



RESEARCH

[Environmental Research, G.B. Pant Institute of Himalayan Environment & Development, Research on Biosphere Reserves, Wetlands, Mangroves and Coral Reefs, Forestry Research, Indian Council of Forestry Research & Education, The Indian Plywood Industries Research and Training Institute, Indian Institute of Forest Management, Wildlife Research, WII, NNRMS]

The Research and Development scheme of the Ministry is a Central Plan Scheme for promotion of research in multi-disciplinary aspects of environmental protection, conservation and development. The objective of the scheme is to generate information required to develop strategies, technologies and methodologies for better environmental management. It also aims at attempting solutions to practical problems of resource management, conservation of natural resources and eco regeneration of degraded areas. Further, the scheme also seeks to strengthen facilities to facilitate research and scientific man-power development. In order to achieve above objectives, research grants are provided in the identified thrust areas to various institution/ universities and non-governmental organisations all over the country. These are supported under the following main programmes :

- Ecosystem Research Programme
- Environment Research Programme
- Research Programme for Eastern and Western Ghats.

- Pitambar Pant National Environment Fellowship Award.
- B.P. Pal National Environment Fellowship Award for Bio-diversity.

Ecosystem Research Programme is an inter-disciplinary programme of research which emphasizes



Fig 62. *Achaea jassata* Linn. larva feeding on flower buds of *Tamarindus indica*



Fig 63. *Gmelina arborea* - damaged by bark eating caterpillar, *Indarbela quadrinotata*

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 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 eco-system approach consistent with the identified thrust areas and orientation.

The Ecosystems Research Advisory Committee considered 68 projects during the year out of which 12 projects were recommended for funding by the Ministry and decision on 12 projects was deferred for want of additional inputs from the principal investigators. The remaining were not found suitable for funding.

The Environmental Research Programme specially deals with problems related to air, water and soil pollution and development of suitable cost effective technology for abatement of pollution load in the environment. Emphasis is given on development of eco-friendly biological and other interventions for prevention of pollution, development of strategies/technologies, instruments etc. Projects are also encouraged for development of biodegradable plastics, epidemiological studies, ways and means to reduce impact of mining, chemical pollution of soils, hazardous substances including pesticides, heavy metals, etc. Waste recycling and resource recovery from waste along with development of eco-friendly and cleaner technology are given due priority.

Three meetings of the newly constituted committee for the programme were held during the year. It considered 146 new projects out of which 29 projects were recommended for funding and decision on 25 projects was deferred and returned for revision. Two review meetings to assess the progress of ongoing projects were held at Central Institute for Medicinal and Aromatic Plants; Lucknow and Central Leather Research Institute; Chennai. The Lucknow meeting was for projects based in the northern region and the Chennai meeting was for the projects of southern region. More than 30 principal Investigators presented their findings in each of these meetings before the committee members. The members reviewed the progress and gave suggestions for further implementation of the project.

The Eastern and Western Ghats Research Programme addresses itself to location – specific problems of resource management in the Eastern and Western Ghat regions of the country. Under this programme, studies relating to Bio-diversity, land use, impact of developmental activities etc. are taken up. Three meetings of Eastern & Western Ghats Committee were held during the year at MoEF, New Delhi, Annamalai University, Annamalai Nagar and SACON, Coimbatore. The Committee considered 85 projects out of which 17 projects were recommended for funding and decision on 8 projects

was deferred for revision of the project. Review meetings were also held at Annamalai University and SACON where the progress of ongoing projects was assessed by the Committee.

During the year, the three Committees of the research programmes were reconstituted. During the year, 43 new projects have been sanctioned and 15 ongoing projects were completed under the scheme. The lists of projects sanctioned and completed during the current year are given in Annexures-VI and VII respectively.

During the year, the Ministry brought out a publication entitled "Environment Research in India". This is the third volume of the Compendium of the executive summaries of 114 completed projects funded under the research programme of the ministry.

Significant results of the completed projects

Biodiversity of Fishes of Manipur and Conservation of Endangered species



Fig 64. *Heracleum candicans* - a high value medicinal plant grown under different treatments

The study was undertaken for an approach to counter the continual loss of the biodiversity of the fish fauna and also to save endangered species. Collection and identification of fishes were carried out in all the nine districts of Manipur and detailed survey of ichthyofauna of all the rivers, lake and hill stream were carried out. A



Fig 65. *Russula praetervisa* Sarnari - a new record of fungus from India

total 167 species have been reported under the study. Four new species (*Puntius ornatus*, *P. bizonatus*, *Hara serratus* and *Myersglanis jayarami*) were described and two new records of fishes (*Mystus pulcher* and *Exostoma sturti*) were reported out of the total of 167. Phylogenetic relationship for the genus *Puntius* has been illustrated considering the species, *Puntius ticto*, *P. manipurensis*, *P. chola*, *P. sophore*, *P. jayarami*, *P. conchoniis*, *P. stoliczkanus* and *P. orphoides*. Phylogenetic relationship of the genus *Silurus* has been established between *morehensis* and a new species. Many commercial values ornamental fishes have also been sorted out. Moreover, biological studies of certain high value food fishes have been carried out for its conservation under the study.

Ecological and Faunistic survey of Homopteran Pests (Leaf and Plant Hoppers) from rice fields, grass lands and wet lands of Sagar Island and Adjacent Namkhana Delta Lobe of Sundarbans, West Bengal

The study was undertaken to assess the magnitude and diversity of Homopteran insects at Sagar Island in different seasons of the year and the adjacent Namkhana Delta Lobe of Sunderbans Biosphere Reserve by using common ecological indices. A total of 21 Homopteran species from this region distributed over two families (Cicadellidae and Fulgoridae). One is entirely new species. The seasonal occurrence of species in the culturable paddy crops and salt marsh grass based on the conspicuous environmental variables are also enumerated. The study also illustrates distribution of these pests in Asian subcontinent and some of them playing the role of carrier of agricultural disease virus have been reviewed. Information generated in this study is expected to be helpful to the agriculturists to devise remedial measures for their control.

Exploiting Vesicular-Arbuscular Mycorrhizal Fungi for Revegetation of Land Degraded by Shifting Cultivation in N.E. Region of India

Under the study extensive survey was carried out to determine Vesicular-Arbuscular Mycorrhizal (VAM) Fungal status of the land degraded by shifting cultivation. In addition to it, survey was also conducted to ascertain the micro-biological and biochemical status of the degraded

lands as well as their vegetation. Attempt was also made to raise seedlings on the degraded soil using VAM inoculation.

The study showed that the shifting cultivation caused extensive damage to the VAM population as well as to the other microbial population of the soil. The pH, P_2O_5 and K_2O level also underwent drastic change. Even after 5 years of abandonment, the VAM population, the microbial population, the pH, P_2O_5 and K_2O level did not show much improvement. The study also revealed that the succession of vegetation was slow due to poor VAM population of the degraded soil. Only few VAM independent plants colonized the degraded soil in the first year. From second year, a few more types of weeds started appearing but the process of colonization was extremely slow. The percentage of VAM infection in roots of such weeds was very low compared to their counterparts in adjacent natural areas. The complete coverage of open space by *Mikania scandens* reduced further plant diversity.

Lack of adequate VAM spores in degraded soil was found to be the main cause that hampered establishment of introduced plants and therefore revegetation with economic plants was not possible in such abandoned degraded land. Experiments showed that VAM inoculation would help survival and establishment of introduced plants but their further growth and development were dependent upon some other associated problems like lack of adequate microbial support and lack of organic matter and nutrient.

Toxicity evaluation of the Leachates of solid hazardous industrial wastes

Objectives of the study was to generate the toxicity data on leachates of solid hazardous industrial wastes and to develop and validate the cost-effective tests for safety evaluation of toxicity and its fate in the ecosystem and the safe disposal; while disseminating the awareness to the authorities managing the solid waste particularly to industrial hazardous wastes. Leachates were subjected to bioassay test in aquatic organisms, phytotoxicity in seed germination, microbial toxicity test and earthwork toxicity test as a part of ecotoxicological tests. Chromosome breaks were observed in allium cepa test with the tannery waste leachates. The effects of leachates from metals solid wastes on cytogenetic profile were quite significant as large number of chromosome breaks were noted.

Behavioural changes were noticed in the earthworm toxicity tests. Some changes too have been encountered in the borrowing time of earthworm. Metal leachate was found to be most toxic among all leachate samples in the cocoon production. Three research papers have been published during 2002 based on the data of the project.

Fabrication of low cost hospital waste incinerator and performance evaluation

Project was commenced on 01.11.2001 and completed on the march 31, 2003 with a total grant of Rs.10,17500/-.The primary objective of the project was to fabricate a medical waste incinerator with Best Available Technique Not Entailing Excessive Cost (BATNEC). Beside, the project aim was to popularise the use of incinerators among small and moderately functioning hospitals. Research on the above discovered that the double chamber round incinerator placed side by side was better than that of the rectangular incinerator. The double tier incinerator was found to be non-performer. Fabrication of double tier incinerator was proved to be difficult notwithstanding its good performance. Finally, it was noted that the small incinerator were economically not viable as the fuel consumption was found to be too high and the high pressure necessary to push the air in the air column of the stack could not be met by the small incinerator.

The Species Diversity of the algal flora of the Western Ghats of Kerala Region

The study has been undertaken to survey the algae vegetation from different habitats of Western Ghats of Kerala Region with an attempt to generate first hand, usable information on taxonomy of terrestrial and aerial algae of Kerala. Under the project, 452 species were collected and identified from different regions of the Western Ghats. 227 species of Chlorophyta were reported from 44 genera, 18 families and 9 Orders. The highest number of species is from *Oedogonium* (33), *Closterium* (29), *Euastrum* (24), *Spirogyra* (14) and *Zygogonium* (10). The diatoms species were numerous in the sample and only 71 species were identified from 10 genera, 6 families and 2 orders. From Blue Green Algae 89 species were identified from 25 genera, 8 families and 3 orders. The maximum species were collected from *Oscillatoria* (16) followed by *Lyngbya* (10) and *Phormidium* (10). Only 7 species were collected from *Euglenophytes* from



Fig 66. *In-vitro* conserved shoots of rare endemic (*Piper barberi*)

2 genera and one family. From *Dinophyta* and *Rhodophyta* three species each were reported. The Division *Xanthophyceae* is reported by only 2 species.

G. B. Pant Institute of Himalayan Environment and Development, Almora

G.B. Pant Institute of Himalayan Environment and Development was established in August 1988, at Kosi-Katarmal, Almora (Uttaranchal) by the Ministry as an autonomous institute. The institute is identified as a focal agency, to advance scientific knowledge, to evolve integrated management strategies, demonstrate their efficacy for conservation of natural resources and to ensure environmentally sound development in the Indian Himalayan Region (IHR). The institute executes its mandate through the headquarters located at Almora, and through four regional units located at Mohal-Kullu (Himachal Unit), Srinagar (Garhwal Unit), Tadong-Gangtok (Sikkim Unit) and Itanagar (NE Unit), so as to promote S&T initiatives for overall development in the



Fig 67. Nursery of *Allium spp.* and *Rheum emodi* grown at a high altitude village in Garhwal Himalaya

Indian Himalayan Region (IHR). The broad areas of concern are covered through seven Core Programmes, namely Land and Water Resource Management, Sustainable Development of Rural Ecosystems, Conservation of Biological Diversity, Ecological Economics and Environmental Impact Assessment, Institutional Networking and Human Investment, Environmental Physiology and Biotechnology and Indigenous Knowledge Systems.

Land and water are the two prime resources for sustaining life in the IHR. To make the optimal use of these resources researches were conducted and environment-friendly land management models were demonstrated and trainings were imparted among the rural communities. Use of rain water harvesting for rehabilitation of community wastelands was one of the approach. The Institute followed watershed management approach to serve the local needs for sustainable management and utilization of bio-physical resources in several watersheds across the IHR Dugar Gad, Srikot Gad and Takoli Gad watersheds in Garhwal Himalaya, Bhetta Gad-Garur Ganga watershed in Kumaun Himalaya and Mamaly watershed in Sikkim Himalaya). The indigenous methods of soil and water conservation (SWC) among the traditional communities were documented and some of them were found promising to be incorporated suitably in our resource management models. For example Nyshi tribe in North Eastern region mostly use wood barriers with stone lining against the slope in a zig-zag pattern to check soil erosion. Studies on tectonic

deformation fields in Central Himalayan are being carried out through GPS permanent station at Katarmal (Almora) and other selected campaign sites in Uttarakhand.

Water was given special focus in this “**International Year of Freshwater**”. Springs (the fresh water sources of mountain dwellers) were monitored in the region and bio-engineering measures to increase the discharge of drying springs were suggested to the rural people and extension agencies. Studies on glaciers (Gangotri and Dokriani Bamak in Uttarkashi district of Uttarakhand) were conducted and silt load in the glacial melt water of Gangotri glacier was measured. Preparation of yearbook on hydro metrology and erosion data for selected places in Kumaun Himalaya is in progress. Global change impact assessment studies in Alaknanda river basin (using PRA technique) indicated that in the lower altitude (< 1000 m) the trend of rainfall (seasonality and duration) has been changed and frequency of drought has increased in the last one to two decades. In the upper elevations (1000-2000) the frequency of extreme rainfall and other climatic events have increased and snowfall has restricted to higher ridges.

Finding suitable innovations for sustainable development of rural ecosystem has been the important R&D activity. Data on bio-resources and use practices were collected from the rural areas to develop suitable management plans for these resources. In the mountain communities there exist rich indigenous knowledge (IK) on various aspects of livelihood practices. Temur (*Xanthoxylum armatum*) is one such plant that is used for preparation of soup, chatni, leech-repellent, curing toothache, cough and cold, and as a vermicide among the Bhotiya tribes in Central Himalayan region. The IK related to the use of medicinal plants for curing different ailments by the “Vaidyas” is also very rich among the mountain communities. Similarly, IK related to vegetable drying is also being compiled.

During the year trainings on sustainable livelihood technologies viz. Raising polyhouses, polytunnels and polypits (Plate 2), cash crop cultivation in polyhouses, fish farming making small farm ponds, vermi-composting and its use for improving soil fertility, mushroom cultivation, bamboo propagation, etc. were imparted through fifteen training programmes conducted at the Institute HQs to 386 people (217 male, 129 female and 40 students) from different social strata of the region. The capability of

young researchers was improved through trainings on GIS based thematic map preparation. In the NE region contour-hedgerow-farming systems technology was found promising with regard to fertility improvement, SWC and enhancement of crop yield. For example, at one of the demonstration sites at Itanagar, yield of corn increased from 0.9 to 2.4 t/ha and that of tomato from 4.3 to 8.6 t/ha. Soil erosion was reduced to 4.3 t/ha from a high of 19 t/ha at the control site. Under the skill development and trainings on sustainable environmental technologies for NE region 45 persons belonging to eighteen NGOs from six states were trained on contour-hedgerow intercropping, water harvesting, organic farming, bio-composting, bamboo propagation, nursery and green house techniques etc. Through the Sikkim Unit thirty farmers were trained on bio-globule preparation using weeds. Also technical supplements were given to farmers for improved cultivation of ginger and other vegetables. Efforts were made to cover the tribal communities of NE region in the form of indigenous natural resource management strategies and people centred land use development in west Kameng district of Arunachal Pradesh. There are several extension programmes through which the stakeholder communities are getting direct benefits in the region. The central Himalayan region 15 ha of village culturable wasteland was brought under silvi-pasture demonstration and about 2600 saplings of fodder trees were planted in the land and fodder grass was also grown. From these sites the local people harvested more than 100 q of fodder grass, thus easing workload on the women and pressure on the surrounding forests.

Concerted R & D efforts were carried out across IHR for conservation of biological diversity. Bio-resource inventory was prepared for 677 medicinal plants of Uttaranchal. Similarly, compilation of information on over 800 species of orchids (200 of them are native of IHR) and avifauna of Himalayan Biosphere Reserves was accomplished. The Institute is a I.E.A.D coordinating Institution for Nanda Devi, Manas, Dibru-Saikhowa, Dehang-Debang and Kanchendronga Biosphere Reserves. Under this programme database on vascular plants (>300 spp.), birds (>150 spp.), arthropods (>150 spp.), mammals (sixty spp.), amphibians (seven, spp.), fish (twenty two spp.), reptiles (thirty three spp.) and useful plants (sixty spp.) was developed on UNESCO-MAB net format.

Considerable R & D efforts were made towards development of propagation protocols of important and endangered medicinal, aromatic and other plants of multiple uses for the rural inhabitants in the IHR. Some of the main aromatic and medicinal plants worked out were : *Aconitum hetrophyllum*, *Angelica glauca*, *Arnebia euchroma*, *Heracleum candicans*, *Pittosporum napaulensis*, *Picrorhiza kurrooa*, *Saussurea obvallata* and *Swertia chirayita*. Seed germination was significantly improved in *S. chirayita* from 33% (control) to 79% (GA₃ treatment) and KNO₃ treatment (Plate 3 & 4). Organogenesis and somatic embryogenesis has been induced in *A.euchroma*. In Kanawar Wildlife Sanctuary studies on population studies on population dynamics of *A. glauca* were carried out. Some of the other useful plants investigated for propagation were : Bamboo, *Myrica esculenta*, *Rhododendron spp.* and *Taxus baccata*. *In-tivto* and conventionally raised seedlings of *M.esculenta* (5000), *P.napaulensis* (1000), *P. kurrooa* (2000), *H. candican* (700), and 3000 seedlings of varous multi-purpose tree species (MPTs) were distributed for developing conservation models for restoration of degraded lands in

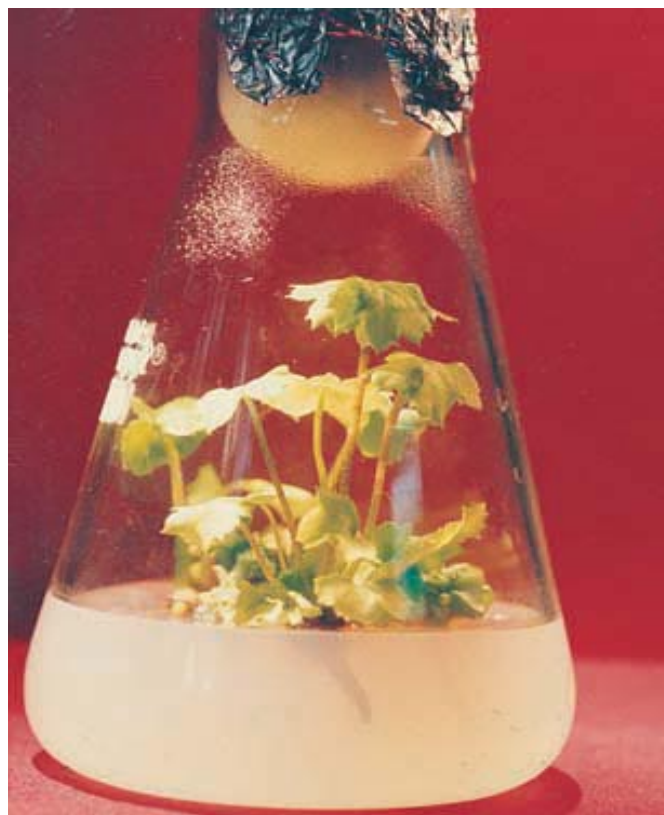


Fig 68. Micropopagation of *Porophyllum hexandrnos*

the region. Arboretum and herbal gardens to serve as a germplasm bank of the IHR and education and awareness centre for visitors have been maintained at several locations in the village community lands at the HQs, Kullu (H.P.) and Garhwal region (Plate 5). Transfer of technology on medicinal plant cultivation was imparted through training workshops from time to time. Two training workshops on biodiversity and medicinal plant conservation to students and teachers at Kullu and Sikkim. In Kullu (H.P.) 120 people (70 males and 50 females) were given training.

Mycorrhizae help in plant nutrition. VAM fungi associated with rhizosphere of five different species of Rhododendrons are being studied. Five strains of *Agrobacterium rhizogenes* were cultured and tested for antibiotic sensitivity to be used for induction of hairy roots in *P. kurroa*. This region faces seasonal droughts and adaptation of plants to this drought to study the water stress, gas exchange, growth and morphology of some MPTs were investigated. Studies on Himalayan yew (*Taxus bacata*) for its regeneration potential, phenology and bark thickness to determine its potential for taxol production continued. Wild edible oil plant (*Prinsepia utilis*) was taken up for value-addition.

Timberline vegetation represents the sensitive habitats with regards to climate change. Population dynamics studies on timberline in the central Himalayan region indicated that the species turnover (B diversity) differ from one habitat to another. To bring out better conservation and management strategies in NDBR region



Fig 69. A poly-pond collecting water through a polythene lined minor canal for use in silvi-pasture development in Dugar Gad watershed in Garhwal

and alpine meadows, studies on Oak and Pine forests in central Himalayan region were carried out on disturbance gradients, which have come up with important implications for management of these two important forests of this region. Studies on ecosystem services of these two forest types indicated that in Almora forest division the area under Pine forests is about 4.5 times greater compared to Oak forests and the revenue earned from Pine forest by the forest department was 25 times greater than the Oak forests Rs 6.32 lakh per year).

Action on conservation and sustainable utilization of biodiversity can only be achieved through education, awareness and participation of the regional people. Teachers and students in the regional schools have been trained and so far ten such training programmes have been organized. This year an orientation course for 22 teachers and a training workshop for 18 teachers and 51 students were organised for different schools of the Kumaun region.

In the IHR development works and associated activities have certain impacts on the environment. The hydropower project in Beas valley in H.P. is one such activity that on the one hand generates employment and infrastructure for the local people but also creates adverse effect in the form of air dust, acceleration of landslides, soil erosion and threat to wild life. Similarly, cultivation of vegetables (cash crop) has positive impacts on the local economy but also has adverse effect in terms of use of fertilizers and biocides on the local environment. Same holds true for the tea cultivation in about 500 ha cultivable wasteland in Uttaranchal. Water samples collected from tea gardens had more concentration of nitrite and sulphate as compared to control. EIA studies on such developmental interventions are continued. Tourist flux and associated vehicular pollution is another area of concern being studied under the EIA programme. In selected tourists locations of Kumaun region fluctuation in number of tourists was high in Nainital, and it was uniform at other destinations. In Kullu valley the maximum total suspended particles (TSP) was found in June (207.3 g/m³), and it was only 98.4 g/m³ in a distant location at Kothi in June. Similarly, SO₂ concentration at Mohal (Kullu) was found highest in May (36.1 g/m³)

The outreach of R&D findings of the Institute is primarily made through Institutional Networking and

Human Investment Core Programme. This year eighteen universities and institute facilities, and eight NGOs were brought under the institutional network through Integrated Eco-development Research Programme (IERP) funded research and action based projects. Dissemination of knowledge base in the IHR is also ensured through the publication and distribution of ENVIS Bulletin regularly. To strengthen the networking, management and information system Himalayan database has been compiled and uploaded as a new module to the ENVIS-EMCB website.

R&D inputs from the institute are gradually finding place in the policies of IHR and the line departments are making use of them. Watershed management, water resources development, environment-friendly livelihood supporting and income generating activities (particularly for women), soil and water conservation techniques, mountain risk engineering, biodiversity conservation education, medicinal plants cultivation, rehabilitation of wastelands, improved efficiency of farming practices are some of the areas where the Institute has brought out cost-effective technologies for the environment-friendly development of the IHR.

Research on Biosphere Reserves, Wetlands, Mangroves and Coral Reefs

Research activities under biosphere reserves, wetlands, mangroves and coral reefs programmes are overseen by specific Advisory Committee and Subcommittees under Wetlands, Mangroves and Coral Reefs. During the year, several projects have been sanctioned under these scheme. The list of such sanctioned and completed projects are given in Annexure-VI and VII respectively.

Forestry Research

Indian Council of Forestry Research and Education (ICFRE), Dehradun

The Indian Council of Forestry Research and Education (ICFRE), Dehradun is the premier forestry research organization of the country with the mandate to formulate, organize, direct and manage forestry research, transfer the technologies developed to the states and other



Fig 70. Mangrove vegetation in Upputhanni Island

user agencies and impart forestry education. Major achievements of ICFRE in the field of forestry research, extension and education during the year are as follows:

Artocarpus integrifolia, jackfruit tree is underutilized native species with potential as an important timber as well as fruit tree. This species has inherent potential to grow in hills as well as in plains of Tamil Nadu and Kerala. Populations of this species in the wild (Western Ghats) and cultivated conditions were studied and potential populations were selected. Seedlings from these selected populations were raised and trials have been established. Other two species of *Artocarpus* namely *A.hirsuta* and *A. lakoocha* are grown in Kerala. A Seed Production Area (SPA) of *Artocarpus hirsuta* has been established in Kerala. This SPA will serve as a seed source for future planting and it can also be maintained as a unique ex situ conservation stand since *A.hirsuta* is a threatened species and endemic to Western Ghats.

Genetic variability between twenty provenances of *Eucalyptus camaldulensis*, which are used for large-scale plantations by the state forest departments, and paper industry were analyzed using AFLP markers. In *Casuarina equisetifolia* genetic variability within and among twelve provenances obtained from the breeding program of Andhra Pradesh Forest Department at Rajahmundry were analyzed using RAPD markers. These studies have developed method for characterizing and documenting high quality planting material.

Seed handling techniques for eight commercially important medicinal trees namely *Aegle marmelos*, *Feronia elephantum*, *Emblica officinalis*, *Syzigium cuminii*, *Strychnos nux-vomica*, *Oroxylum indicum*, *Pterocarpus marsupium* and *Terminalia bellirica* were standardized and published in the form of pamphlets.

Biocontrol method of management of the major diseases like powdery mildew, leaf blight and leaf rust on tamarind, teak, artocarpus, red sander and Terminalia chebula was worked out using antagonistic organisms like *Trichoderma viride* and *Pseudomonas fluorescens*.

Species distribution mapping was carried out for twenty-one threatened medicinal plants in Kolli hills. Two species namely *Aristolochia tagala* and *Raphidophora laciniata* showed very restricted distribution, thus vulnerable. Disturbance in that area may destroy whole population of these species in Kolli hills.

Trichogramma raoi an indigenous species and egg parasitoids was collected alive and multiplied in the laboratory. In order to enhance percentage of parasitism an experiment was laid by exposing the eggs at different temperatures and was found that eggs exposed at -8°C were proved most effective. Two field experiments were carried out on the field efficacy of egg parasitoids and their adaptability to the released sites. Five species of egg parasitoids were introduced separately in 42 ha. area of teak forest in Bihadandi and Kalpi forest ranges of north Mandla forest division. Result showed that introducing the exotics *T. chilonis*, *T. japonicum* and indigenous *T. raoi* in teak forest are equally effective to reduce defoliation caused by larvae of teak skeletonizer by 50%.

In the Institute of Wood Science and Technology, Bangalore bending behaviour of coconut wood was studied using vapour phase ammonia treatment and samples of various dimensions were successfully bent to different radii. An approach based on chemical kinetics was developed to study viscoelastic behaviour of wood. Enthalpy-Entropy compensation effect was shown to be related to swelling behaviour of wood.

Observations on phenological aspects of the mangroves at Coondapur were carried out. Studies on bio-deterioration of the mangrove wood and plants revealed that about 40% of the mangrove trees are riddled

by the marine woodborers at varying intensities. The marine woodborers responsible for the damage are identified as *Bankia ronchii* and *Sphaerana terebrans*.

Plantation surveys conducted in five divisions of north Canara Circle revealed that heartwood borer, *Alceterogystia cadambae*, infested 15.85% of teak trees above 20 years of age. Studies in the teak depts showed that an average of 12% of logs were damaged in varying degrees by the attack of termites, microbes and heartwood borer; 36% of them having bore hole complexes caused by heartwood borer. Highly perishable rubber wood was modified in two-step reaction of esterification and oligoesterification with anhydrides and epichlorohydrin to get complete protection against wood rotting agents. Methanolic extract of leaves of *Clerodendrum inerme* at 5% concentration and a dye obtained from the bark of *Persea macrantha* at 1% concentrations were found inhibiting the development of nymphs of *A. dispersus*. These insecticidal principles can be utilized for effective management of whiteflies. Soil application of neem cake and pongam cake along with VAM was found to control the incidence of the spiraling whitefly on the seedlings of *Michelia champaca* and *Bauhinia variegata*.

Ethnobotanical data was collected on 114 plant species from Rampachodavaram and Polavaram agencies of east and west Godavari districts, respectively. Ethno botanical information on medicinal uses such as cuts, pains, fever, head ache, wounds, sprains, abortion, snake bite, diabetes, epilepsy, jaundice, boils and blisters,



Fig 71. Hi-tech plantation of *Buchanania lanzan* in Centre for Forestry Research and Human Resource Development campus, Chhindwara

bone fracture, cough and cold, eye diseases, etc., insecticidal and piscicidal applications, agricultural implements, house construction, hair wash, detergents, fiber, food habits, religious rites, cultural aspects, taboos, etc., was gathered from local herbal doctors and priests of Konda Reddy, Konda Kammara and Valmiki tribes of Godavari valley. Ninety two plant specimens of ethno botanical interest were identified and made into herbarium; three live plant materials of ethno botanical interest were introduced in the campus for ex situ conservation. Museum articles such as fruits and seeds were gathered and are displayed in the Shore Laboratory, Visakhapatnam.

Analysis of colour changes on wood surfaces of *Pinus roxburghii* (chir pine) and *Hevea brasiliensis* (rubber wood) irradiated by ultra violet radiation was carried out. The effect of presence of extractives on photo-discoloration and degradation of wood surfaces of *Acacia auriculiformis* was studied. Analysis of colour changes and FTIR spectra measured from irradiated wood surfaces indicate that presence of extractives increases rate of discoloration and an apparent increase in rate of photo-degradation of wood surfaces in the initial period of exposure.

Rhizosphora soil and root sample were collected to identify different VAM fungi associated with *P. cineraria* plantations from five districts of western Rajasthan viz., Nagaur, Sikar, Jhunjhunu, Jodhpur and Churu. Rhizosphere soil sample were found rich in VAM fungi but spore density ranged between 70-346 spores / 100 gm soil. The rhizosphere soil collected from agroforestry site was found rich in spore population as compare to soil collected from disturbed area or roadside plantation. The *Glomus fasciculatum* was found rich in spore population as compare to soil collected from disturbed area or roadside plantation. The *Glomus fasciculatum* was found dominant genera and was isolated from all sites. The associated AMF genera were *Glomus fasciculatum*, *G aggregatum*, *G macrocarpum*, *G. microcarpum*, *G. monosporum*, *G. constrictum*, *Gigaspora margarita*, *Sclerocystis indica* and *Scutellospora bionarta*.

Forestry Research Extension

Andhra Pradesh Forest Department (APFD) in collaboration with the Institute of Forest Genetics and

Tree Breeding (IFGTB), Coimbatore is implementing programmes for production of quality seeds multiplication of clones, testing and transfer of clones for user agencies and further improving the productivity of plantations. This is being implemented through training cum assistance strategies. In this approach, the APFD is being enabled to develop its technologies through improving its genetic resources and further to plan its own productivity requirements. This is a method by which the research technologies developed in the institute are being effectively transferred to the APFD. This will have a multiplier effect in terms of yield and productivity in the plantation programme of APFD.

The Tamil Nadu Electricity Board, which is facing serious problems of fly ash disposal, has identified the IFGTB to develop technologies for utilization of fly ash in agricultural lands. Accordingly, the TTPS and MTPS have provided grants with which agro-forestry strategies and soil amelioration strategies are being developed in farmers' lands. Combination of agricultural and tree species are being used. Soil amelioration with compost and fly ash is used for nutrient availability. The results obtained are expected to be useful in fly ash disposal, and to further improve the nutrient status in deficient lands.

To disseminate latest findings in forestry research, a number of training courses of different durations were conducted in the ICFRE institutes.

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

The IPIRTI established in 1961-62 as a Central Research Laboratory of Indian Plywood Manufacturer Research Association under the Cooperative Research Scheme of the Government of India from out of the funds provided by CSIR and voluntary contribution from the plywood industries, got converted into an autonomous body of the Ministry of Industry. Subsequently, the institute was transferred under the administrative control of the Ministry of Environment & Forests 1-5-1990. Now on IPIRTI is an autonomous research and training institute under the Ministry of Environment and Forests, Government of India.

The mandate of IPIRTI is to conduct research and training on all aspects related to production of plywood and other panel products from wood and other ligno-

celluloasic materials. Joint efforts of IPIRTI and industry made the wood panel industry self reliant with respect to technologies, machineries, equipment, standardisation of processes and products, Multidisciplinary and applied research projects based on problems identified by the institute, industries and other interested organisations are taken up.

'Inspection, certification and marking' of all forest products viz. plywood, particularly chipboard, furniture, panel door, blackboard, composite boards is one of the important mandates of the institute.

The institute vision is conservation of natural forests through development and adoption of efficient technologies for manufacturing wood alternative and panel products from renewable fibres, agrowaste including plantation timbers and bamboos in particular to meet the vital needs of developing society.

The important goals of the institute are :

- Rationalising the utilisation of available wood

resources through appropriate technological interventions.

- Development of wood alternatives from other natural renewable fibres.

The institute has 45 ongoing research projects including 11 sponsored projects, classified into three categories namely :

- Wood composites
- Non-wood composites
- Solid wood

Indian Institute of Forest Management (IIFM), Bhopal

The Indian Institute of Forest Management (IIFM), Bhopal was established in 1982 as an autonomous organisation under this Ministry. The objectives of the Institute are to provide training in forest management and



related subjects to government and non-government personnel; to select and prepare outstanding and talented young persons for careers leading to management responsibilities in forestry sector; and to meet the needs of forestry sector with respect to updating information on forestry management through undertaking research and consultancies and publication of reports.

The activities of the IIFM fall under four realms viz. education, training, research and consultancy. Highlights of the activities carried out during the year are as follows:

The research programmes of the institute are focused on applied and multidisciplinary research on forest and natural resource management. The projects lay emphasis on sustainability of natural resources and benefit flow to the disadvantaged communities dependent on the forestry resources. During the year 12 research projects have been completed, and other eight projects are in progress. Majority of these projects has been funded by the national and international agencies. Internal resources are also used to fund a few projects.

The institute bagged six consultancy assignments from national and international organisations on a wide range of topics till 2003. The topics of consultancy assignments include sustainable management of NTFP by Maharashtra State Forest Department, study on raw material from forest and agricultural based resources by sustainable management of bio food security through people's

ch of India (WII), Dehradun

ecological, biological, socio- al aspects of wildlife conservation e country. The research projects entific data, help evolve study the Indian ground condition, and trained field biologists, socio- life managers. The scientific is utilized for management of t of on-going research projects ies at Annexure-XI.

Institutional Collaborations

National Institute for Coastal and Marine Biodiversity

The National Institute for Coastal & Marine Biodiversity (NICMB) was set up at Kanyakumari, Tamil Nadu during October, 2003. This was a recommendation of the National Seminar on Coastal & Marine Biodiversity for Conservation and Management organized by WII at Kanyakumari in March, 2003. The Ministry endorsed this recommendation and decided to set up the NICMB at Kanyakumari. The WII was given the responsibility for setting up of the NICMB, Kanyakumari. The decision was appreciated by the Indian Board for Wildlife. The NICMB will collate information on activities by various agencies on the coastal and marine environment in India and co-ordinate the Ministry's funded activities of conservation agencies along the coast and marine habitats. The capacity building, management oriented research, awareness education and transfer of state of art management methods to marine conservation practitioner will be the main agenda of the NICMB.

Important Field Visits

Exchange visits to University of Tromso, Norway, April - May 2003: Under the Institutional Co-operation Programme between Wildlife Institute of India and University of Tromsø, Norway in Natural Resource Ecology and Management

The Wildlife Institute of India (WII) and University of Tromso (UiTo), Norway, have initiated an Institutional Co-operation Programme in Natural Resource Ecology and Management in 2002. This three-year co-operation programme is funded by NORAD and includes a component on faculty/student exchange visits.

Task

Ecological Attributes of Vegetation in Nanda Devi National Park, Biodiversity Monitoring Expedition Nanda Devi 2003 was organized/sponsored by Ministry & Uttaranchal State Forest Department, Dehradun. A total of seven participants participated in the task.

Biodiversity Monitoring in Nanda Devi National Park. The Biodiversity of Nanda Devi National



Park was assessed after 10 years by a team of scientists who undertook a Scientific Expedition during June-July 2003 organised by the Uttarakhand State Forest Department. The crucial Biodiversity Monitoring exercise was carried out by a team of scientists from the Wildlife Institute of India, Dehradun (WII), G.B. Pant Institute for Himalayan Environment and Development, Almora (GBPIHED) and the H.N.B. Garhwal University, Srinagar. While the Uttarakhand Forest Department wildlife staff provided the logistic and expedition management support, the Indo-Tibet Border Police (ITBP) provided the support of medics, climbers and communication personnel. From WII, Dr. S. Sathyakumar and Dr. B.S. Adhikari participated in this expedition.

The expedition team surveyed along the main route to Nanda Devi Base camp, which is considered as one of the world's most formidable routes. The team surveyed areas in and around Dharansi, Dibrugeta, Deodi, Bethartoli, Ramni, Bhojgara, Patal Khan, Sarsonpatal, Nanda Devi and Devasthan I Base Camp areas.

National Natural Resources Management System (NNRMS)

The main objective of National Natural Resource Management System (NNRMS) is utilization of remote sensing technology with conventional methods of monitoring of natural resources such as land, water, forests, minerals, oceans etc. for attaining sustainable development by addressing the following aspects :

- Optimal utilization of the country's natural resources by a proper and systematic inventory of the resource availability.
- Reducing regional imbalances by effective planning and in tune with the developmental efforts

- Maintain 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.

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. Out of the above 49 priority areas, more than 20 have been covered so far.

So far SC-B has met 19 times and sponsored more than 73 remote sensing application projects addressing key environmental and ecological issues such as management of forests, grassland, faunal resources, wetland, coastal areas, mangroves and coral resources, land degradation, impact of mining and industrialization, river pollution, etc. More than forty projects have so far been completed. The 19th meeting of Standing Committee of National Natural Resource Management System (NNRMS) was held on 31-12-2003.

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 of Environment and Forests itself including the various organizations under its administrative control like FSI, ZSI, BSI etc.