hill areas only. PGG-9 of *Panicum maximum* can be successfully introduced in low and mid hills while Hima 4 of *Festuca arundinacea* performed well in high rain fall high hill areas.

Good diversity in the existing natural grasses was observed and 61 grass species belonging to 40 genera were collected from the district.

Insect faunal diversity of Buxa Tiger Reserve, Jalpaiguri, West Bengal

The study was undertaken to provide systematic baseline data on the insects of Buxa Tiger Reserve, their composition, richness, diversity, biogeography, seasonal diversity, adaptive features and habitat specificity. Rajabhatkhawa was the richest of all the localities (habitats) in terms of taxa; Premonsoon is the best season for diversity assessment; Random sampling is the best method of recognising taxa; Coleoptera is represented by maximum number of individuals.

A total of 465 species under 307 genera belonging to 82 families of 11 orders were collected and reported. Of these two species are new to science, 13 new to India, 51 new to West Bengal, 22 new to the distinct Jalpaiguri, and 19 new to the study area, insect fauna in bulk was composed of Oriental-Malayan elements.

Reproductive biology and genetic diversity of three economically useful forest tree species of Western Ghats

A study on pollination mechanism including the time of anthesis, pollinating agents anther dehiscence, *in vitro* pollen germination, pollen tube growth and stigma receptivity of *Buchannania lanzae* (Anacardiaceae), *Terminalia chebula* (Combeteraceae), *Garcinia indica* (Clusiaceae) and *Vateria indica* (Dipterocarpaceae) was carried out. An attempt to assess the prevailing diversity in above four tree species growing in Western Ghats has been made. Phenology including appearance of vegetative buds, flowering, fruiting, seed dispersal and germination of all the four selected trees was studied. *Garcinia indica* is a gynodioecious tree in which dehiscence occurred 15-20 minutes prior to anthesis. It is a wind pollinated species. In others, flowers opened in the mid night and continued till morning followed by anther dehiscence. The flowers offer pollen and nectar for the visitors, which include honeybees, butterflies, wasps and black ants. *In-vitro* pollen germination was highest in 15% sucrose solution (10% for *V. indica*). Stigma was most receptive at the time of anther dehiscence. In *V. indica* receptivity lasted for single day while in *G. indica* stigma became receptive one day before anthesis. In *T. chebula* and *B. lanzae* stigma was receptive for two days.

Genetic diversity was observed in morphological, economical and biochemical traits in all plant species collected from five different sites in Western Ghats. The fruits and seeds collected from Yellapur and Calicut were richer in protein and carbohydrate content. The Gas Chromatography analysis of oil extracted from seeds of *B. lanzae* and *G. indica* collected from Kankavali and Dapoli have a higher oleic acid content and less palmitic acid. High Performance Liquid Chromatographic (HPLC) analysis showed that fruits of *T. Chebula* collected from Yellapur have higher tannic acid content, than fruits samples from other sites. HPLC was also carried out to analyse hydroxy citric acid concentration in fruit rind of *G. indica* from the fruit collected from various sites. Flowers collected from various sites showed variation in size, number of stamens, petals and

carpels in *B. lanzae*.

Litter insect dynamics with special reference to ecological succession and chemical ecology along varying altitudes in the Wynad and Coorg forests of Western Ghats

Diversity and abundance of litter arthropod fauna in relation to the litter chemical quality was assessed along the altitudes of Wynad forest and the Coorg-Brahmagiri forests of Western Ghats. Succession pattern of litter insects and litter chemical quality variation during different phases of litter decomposition and litter decomposition studies and Coorg-regions were analysed during the implementation of the projects.

It was observed that the pattern of altitudinal distribution, diversity and abundance of the litter insect along elevation gradients differ widely in two geographically closely placed regions. A comprehensive litter faunal inventory and altitudinal distribution of litter arthropods from Wynad & Coorg-Brahmagiri forests of Western Ghats has been prepared for the first time. Site-specific reference to regional forest floor insect inventory of the study sites are provided and also the forests are ranked based on the litter quality indicators along an elevation gradient. Lack of a consistent pattern in the community structure of invertebrate communities along different altitudinal gradients has important consequences for conservation and biodiversity management practices indicating generalizations about the altitudinal distribution of litter invertebrate fauna in Western Ghats may not be accurate based on studies along a few altitudinal transects.

Decomposition rates were observed to be faster in the low altitudes of Wynad and high altitudes of Coorg. There distinct phases were observed during litter faunal succession. Parallel relationship between fauna and chemical loss was present at all regions except at Periya in Wynad and Paithalmala at Coorg region. Faunal analysis during succession indicated clear differences between the litter arthropod communities with mites and collembolan dominating the earlier stages, coleopters, spiders and ants in the mid stages and termites and predatory coleopterans in the late

phases at both regions irrespective of the altitude.

The present study provide a baseline data on the distribution and diversity of litter invertebrates in Wynad and Coorg region and gives ample evidence of the altitudinal variation in the abundance of decomposer assemblages and their relationship with litter chemical quality.

National Natural Resource Management System (NNRMS)

Objective

The Scheme of National Natural Resource Management System (NNRMS) involves utilization of remote sensing technology for accurate inventory of resources such as land, water, forests, minerals, oceans, etc. and to utilize this information for monitoring changes in ecological system. This Scheme is looked after by the RE Division of the Ministry. A Standing Committee on Bio-resources and Environment (SC-B) has been constituted by the Planning Commission under the Chairmanship of Secretary (E&F) with the following objectives:

- ◆ Optimal utilization of country's natural resources by a proper and systematic inventory of resource availability.
- ◆ Reducing regional imbalances by effective planning and in tune with the environmental efforts
- ◆ Maintaining the ecological balance with a view to evolve and implement the environmental guidelines.

The Standing Committee on Bio-resources and Environment (SC-B) constituted by the Planning Commission advises on the methods of using the remote sensing technology for optimal use and management of natural resources in the country. In order to streamline the projects NNRMS, SC-B has constituted a Technical & Financial Sub-Committee to scrutinize/review all the proposals submitted for funding under NNRMS, SC-B from the technical and financial angle. Only those proposals recommended by the Sub-Committee are taken up by NNRMS, SC-B for financial assistance. The Committee also oversees and monitors the progress of sanctioned

projects.

The SC-B had identified 49 priority areas for taking up remote sensing based studies in tune with key environment and ecological issues of the country. They encompassed forest, grassland, plant and faunal resources, wastelands, land degradation, water and air pollution etc. for information requirements for the Man and Biosphere Reserve Programme and some typical areas like mining, coastal areas, wildlife habitats, etc.

The potential user agencies for utilizing the outcome/information generated in the projects sanctioned by the Ministry under NNRMS programme are the Central Government Departments / Agencies, and the Ministry itself including its various organizations under its administrative control like FSI, ZSI, BSI etc.

Progress / Achievement made during the year

During the year, two Meetings of Technical and Financial Sub – Committee of National Natural Resource Management System on Bio-resources and Environment (NNRMS, SC-B) were held to review the ongoing projects and evaluate the new projects from financial and technical angles. The Sub – Committee recommended eight new projects for consideration of Standing Committee of NNRMS, SC-B. One Meeting of the Standing Committee of National Natural Resource Management System on Bio-Resource and Environment was also held. The Committee considered eight new proposals and recommended eight projects under NNRMS Programme. Out of this, seven projects have been sanctioned. The Committee also reviewed the recently completed projects and accepted the Final Technical Reports of six recently completed projects.

The following projects were also monitored by the Steering Committee of the respective projects:

- ◆ Forest Type Mapping of India's Forests on 1:50,000 scale (entire country)
- ◆ Mapping of Wildlife Sanctuaries and National Parks on 1:12,500 scale
- ◆ Coastal Studies (including mangroves and

- coral reefs) on 1:25,000, and for selected areas on 1:5000 scale
- ◆ Snow and Glaciers Studies of entire Himalayas (1:2, 50,000/1:50,000 scales)

G. B. Pant Institute of Himalayan Environment & Development, Kosi-Katarmal, Almora

Introduction

G.B. Pant Institute of Himalayan Environment and Development (GBPIHED), established in August 1988 by the Ministry as an autonomous Institute has been identified as a focal agency for Research & Development on Environment and Development related issues in the Indian Himalayan Region (IHR). The Institute executes its mandate through the Headquarters located at Kosi-Katarmal, Almora (Uttarakhand), and its four regional Units located at Mohal-Kullu (Himachal Unit), Srinagar (Garhwal Unit), Pangthang (Sikkim Unit) and Itanagar (NE Unit),

so as to promote S&T initiatives for overall development in the IHR. The R&D activities of the Institute are essentially multi-disciplinary in nature and based on conscious efforts to inter-link natural and social sciences to promote sustainable development in the region. Institute's activities are centered on seven core programmes, viz., Land and Water Resource Management, Sustainable Development of Rural Ecosystem, Conservation of Biological Diversity, Ecological Economics and Environmental Impact Analysis, Environmental Physiology and Biotechnology, Institutional Networking & Human Investment and Indigenous Knowledge Systems (IKS). The project sites are spread over different parts of IHR and have been selected carefully keeping in view the biophysical heterogeneity and location-specific needs of the inhabitants. All activities are need-based, target-oriented and time-bound. Research, demonstration and dissemination are underlying elements of all project activities to develop technology packages.



Fig 56. Experiments on tea physiology at GBPIHED



Fig 57. *In-vitro* shoot multiplication in *A. Balfourii* (A), and hardened *in-vitro* raised plants of *R. maddenii* ready for field transfer (B).

Objectives

The Institute has the three broad objectives:

- ◆ To undertake in-depth research and development studies on environmental problems of the Indian Himalayan Region;
- ◆ To identify and strengthen the local knowledge of the environment and contribute towards strengthening researchers of regional relevance; and
- ◆ To evolve and demonstrate suitable technology packages and delivery systems for sustainable development of the region in harmony with local perceptions.

Activities undertaken so far

During the year, the targeted R&D activities of the Institute were undertaken under the following seven core programmes:

- ◆ Land and Water Resource Management
- ◆ Sustainable Development of Rural Ecosystems
- ◆ Conservation of Biological Diversity
- ◆ Ecological Economics and Environmental Impact Assessments
- ◆ Institutional Networking and Human Investment
- ◆ Environmental Physiology and Biotechnology and
- ◆ Indigenous Knowledge Systems.

State-wise status

- ◆ At the Himachal Unit, the studies on

conservation of biodiversity, impact of hydropower projects, air quality monitoring for assessment of impact of vehicular traffic due to tourism and plant physiology were the major focus.

- ◆ At the Garhwal Unit, Uttarakhand the major focus was placed on medicinal plant cultivation, demonstrations of rural and cost effective technologies, documentation of indigenous knowledge and soil fertility studies.
- ◆ At the Sikkim Unit, the main emphasis was on conservation of rare and threatened plants, GPS campaigns, and disaster management trainings and ecophysiology of plants.
- ◆ At the NE Units, efforts were put on documentation of indigenous knowledge of travel communities, NTFPs use, and soil fertility studies. Technology backstopping of NGOs is another programme. The demonstrations, dissemination and capacity building activities of the stakeholders are inherent in all the R&D efforts.

Progress / Achievement made during the year

- ◆ Land and water being the fundamental resources for the region and issues involved in their conservation and management R&D activities were focused on traditional land and water management systems, water availability and use pattern, water discharge from springs of different geology, land use and land cover, in selected catchments of IHR. Studies were continued on glacial retreat and sediment discharge pattern in Gangotri, Thelu, Dokriyani and Milam glaciers in Uttarakhand. To understand and quantify the dynamics of tectonic deformation rate, data was retrieved from the Global Positioning System installed around the four regional Units and Institute HQs and also for landslide monitoring in certain localities in Uttarakhand and Sikkim.
- ◆ Quantification of resources and their use patterns for rural development planning are another important area for natural resource

management. Surveys were continued for resource dependency including pasture use by the migratory livestock in the selected locations of the region. Biodiversity conservation efforts were focused on:

- ❖ consolidation of information on temperate plant endemics;
- ❖ biodiversity studies in protected areas (i.e., Cold Desert Biosphere Reserve and Manali, Kais and Khokhan Wildlife Sanctuaries);
- ❖ up-gradation of *ex-situ* gene banks; and
- ❖ promotion of conservation education through participatory mechanisms.
- ◆ The database on Himalayan bioresources was further strengthened through:
 - ❖ updating information on plants from Trans, North West and West Himalaya;
 - ❖ diversity assessment of pollinators, avifauna, and fishes; and
 - ❖ biodiversity database for Himalayan Biosphere Reserves.
- ◆ In order to strengthen the conservation efforts further, propagation protocols for some of the rare threatened and economically important plants were continued to be developed, some of these were adopted for large-scale multiplication and field demonstration. Active ingredients of medicinal plants, such compounds were quantified for selection of elite stock plants. Several bacteria, isolated



Fig 58. Screening of various landraces of rice collected from Central Himalayas

from various types of soil were developed as inoculants, which improved survival of *in vitro* raised plants and influenced plant growth. The use of chemicals on improvement of root formation in cuttings and seed germination of *Podophyllum hexandrum* and *P. peltatum* was applied extensively for plant propagation. Experiments on seed germination (*Hypericum perforatum*, *Swertia angustifolia*, *S. chirayita*) and propagation protocols (*Hedychium spicatum*; *Malus sp.*; *Selinum tenuifolium*).

- ◆ Himalaya being a sensitive domain is susceptible for changes due to developmental activities. Studies were therefore undertaken to analyze the impact of urbanization and tourism on air quality in selected destinations in HP and socio-economic and environmental impacts (soil and water quality, biodiversity) of vegetable and tea cultivation in Uttarakhand hills.
- ◆ The hydropower generation from the Himalayan rivers is another important thrust push forward by the Government. Therefore, EIA studies and formulation of environmental management plans for a few hydropower projects in Uttarakhand and Himachal Pradesh were undertaken.
- ◆ Indigenous knowledge system (IKS) is another area that has vast potential for conservation and sustainable use of resources. Documentation of IKS was therefore carried out relating to pastoralism, weather indicators in central Himalaya, crop field soil fertility management, pest control practice in the traditional societies of Manipur and NE region. The IKS digital library has added more datasets based on published literature on IKS in the Himalayan region. Through the Integrated Ecodevelopment Research Programme (IERP) of the Institute, the infrastructure, expertise and scientific manpower available in the IHR were effectively complemented.
- ◆ The demonstration activities make another important aspect of the R&D programmes



Fig 59. Training Programmes among the rural communities coordinated by GBPIHED

of the Institute. Demonstrations relating to land and water resources conservation to accrue the direct benefits such as fodder production was one such example. To achieve this, Sloping Watershed Environmental Engineering Technology (SWEET) package for rehabilitation of community wasteland executed over 120 ha in 11 different localities was maintained and monitored for fodder production and other benefits. Under the PARDYP (People and Resource Dynamics)

Project integrated water harvesting linked with pisciculture helped over 52 farmers of 25 villages (Table-21). The water harvesting linked with off-season vegetables and cash crop cultivation, high-yielding agricultural crops, nursery development, etc., have been adopted by 145 farmers of 39 villages. In addition, rehabilitation of degraded community lands through silvi-pasture and other rehabilitation approaches at eight locations (in Kumaun and Garhwal hills)

Table-21. Adoption of integrated fish farming and earning over a period of six years

Items	2000	2001	2002	2003	2004	2005
No. of farmers engaged	2	15	20	40	45	52
No. of villages covered	2	9	15	22	24	25
Total no. of tanks	3	22	35	61	67	70
Total inputs (Rs.)	2,900	18,300	32,800	43,200	44,500	46,000
Total income (Rs.)	6,200	67,700	97,620	178,370	183,700	190,500
Net income (Rs.)	3,300	49,400	64,820	135,170	139,200	144,500

significantly improved the ground cover and produced around 65 tonnes of fodder grass.

- ◆ The Village Environment Action Plan (VEAP) developed by the Institute was implemented in a model village (Raikot; Distt. Almora) jointly with NCC under “*Operation PARADE*” project. The main components of the project were: wasteland rehabilitation, rainwater harvesting and capacity building of the inhabitants on environment-friendly technologies. Strengthening the Rural Technology Complex and demonstration centers at Kosi-Almora, Garhwal and NE Units for training and extension of environment-friendly and cost-effective technologies among a range of user-groups continued to be one of the main activities. Through this activity 35 training programmes covering a total of 3160 people were trained. Trainings were imparted on protected cultivation, bio-composting, mushroom cultivation, vegetable cultivation, agroforestry, horticulture, multipurpose tree plantations, cash crop cultivation, water harvesting, fish cultivation, bio-briquetting, soil conservation, watershed management, waste land development, etc. to the farmers selected by different Government organizations NGOs, and students. Promotion of conservation education in school/college students and teachers through orientation courses and training workshops and involvement of youth in real time weather observations, improved the outreach of the Institute.
- ◆ Demonstrations on income generating activities such as cultivation of medicinal and aromatic plants (MAPs), value-addition in wild edibles and bamboo resources were also extended among the rural areas of the region. A bamboo network programme improved the outreach in terms of elite stock raising and its distribution to user groups and plantation. The existing *ex situ* gene banks of the Institute [i.e. Arboretum (HQs & Sikkim Unit); herbal

gardens (HQs, Sikkim & HP Unit)] were further strengthened through new introductions and area expansion.

Research on Biosphere Reserves

Research and development projects are supported in the designated Biosphere Reserves and potential sites. During the year, nine research projects were completed which provided baseline data in the scientific management of these Reserves. Important achievements include:

- ◆ Database for land resources and strategy for their management in Nanda Devi Biosphere Reserve
- ◆ Development of Desert Biosphere Reserve
- ◆ Land use changes in Panchmarhi Biosphere Reserve, and
- ◆ Monitoring of elements of Biodiversity in Biosphere Reserve

A list of completed projects under the scheme is given in Annexure-IV. During the year, five new research projects were also invited which aimed at monitoring of Biodiversity for long term conservation as per details at Annexure-III.

Research on Wetlands, Mangroves and Coral Reefs

Wetlands

A Research Sub-Committee on Wetlands has been constituted to identify more wetlands of



Fig 60. A view of Indian Corals (*Acropora sp.*)



Fig 61. Mangroves with seedlings – a species needs extensive conservation

national importance and to supplement management action plan for intensive conservation on thrust areas of research.

During the year, four research projects were sanctioned as detailed at Annexure-III.

Mangroves and Coral Reefs

The Research Sub-Committee on Mangroves and Coral Reefs has been constituted to supplement baseline information on priority areas of research through research projects for effective executives of Management Action Plans.

The research Sub-Committee on Mangroves and Coral Reefs met on June 2, 2006 in the Ministry and reviewed the ongoing research projects. The Committee also considered 22 new projects and recommended only seven projects which are being processed for financial assistance by the Ministry.

Indian Council of Forestry Research and Education

Introduction

Indian Council of Forestry Research and Education (ICFRE) is an apex body in national forestry research system with the mandate to develop a holistic approach through need based planning, promoting, conducting and coordinating research, education and extension covering all aspects of forestry for ensuring scientific management of forests, tree improvement, forest productivity through scientific and biotechnological researches, bioremediation of degraded land, efficient utilization of forest produce, value addition of forest products, conservation of biodiversity and climate change, appropriate agro forestry models for various agro ecological zones, policy research, environmental impact assessment and integrated pests and disease management.

ICFRE has eight regional research institutes and four advanced research centres in different bio-geographical zones of the country to cater to the forestry research needs of the nation. These are as follows:

Research Institutes

- ◆ 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

- ◆ 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 Centre for Bamboos and Rattans (ACBR), Aizawl

Objectives

- ◆ To undertake, aid, promote and coordinate forestry education, research and applications thereof.
- ◆ 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 other 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.

Activities undertaken by the Council

- ◆ An integrated community based forest management project sponsored by Planning Commission of India is being implemented in Bihar by ICFRE.
- ◆ Preparation of Catchment Area Treatment Plan (CATP) for bauxite mining in Muliagalugu, Anantagiri and Sunkermetta Reserve forests in favour of Andhra Pradesh Mineral Development Corporation (APMDC) is under completion by ICFRE.
- ◆ Forest Research Institute (FRI), Dehradun optimized reaction conditions to modify a-cellulose (Av. DP 816) obtained from Bamboo, (*Dendrocalamus strictus*) into hydroxypropyl cellulose using varied concentration of propylene oxide, NaOH, hydroxypropylation time and temperature.
- ◆ FRI, Dehradun has prepared particle board from sisal fiber blended with parthenium. It qualifies for most of the properties of particle board.
- ◆ FRI, Dehradun has optimized conditions to produce (Alkaline Peroxide Mechanical Pulping) APMP pulp from *Eucalyptus tereticornis*.
- ◆ FRI, Dehradun has produced and tested Lignosulphonate from dry pine needle.
- ◆ FRI, Dehradun conducted isolation of *Bipolaris* from different clones of *P. deltoides* and their photographic documentation.
- ◆ Arid Forest Research Institute (AFRI), Jodhpur has raised nursery for clonal plants of *Jatropha* from stem-cuttings of four local and twenty strains from Tamil Nadu and Kerala supplied under network programme.

- Oil of selected accessions has been tested which varied from 25% to 35% on seed weight basis.
- ◆ AFRI, Jodhpur has conducted experiments on use of cheaper alternatives to media components, which show the potential of sago and isabgol as viable solidifying agents in Tissue culture.
 - ◆ AFRI, Jodhpur identified four species of wood boring insects, which cause considerable damage to the living standing trees of *Tecomella undulate*. Three species of termites are also observed to be associated with the infestation in *T. undulata*. They cause a considerable damage to the dead wood as well as living trees.
 - ◆ Himalayan Forest Research Institute (HFRI), Shimla has raised demonstration plots of medicinal plants at Deedagh (High altitude), Kalat (Mid altitude) and Salahan (Lower altitude) covering an area of over 0.05 ha at each locations under Good Idea Fund Project in district Sirmour, Himachal Pradesh. Plots as established included species of *Actonitum*, *Valeriana*, *Picrorhiza*, *Rauwolfia*, *Withania*, *Aloe vera* etc.
 - ◆ Centre for Social Forestry and Eco-Rehabilitation (CSFER), Allahabad has completed plantation work and analysis of data for progeny trial under the NOVOD Board Project titled 'Research and Development of Jatropha under National Network Programme'.
- Progress/Achievements during the year**
- ◆ FRI, Dehradun has studied variations in lignin, extractives and ash in case of subabul collected from different geographical regions.
 - ◆ FRI, Dehradun has identified *Earliella scabrosa* as a white rot causing fungus in stored wood of poplars.
 - ◆ As part of *ex-Situ* conservation project *Angelica glauca*, *Valeriana wallichii*, *Nurdostachys jatamansi* and *Eremostachys superba* collected from Gopeshwar Mandal and Kaddu Khal were introduced in Botanical Garden by FRI, Dehradun.
 - ◆ Fifteen Bamboo species other than existing in FRI Bambustum were collected from Arunachal Pradesh and introduced in the bambusetum of FRI, Dehradun.
 - ◆ Institute of Wood Science and Technology (IWST), Bangalore estimated the viscosity and density of oil of *Pongamia pinnata* seeds collected from all four silvicultural zones of Karnataka.
 - ◆ AFRI, Jodhpur has identified five promising clones for *Eucalyptus camaldulensis* out of thirty clones planted.
 - ◆ AFRI, Jodhpur has completed model plantation work and establishment of experiments at Kaushalgarh, Saira (Rajasthan) and Dahod (Gujarat) as per guidelines of DBT with planting stock of *B. bambos* and *D. strictus*. Initail data recorded after one month and survival percentage is more than 90 at all sites.
 - ◆ Documentation of traditional knowledge regarding various uses of plants by the tribals of Hoshangabad circle was done in Tropical Forest Research Institute (TFRI), Jabalpur.
 - ◆ TFRI, Jabalpur conducted vegetation study, profile study and microclimatic study at Jagdalpur (CG) ecotone area.
 - ◆ HFRI, Shimla has raised, maintained and distributed seedlings of around 90,000 medicinal plants under National Medicinal Plant Board funded project to various end users including State Forests Departments, Non-governmental organizations and farmers.
 - ◆ CSFER, Allahabad has developed the planting stock of medicinal plants as agroforestry cash crop for local farmers.

Other Activities

- ◆ The ICFRE organized a meeting of stakeholders on "Proposed policy reforms to remove the barriers to CDM Afforestation

and Reforestation (A/R) Projects" on September 14-15, 2006.

- ◆ FRI, Dehradun celebrated 'Centenary' on the theme 'Research Achievements of FRI since last 100 years' on June 5-6, 2006.
- ◆ FRI, Dehradun organized a conference on 'Natural Products and Biodiversity: Chemistry and Utilization' on November 2-3, 2006.
- ◆ FRI, Dehradun organized an International Seminar on 'Planted Forest : Eco-system Goods and Services' from December 13-15, 2006.
- ◆ Sir Brandis Walking Trail was laid out in the city center of FRI, Dehradun to provide information on tree diversity.

Comparison of progress

Initiatives has been taken for establishment of Van Vigyan Kendra in each State/UT for under taking research activities of the institutes and training of the stakeholders. State/UT-wise status of research projects is given in Table-22.

Indian Institute of Forest Management, Bhopal

Introduction and Objectives

Indian Institute of Forest Management (IIFM) was established in 1982 as an autonomous institution of the Ministry in response to the recommendations by the National Commission on Agriculture. It is a registered society and governed by a Board of Governors.

Table-22. State/UT-wise status

Name of state	No. of Projects completed in 2005-2006	No. of ongoing Projects in 2005-2006	No. of Projects initiated in 2005-2006
Andhra Pradesh	—	8	1
Andaman & Nicobar	—	—	1
Arunachal Pradesh	2	5	—
Assam	10	8	6
Bihar	—	1	—
Gujarat	—	2	—
Haryana	3	2	—
Himachal Pradesh	4	27	8
Jharkhand	2	10	1
Karnataka	2	8	6
Kerala	2	11	2
Manipur	2	4	—
Meghalaya	3	5	—
Mizoram	2	3	1
Nagaland	3	4	—
Punjab	4	—	2
Rajasthan	8	14	5
Tamil Nadu	5	13	6
Tripura	3	4	—
Uttarakhand	8	18	20
Uttar Pradesh	1	1	—
West Bengal	1	8	—
Total	65	156	59

The Institute, as a sectoral management institute, imparts education in forest management, which is a judicious combination of management, social, and forestry sciences. As a management institute in the forestry sector, the institute undertakes research activities of applied nature in the field.

Indian Institute of Forest Management to be among the leading international institutions in the area of forest, environment and development management and, be respected, both nationally as well as internationally, for its outstanding contributions in the fields of education, training, research, consultancy and, thought leadership.

Activities undertaken

The Institute is carrying out around 20 research projects under different funding categories. Apart from these short-term projects, the institute is implementing two long-term projects, one on community Forestry and another project on Sustainable Forest Management. During the year, the institute has completed another externally sponsored long-term project on 'Capacity building of village level institutions for collaborative NRM'. Following are the significant findings that emerged out of research projects completed during the year:

- ◆ Recently, many farmers left medicinal plant cultivation due to high planting material and production cost and low prices.
- ◆ In Joint Forest Management (JFM), conflicts often occur due to lack of livelihood opportunities and hence villagers resort to illicit felling activities. The conflict management capacity of a joint forest management committee also depended on the age of the committee. Human resource development can be part of the project prepared for Forest Development Agencies.
- ◆ The project aimed at exploring the potential corridors that can connect the Kanha and Pench national parks by using GIS revealed that wildlife migration corridors between these two areas were very much possible both in terms of physical connectivity and land availability. Most land in the proposed

migration routes is with the forest department and as such needs to be developed to meet animal migration requirements.

- ◆ The motivational analysis revealed that EDC should be strengthened by integrating the immediate needs so that villagers' level of survival and safety needs can be raised and people start believing the relation between Protected Areas (PA) conservation and their need satisfaction and understand the role of forest department in this regard.
- ◆ The JFM policy had revived villager's sense of belongingness towards forests which was lost during the period when forest was under the full control of the Government. There was a good amount of horizontal solidarity among the villagers and between the villages; but the vertical linkage between the villages and the government, the NGOs, and other stakeholders outside the village was low.
- ◆ The Natural Resource Accounting project developed methodologies and framework for accounting of Forest and Land in the states of Himachal Pradesh and Madhya Pradesh. The study has generated various resource accounting tables for land and forestry sector respectively using secondary and primary data.

Indian Plywood Industries Research and Training Institute (IPIRTI), Bangalore

Introduction

Indian Plywood Industries Research and Training Institute (IPIRTI) is an autonomous research and training institute of the Ministry. It is mandated for research, extension, training, testing and standardization on all aspects related to production of plywood and other panel products from wood and other lignocellulosic materials with special emphasis on utilization of bamboo and converting the same to value added products like bamboo mat corrugated sheets, bamboo mat board, bamboo mat veneer composites, etc.

Objectives

The research mandate of the institute includes:

- ◆ Research on all aspects related to production of sawn timber, manufacturing plywood and other allied engineered and reconstituted panel products from wood and other lignocellulosics including improvement of products, manufacturing processes, improvement of machines and appliances, conditions of work - time and motion studies - standardization of methods of working of factories.
- ◆ Inspection, certification and testing of all forest products viz. plywood, wood, timber, hardboard, particleboard, chipboard, furniture, glulams, compreg, doors, panel doors, block board, flush doors, veneered panels, veneers laminated panels, composite boards, and the products of allied trade and industry.

Highlights of activities during the year

Establishment of Particle Board Pilot Plant Facility at IPIRTI, Bangalore

Establishment of Pilot Plant for Particle board at IPIRTI will serve many purposes:

- ◆ The plant is set up with entirely indigenous machinery which will encourage the industry to set up bigger plant with indigenous machinery.
- ◆ Exploration of the suitability of various timber species, soft and hard for particle board manufacture.
- ◆ Development of suitable adhesive with low formaldehyde content and standardize process parameters.
- ◆ HRD through training for supporting the industry.
- ◆ R&D for product development.

Establishment of Common Facility Centre [CFC] for Primary Processing of Bamboo and Mat Weaving at Thiruchirappalli

The Center was inaugurated by the Hon'ble Union Minister on December 16, 2006. IPIRTI took key role in preparation of specification for the machineries for the Centre, procurement of

machineries, commissioning and installation and training of artisans on floor level by deputing two technicians from the Institute.

Machineries for primary processing of bamboo include Bamboo Cross Cutting 1No., Bamboo Splitting 1 No., Knot removal and width sizing 1 No., Slab making 2 Nos., Sliver making 3 Nos., Mat weaving 1 No.

Development of Moulded skin from bamboo mat for door shutters

Bamboo mat moulded skin developed for door shutters is of high strength values. This will reduce the consumption of wood used in door shutters and also serves as an import substitute for high density skin boards for door shutters.

Progress/Achievements made during the year

Some of the research projects of IPIRTI are as follows:

- ◆ Technology Development of Phenol Lignin Formaldehyde Resin/Adhesive suitable for plywood production as per Indian Standard where replacement of phenol partially by lignin in phenolic resin for higher grade plywood have been developed.
- ◆ Development of adhesive from bio materials. Under this project utilization of bio materials obtainable from natural renewable source are being used in the development of phenolic adhesives which also helps in the reduction in the use of petroleum based chemicals and also helps in disposal of industrial wastes for better utilization, thereby reducing the pollution problems.
- ◆ Establishment of Demonstration Unit for preliminary bamboo processing with indigenous machinery at Tiruchirappalli, Tamil Nadu for production of bamboo mats and training - The main aim of this project is to make the availability of bamboo mats for industrial needs to produce Bamboo Mat Board (BMB), Bamboo Mat Veneer Composite (BMVC), Bamboo Mat Corrugated Sheets (BMCS) etc., .and also to



Fig 62. Two storey bamboo house construction

improve the quality of the mats and increasing the productivity with the help of bamboo processing machinery.

- ◆ Setting up production and training centre for Bamboo Mat at Magadi sponsored by NMBA, New Delhi - The main aim of this project is to make the availability of bamboo mats for industrial needs to produce BMB, BMBC, BMCS etc., and also to improve the quality of the mats and increasing the productivity with the help of bamboo processing machinery.
- ◆ Development of particle board from plantation grown timbers like eucalyptus and Poplar: This development helps to utilize timber of plantation origin (soft and hard) for the manufacture of particle board.
- ◆ Development of phenolic resins for high moisture content veneers : The objective of this project was to increases the production capacity and input of less energy for drying.
- ◆ Development of Moisture Resistance (MR) grade plywood by substituting the commercial extenders by an additive (VISCOPLUS) in urea formaldehyde resin adhesive. This project is aimed to find a replacement to the commercial extenders used by the industries. This project is aimed to find the replacement to the commercial extenders used by the industries.
- ◆ 5Ec (Biflex) against borers and termites for protection of wood and plywood at IPIRTI :
- ◆ Broadening the use of bamboo technologies in the construction of social infrastructure Phase 1: Modular prefab house using bamboo mat boards was designed and fabricated.
- ◆ Study on preferential absorption of chemicals in dip diffusion process of veneer treatment with fixed type of preservative: This study will help to achieve uniform retention of chemicals in treated panels at every stage.
- ◆ Life Cycle Analysis of BMCS : This study is aimed to predict the durability of bamboo mat corrugated roofing sheets.
- ◆ Study on resin intake of bamboo mats at each stage of dipping and its effect on resin properties on bamboo mats and residual resin solution.
- ◆ Development of compreg from Bamboo mat and veneer from plantation timber or in combination: The compregs developed can find application in railway coaches and for electrical grade purposes.
- ◆ Development of high density shuttering grade plywood using bamboo mat and veneers from plantation timbers: This project is aimed to ease the pressure on import of timber currently being used considering the demand of this product and cost reduction of the final product by using bamboo mats.
- ◆ Development of fire retardant flush door: To develop doors with fire resistance properties wherein it can meet national building code requirements for high rise buildings.
- ◆ Development of Cellular Core Flush Door from solid: This project is aimed to replace timber in the core frame with bamboo ring thereby having maximum utilization of bamboo with virtually no waste.
- ◆ Development of low cost phenol formaldehyde adhesive: This study reduces the cost of existing phenol formaldehyde

- resin. Under this project a three stage phenol formaldehyde resin has been developed for manufacturing BWP grade panels.
- ◆ Effluent treatment of chemicals discharged from plywood industries: This project is aimed to evolve process for reduction of pollution level in effluent from wood based panel industry.
 - ◆ Development of acoustic panel from jute, coir and sisal fibre: The objective of this project is to develop economically viable acoustic panels.
 - ◆ Development of pilot scale facilities for research and training for manufacture of particle board and bamboo laminates : This project facilitates for the development of appropriate technologies thereby creating technological capabilities in the country with small capacity indigenous machinery and also the usage of agro and forest residues can also be made for manufacture of particle board.
 - ◆ Development of floor tiles – glazed and mat finish from bamboo strips : The project aims to develop flooring material from bamboo which can replace ceramic tiles or marbles and also the improvement of surface design to make the product attractive to users.
 - ◆ Development of machine for efficient veneer finger-jointing: The machine for veneer finger-jointing was developed, installed and commissioned. Trials were taken on veneers from different species of timbers and thicknesses. The performance of machine was found to be quite satisfactory.
 - ◆ Enhancement of utilization of plantation timbers through edge lamination: Pneumatic clamp carrier developed and installed in the plant was used for the study. Detailed studies were carried out on finger-jointed and edge laminated panel boards made from rubberwood. Strength properties were also studied for edge laminated boards made from another plantation timber species, viz *Grevillea robusta*, using UMF resin.
- ◆ Suitability of plantation grown timber species received from Tamil Nadu for finger jointing– Phase I. Three species of timbers viz. *Gravillea robusta*, *Acacia suma* and *Chloroxylon swietenia* were taken up for studies. The work on three species of timber were completed. It was found that finger-jointed timbers from these species had strength in the range of 60-70% compared to defect free solid timber from the respective species.
- ◆ Development of products from new generation eco-friendly materials: Design, fabrication, installation and commissioning work of moulding dies on hydraulic hot press was completed for making moulded skin board for doors using bamboo mats. A number of Moulded skin boards and doors were made and were tested for strength properties. Finishing works on doors were also taken up and were at various stages of trials.
- ◆ Setting up of demonstrative unit of bamboo mat manufacturing in collaboration with M/ s Sri Sankara Educational and Charitable Trust, Trichy.
- The procurement of primary processing machines for the unit at Trichy was carried out. The machinery were installed and commissioned.

Wildlife Research

Wildlife Research covers ecological, biological, socio-economic and managerial aspects of wildlife conservation in various parts of the country. The research projects generate valuable scientific data, help evolve study techniques relevant to the Indian ground condition, and also create a group of trained field biologists, socio-economist and wildlife managers. The scientific information generated is utilized for management of protected areas. Wildlife research is coordinated by Wildlife Institute of India (WII), Dehradun.

A large number of research projects on diverse aspects on wildlife and coordinated by WII is at various stages of implementation. These projects are either grants-in-aid projects of WII or sponsored as collaborative projects.