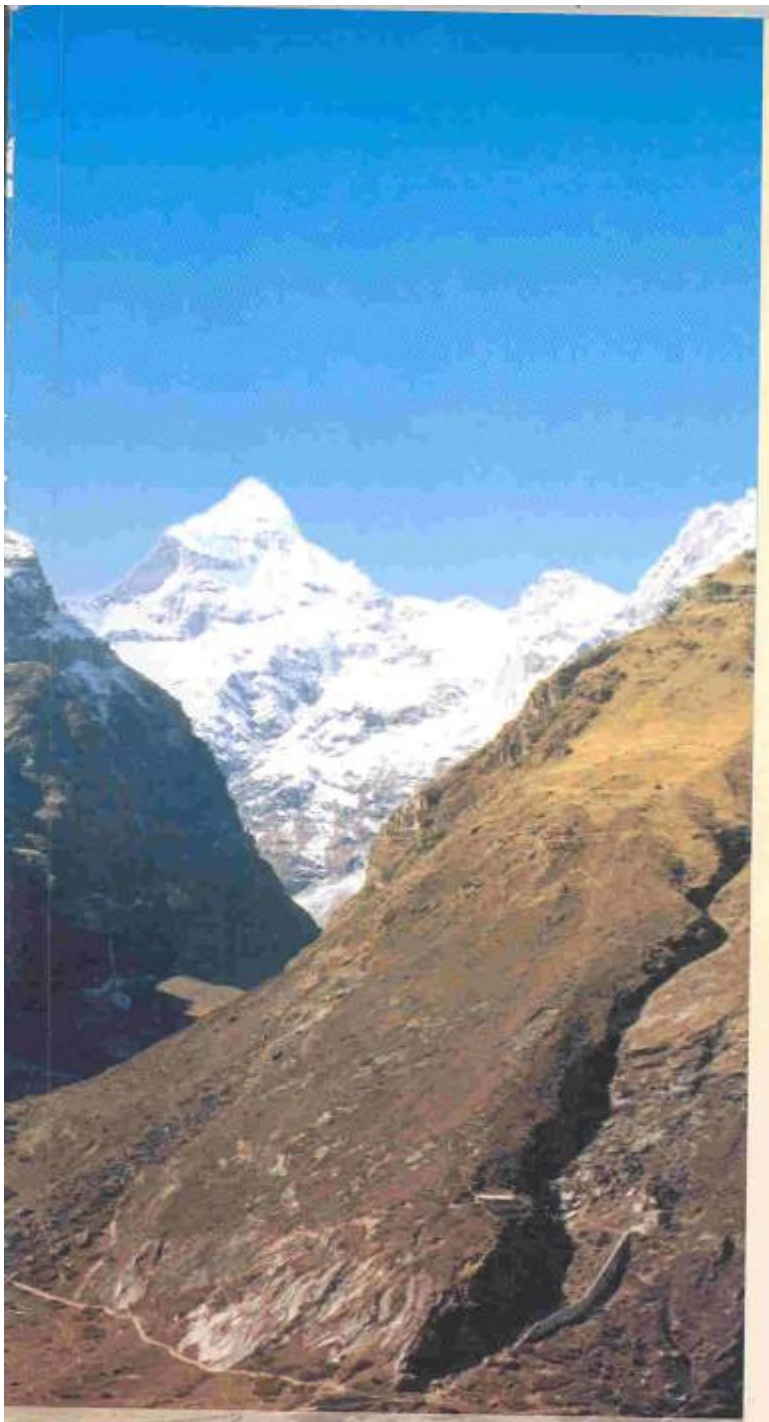

Annual Report

2002 - 2003

G. B. Pant Institute of Himalayan Environment & Development
(An Autonomous Institute of Ministry of Environment and Forests, Govt. of India)
Kosi-Katarmal, Almora - 263 643, UA, INDIA

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Ministry of Environment & Forests
Government of India
New Delhi

Vice President

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Government of India
New Delhi

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Uttaranchal

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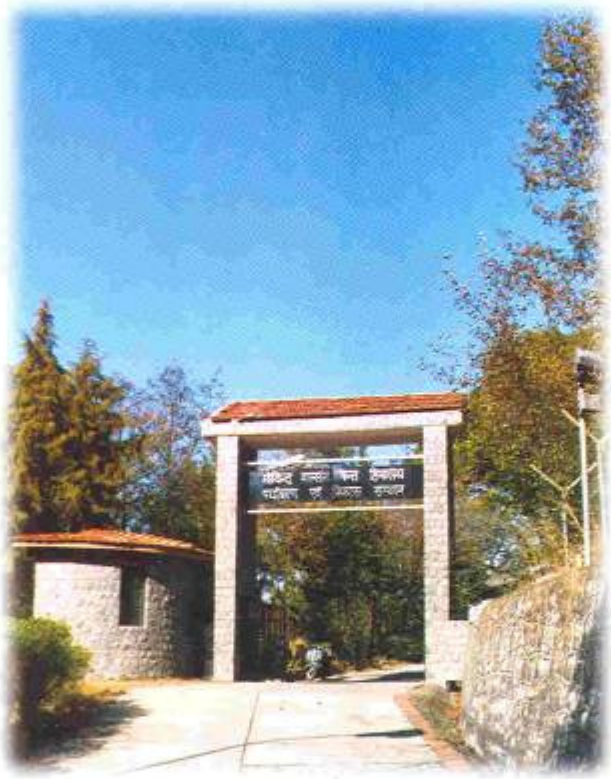
(Nominee of the Director, GBPIHED).

ANNUAL REPORT
2002-2003



G.B. Pant Institute of Himalayan Environment & Development
(An Autonomous Insitute of Ministry of Environment and Forests, Govt. of India)
Kosi-Katarmal, Almora-263 643, Uttaranchal, India

CONTENTS

FOREWORD

The Institute made considerable advancement in achieving R&D objectives, infrastructure expansion, and creation of new facilities during the reporting period. The training and capacity building programmes for hill women, farmers, NGOs, scholars and school children were further strengthened and expanded to cover representative areas and diverse stakeholders. Emphasis on development of medicinal plant propagation protocols and cultivation, conservation of biodiversity using various approaches and technical supervision, monitoring and evaluation of 162 Swajal villages facilitated the outreach mechanisms. Our Networking with NGOs and educational Institutions was steadily strengthened. The Institute has set targets for better understanding ground realities, developing and demonstrating appropriate technologies for environmentally sound development, together with influencing the decision making process at all levels. Our responsibilities have increased manifold in the light of contemporary thinking on environment related issues. The Institute's horizontal and vertical development depends on the availability of qualified manpower and funding; both of these are sure to grow and strengthen in the years to come. Bilateral exchange programmes and collaborative ventures undertaken by the Institute have contributed a great deal towards the growth and development of the Institute and its faculty.

During the year the Institute hosted a series of events across the Indian Himalayan Region (through its four Regional Units and the Headquarters) to celebrate the International Year of Mountains (IYM– 2002). Besides, the Institute made significant headway in a number of activities. Notable among them include organisation of scientific expedition from Milam (4000 m) to Dung (6000 m) for identifying the GPS campaign sites in Kumaun higher Himalaya to quantify tectonic deformation rate, development of easy to grasp print material highlighting different environmental and developmental issues and options for dissemination among various users, and maintaining the possible influence of climate change on glacial bodies and sensitive sites. Detailed population dynamics studies and development of propagation protocols for selected endemic medicinal plants of the Himalaya provided a strong research backup for management and conservation of such high value natural wealth. More over, the Institute continued to strengthen its R & D efforts considering the basic needs of rural inhabitants of the region on one hand and contemporary global thinking on mountain ecosystems on the other.

UPPEANDRA DHAR
Director Incharge

MAJOR ACHIEVEMENTS

- A chain of events across the Indian Himalayan Region were observed through the four regional Units and the headquarters of the Institute to celebrate the International Year of Mountains.
- Successful completion of technical supervision, monitoring and evaluation assignment of Catchment Area Protection (CAP) activities in 162 SWAJAL villages of Uttaranchal for rejuvenation of drying water sources.
- Identification of *Lantana camara* (a shrub weed) as a better mulch material to replenish soil fertility and conserve soil and water in rain fed agriculture as compared to traditionally used Oak and Pine tree leaf litter in Uttaranchal.
- Organisation of scientific expedition from Milam (4000 m) to Dung (6000 m) for occupying the GPS campaign sites in Kumaun higher Himalaya for quantification of tectonic deformation rate.
- Assessment of hill slope instabilities along roads network in Sikkim Himalaya on RS/GIS platform to suggest remedial measures.
- Development of microbial inoculants for selected plant species.
- Organization of twelfth meeting of the Project Evaluation Committee (PEC) and sanctioning of 26 IERP projects for execution of location-specific R&D activities in the states of J&K, H.P., Uttaranchal, Assam and Nagaland.
- Population dynamics studies and development of propagation protocols for selected endemic medicinal plants of the Himalaya.
- Complementing ongoing conservation education programmes through organisation of orientation camp for selected teachers of Kumaun Himalaya.
- Development of easy to grasp print material highlighting various environmental and developmental issues for dissemination among various users.

Executive Summary
Research and Development Activities

The Institute follows a multidisciplinary and holistic approach in research and development programmes to address the issues of sustainable development of the Indian Himalayan region (IHR). The emphasis on interlinking of natural and social sciences is the major thrust of all the programmes. In this effort special attention has been placed on the preservation of fragile mountain ecosystems, indigenous knowledge and customs. A conscious effort is being made to ensure participation of local population for long-term acceptance and success of various programmes. The R & D activities of the Institute are centred on following seven core programmes.

Land and Water Resource Management

Like previous years, the activities of LWRM core during the current year were focused on both research and extension works related to study of operational canal irrigation systems, documentation of traditional soil and water conservation (SWC) practices, testing and demonstration of SWEET model for rehabilitation of community and private wasteland, study of tectonic deformation rate using GPS survey, suspended sediment study and hydrometry of Gangotri glacier, global change impact assessment for environment management and sustainable development and people resource dynamics for mountain watersheds, etc. Based on the spring sanctuary development work a consultancy project of technical supervision, monitoring and evaluation of catchment area protection work for 162 SWAJAL villages was successfully completed during the year. Water application efficiency of hill irrigation systems was studied.

Sustainable Development of Rural Ecosystems

During the reporting period studies on natural resource management in diverse physio-cultural landscapes of Northeast India continued focusing on local issues and area specific developmental plans. In short, the increase in Jhum cycle has increased the farm productivity and checked the environmental degradation. Impacts on crop production by introducing N_2-fixing multipurpose hedgerow species were studied. The study of natural resource inventories in Hawalbagh block has been completed the data base and development of models for effective management is in progress. Experiments on different agroforestry models were continued in the Central Himalayan region to recommend the best approach for maximizing various farm outputs. Medicinal plants having economical potential and market were promoted for cultivation through awareness programmes, field demonstrations and by providing technical guidance. A number of hill-specific livelihood technologies have been demonstrated on the farm sites and in the Rural Biotechnology Complex of the Institute. Across the IHR human capacity building programmes were undertaken and over 3300 persons trained.

Conservation of Biological Diversity

Realizing the need for in-depth research and understanding the importance of information dissemination, during reporting period (2002-2003), the core group attempted to keep a balance of the both. Following standard scientific approaches, considerable information was generated to strengthen the Himalayan biodiversity database. Here, the new initiatives undertaken for understanding dynamics of structural and functional features of biodiversity in relation to disturbance gradient in forests of Kumaun Himalaya deserves special mention. Inventory of Orchids of IHR, wild edible and threatened medicinal plants of HP, medicinal plants of Uttaranchal are in the process of completion. Evaluation (population density, inter population variability) and development of propagation protocols for selected (i.e. *Angelica glauca, Arnebia benthamii, Saussurea obvallata* and *Swertia angustifolia*) high value endemic medicinal plants of the Himalaya provided first hand information to evolve

conservation and sustainable use strategy for these taxa. *Ex situ* gene bank initiatives were further strengthened through R&D interventions in arboretum (Institute HQs) and herbal garden (HP Unit). Both the *ex situ* gene bank sites were extensively used for teaching, training and demonstration for different target groups. Another initiative for assessment of existing stock and scaling up productivity of selected high value medicinal plants through biological and biotechnological approaches has complemented the ongoing activities for gene bank establishment. Development of database for Himalayan Biosphere Reserve (BRs) through active interaction with the experts and BR managers continued. The participatory biodiversity conservation programme was further strengthened through IX Training Workshop. Also, the organization of an Orientation Camp for teachers of Kumaun region gave a new direction to the programme.

Ecological Economics and Environmental Impact Analysis

The activities of the Core during the reporting period continued to focus on various aspects of EE&EIA related to socio-economic, natural resources, development initiatives, climate and hazards. Based on the experiences of air quality and tourism studies in the Kullu valley work has been initiated on worker's exposure to air pollution and background air pollutants. Database on social infrastructure in the entire IHR has been compiled and studies on influencing factors governing the fertility behaviour of women and aspects of traditional practices related to adaptation to natural system in parts of Central Himalayan region have been completed. Role of individual factors that have prompted inhabitants of Khairna valley of Kumaun Himalaya for vegetable cultivation have been analysed and detailed EIA activity has been initiated. Siwalik Development Strategy cum Action Plan, formulated for the Integrated Watershed Development Programme (IWDP), is being implemented in the Siwalik region of north-western Himalaya. Framework for mountain risk engineering interventions based on field investigations of landslides along road corridors of Sikkim Himalaya has been completed and the output is presented on RS/GIS platform.

Environmental Physiology and Biotechnology

During the reporting period the R&D activities have mainly concentrated on understanding the factors in relation to plant productivity, functioning and regeneration of plants. The combination of conventional and biotechnological methods has been adopted to obtain propagules of elite nature. Propagation protocols and successful transfer of regenerated plants of orchid species have been developed. Bacterial species isolated from temperate locations and colonization of tree seedling roots by mycorrhizae were found to be effective in improving overall plant performance in certain tree species. Studies were also carried out to improve survival and growth of tissue culture raised tea plants using microbial inoculation. Mycorrhizal diversity associated with 5 rhododendron species of Central Himalaya has been assessed. Efforts were initiated to improve and synchronize seed germination and influence rooting in rhizome/ tubers segments of high altitude medicinal plants. Active ingredient content in underground parts of certain medicinal herbs from different locations has also been assessed. The effect of various environmental stresses, morphological and physiological parameters of different tea clones were examined and compared with seed raised tea plants. Evaluation has also been made to estimate biomass and productivity of *T. baccata* (a medicinally important tree) for taxol, along an age series. Further the importance of imparting training and on site demonstrations of various technologies are being appreciated by the village communities, NGOs and Govt. personnel and these activities have contributed significantly towards the improvement of economic and environmental conditions of the rural ecosystem.

Institutional Networking and Human Investment

Twenty six projects were sanctioned and funded to various Organizations/Institutions/ Universities (for the execution of

location-specific R&D activities in the states of J&K, H.P., Uttaranchal, Assam and Nagaland) under the Integrated Ecodevelopment Research Programme (IERP) of the Institute. Funds for twenty three ongoing/completed projects were also released during the year. Thirteen IERP projects were completed successfully and 77 projects were on-going in 11 states of the IHR. Follow-up action on almost 123 project files (old/fresh/ on-going etc.) was also initiated/ completed during the year. In addition to the above, a three day on-site training programme (11th of its kind) on nursery development, tree plantation techniques, natural resource conservation and management, and low-cost farm based techniques was organized at Kharkini village in Pithoragarh district of Uttaranchal in which 69 participants were trained. In the Central library of the Institute 82 new books were added and 132 periodicals (80 International and 52 National) were subscribed. Hima-Paryavaran and Annual Reports of the Institute were also distributed to a number of organizations/individuals/subject experts and others. Besides above, one R&D project entitled "*Study of nutrient dynamics in traditional mixed cropping system*" was completed successfully.

Indigenous Knowledge Systems

The core activities continued to focus on the continuance of few earlier selected themes, namely, indigenous methods of making fermented food and beverages, analysis of indigenous agricultural practices in the light of its efficiency and sustainability, and indigenous knowledge and uses of medicinal plants by *Vaidyas* in Uttaranchal. The main thrust of all these programmes has been on the scientific documentation, and creation of database on these themes which are on the verge of being phased out, and as a result the knowledge can be lost. Indigenous methods of food fermentation and making of alcoholic and non-alcoholic beverages have been documented. Similarly, the analysis of indigenous agricultural practices in the light of its efficiency and sustainability was also carried out. The documentation of various landraces of traditional crops and their role in the agricultural systems is also being analysed. These activities have crossed the stage of resource inventory, and the analysis work is in progress.

1. INTRODUCTION

The reporting year 2002-2003 is fourteenth financial year of R&D activities being carried out by the Institute at various locations in the Himalaya, in tune with the regional issues. Efforts were put to seek practical and workable solutions to mountain specific problems. These activities include programmes supported through core funds provided by the Ministry of Environment and Forests, Govt. of India to the Institute and projects financed by external agencies (National and International). The Institute is also supporting activities of various partner Institutions in various Himalayan states through Integrated Eco-development Research Programme (IERP). The Science Advisory Committees of the Institute reviews the progress of existing projects and provides guidance and help to develop new R&D programmes.

At present, the activities of the Institute are centred on seven designated core programmes. Several projects were successfully concluded during the year. Summaries of these are included at appropriate places in the text. In due course detailed documents will be published and made available to the public. The progress made during the year 2002-2003 on various ongoing and newly initiated projects and a brief account of the academic and other activities, along with the statement of accounts, have been presented in this report. We would be most grateful for crucial comments, suggestions for improvement and for indication of our shortcomings in our effort to achieve the target set by the Ministry of Environment and Forests, Govt. of India.

2. MILESTONE EVENTS

A meeting to review the activities of the Institute was held at the Institute HQs at Almora on July 11, 2002. The meeting was presided over by Shri T.R. Baalu, Honourable Minister of Environment & Forests (MoEF), Govt. of India (GOI) and Chairman, G.B. Pant Society of Himalayan Environment & Development. Dr. Mohinder Pal, Director Incharge, GBPIHED welcomed the Honourable Minister MoEF and other dignitaries. This

was followed by a brief introduction of scientists and officials of the Institute. The Director, thereafter, presented a brief outline of the activities of the Institute. The detailed progress of various schemes and R&D projects of the Institute was presented by Dr. Uppeandra Dhar, Senior Scientist of the Institute. The meeting was attended by Shri Nav Prabhat, Honourable Minister of Environment & Forests, Govt. of Uttaranchal; Shri P.V. Jayakrishnan, Secretary, MoEF, GOI & Chairman Governing Body of the Institute; Shri S.K. Pande, Director General (Forests) & Special Secretary, MoEF, GOI; Shri A.N. Gokhale, Additional Secretary, MoEF, GOI; Shri R.P.S. Katwal, Director General, ICFRE, Dehradun; Shri D.D. Verma, Jt. Secretary, MoEF, GOI and Shri S.K. Sharma, Addl. Director General, Forests, GOI.

During the current reporting year, a total of about 3300 people, including 1062 men, 1148 women, over 350 NGO representatives, 1200 students/ teachers selected from various schools and colleges, over 500 Governmental officials were given trainings on various aspects. The issues varied from biodiversity conservation, medicinal plant cultivation, environment-friendly hill technologies, solid waste management, empowerment and capacity building programmes for women, silvipasture management, science promotion/motivation programmes for students etc. In addition, 8 meetings/exposure visits to various demonstration sites of the Institute spread across the IHR were also organised.

In the observance of the International Year of Mountains (IYM), a two-day Workshop on "Mountain Environment and Development: Potential and Prospects" was organized by the Institute at its Headquarters at Katarmal on December 9-10, 2002. A total of 34 selected participants from all across the country, particularly from IHR attended the workshop. Dr. P. Pushpangadan, Director, National Botanical Research Institute, Lucknow delivered the inaugural lecture on the "Biodiversity and IPR issues in relation to mountains". Professor Jayanta Bandyopadhyay from Indian Institute of Management, Kolkata spoke about the development perspectives in the Himalaya, and Mr. S. Chopra, Secretary, Rural Development and Horticulture, Government of Utttaranchal spoke on the policy implications. Beside a chain of activities throughout the IHR were observed through the four regional Units of the Institute. A National Workshop on "Integrated Development of Mountain Watersheds: Challenges and Options" was organized by the Institute in which several experts and policy makers from Uttaranchal state participated and brought out useful recommendations. A meeting "Integrating culture and sustainable natural resources-management challenges in the North east region of India" was jointly organized by the G.B. Pant Institute of Himalayan Environment & Development (GBPIHED), and The Mountain Institute, USA. The meeting aimed at identifying priorities and important issues, evolved a detailed proposal and plan that could be operationalised during the IYM-2002 for the region.

3. RESEARCH AND DEVELOPMENT PROGRAMMES

In order to achieve the sustainable development of the Indian Himalaya, research and development programmes of the Institute are organized on multidisciplinary and holistic lines with emphasis on interlinking of natural and social sciences. In this effort special attention is placed on the preservation of fragile mountain ecosystems, indigenous knowledge and customs. A conscious effort is made to ensure participation of the local population for long-term acceptance and success of various programmes. The R & D activities of the Institute are centred 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 and Human Investment and Indigenous Knowledge Systems. The achievement of goals and the progress made in various projects during the year have been placed under appropriate core programmes in the text. The project implementation sites have carefully been selected keeping in view the heterogeneous heritage of the Himalaya along with specific needs and aspirations of the local inhabitants. All activities are need based, target oriented and time bound; efforts are made to provide

practicable solutions rather than theoretical prescription. To meet the targets and to accomplish the objectives well equipped laboratories and computer facilities have been established. Rigorous data collection, development modification and demonstration of science and technology inputs, including technology packages of the Institute, are underlying elements of all project activities. While a number of projects were completed during the year, a few new projects were also initiated; most projects are now in their third or fourth year of operation. Highlights of the progress made during the year 2001-2002, along with a brief, conceptual background, specific objectives and major achievements are summarized for individual projects.

3.1. LAND AND WATER RESOURCE MANAGEMENT

Indian Himalayan mountains constitute about 591 thousand sq km of the land surface. They play disproportionately dominating role in the global ecosystem. Nearly half of the population of our country depends on Himalaya for fresh water. Like many other ecosystems of the earth the fragile ecosystems of the Himalaya are also facing ecological degradation further vitiated by the dynamic geological and geomorphological processes, ever growing human population and global climate changes. As a consequence, serious problems of soil and water conservation have arisen. Natural resource management using integrated watershed management is being attempted widely in the region to solve the major problems of land and water resources such as soil erosion, declining water sources, poor agricultural production and vanishing fuel wood and fodder sources. Therefore, the need is felt to conduct long and medium term R&D studies focused on assessment of the efficacy of these attempts on sustainable use of land and water resources.

3.1.1 Management of Irrigation Systems and Rural Water Supply in the Central Himalaya

Background

In most parts of the Indian Himalayan region (IHR) irrigation is practiced on very small scale, particularly in the valleys along the streams and natural water sources. These small irrigation systems are either managed by the community or group of farmers (i.e. community managed irrigation systems) or by the state government (govt. managed irrigation systems). Undulating topography and fragmented agricultural area makes water distribution and application arrangement a complex problem in both types of irrigation systems. Crop response to water deficits at different periods of the growing season is not uniform. There are some critical periods when water stress condition has a significantly higher impact on crop yields compared to others. Thus under the conditions of limited water supply, the irrigation scheduling becomes essential over the growing season. Under this project water application and distribution system of selected canal systems were studied in detail for assessment of their performance.

Objectives

1. Identification and study of operational and institutional aspects of different irrigation systems and performance study for their comparative assessment under different environmental conditions

2. Study of springs with particular reference to water availability, growing water demand and changing people's perception about rural water management

3. Formulation of guidelines for integrated water management based on economic use of available water for irrigation and rural water supply

Results and Achievements

1. Study of operation arrangements of community irrigation systems suggests that the functional success of the system is due to the presence of traditional management system called *Hala*.

2. Field monitoring was conducted in two Government built but community managed canal systems of Almora district. Different efficiency parameters of these canals are given in Table 1.

3. The mean water application efficiency in Vatnayaljoola and Tana canal lies between 99.2 ± 1.21% to 69.14 ± 59.36% and 100% to 90± 3.16%. Similarly, mean water distribution efficiency lies between 68.71 ± 20.21 to 14.3 ± 37.8% and 7.53 ± 15.91 to 4 ± 2.65%.

3.1.2. Study of Traditional Soil and Water Conservation Practices in Himalaya

Background

The Himalaya is a diverse ecosystem where conservation of natural resources (soil and water) is particularly important. Keeping in mind the challenge of meeting the ever-growing demand for water, food and fodder with depleting resource base, several researches have been conducted in the field of modern techniques of soil and water conservation (SWC). But, the farming community has evolved many traditional practices through trial and error in order to conserve soil and water in their crop fields. These practices have complex linkages with the social and environmental setting. These time-tested and cost effective indigenous efforts could be important method to build upon and suggest suitable practices of SWC in the Himalayan mountains. The present project attempts to document and study some of the traditional techniques

Table 1. Range of efficiency parameters in Vatnayaljoola and Tana canal

Parameter / canal	Value	Vatnayaljoola	Tana
Av. conveyance loss (m/day)	Max. Min.	14.92 ±15.33 2.85 ± 1.21	13.79±9.64 11.27 ±4.64
Av. runoff loss in field (cumec)	Max. Min	0.0041 ± 0.003 0.0003 ±0.001	0.003 ± 0.002 0.002 ± 0.002
Av. water application efficiency (%)	Max. Min	99.2 ± 1.21 69.14 ± 59.36	100 90.00 ± 3.16
Av. water distribution efficiency (%)	Max. Min.	68.71 ± 20.21 14.3 ± 37.8	7.53 ± 15.91 4.00 ± 2.65

of SWC employed by the farmers in the Indian Himalayan Region.

Objectives

1. Identify and document traditional SWC practices in Himalaya
2. Quantification of soil loss in different land use practices with or without SWC measures
3. Assessment of performance of selected low cost bioengineering measures and evaluation of its techno-economic suitability

Results and Achievements

1. Based on survey in selected localities and interviews with the local people in the Central Himalayan region a number of indigenous methods of soil fertility management were documented (Table 2).
2. Deep digging (2-3 times) of marshy land is done during spring and the soil is allowed to sun dry. Deep channels are dug out towards the edge of the terraces, and sometimes in between the fields to facilitate the seepage of water.
3. A comparative hydrological study between a slope and a terraced field in the same locality and under similar rainfall condition showed more run-off and lesser percolation under slope than that in the terraced field (Fig.1). After terracing, seasonal soil losses were reduced in terraced fields (70 kg/ha in summer, 46.12 kg/ha in rainy season and 31.17 kg/ha in winter) as compared to slopes (54 kg/ha in summer, 117.76 kg/ha in rainy season and 44.12 kg/ha in winter).
4. *Kuhl* system in the Lahul valley starting from lower elevations of Hinsa (2700 m) to higher elevations of Khoksar (3200 m) revealed that in the higher elevation length of *kuhl* was smaller due to nearer availability of snowmelt water in the higher elevations. Average *kuhl* length ranges from 881 m (both as carrier plus under irrigation area) in Khoksar to 2055 m in Hinsa.

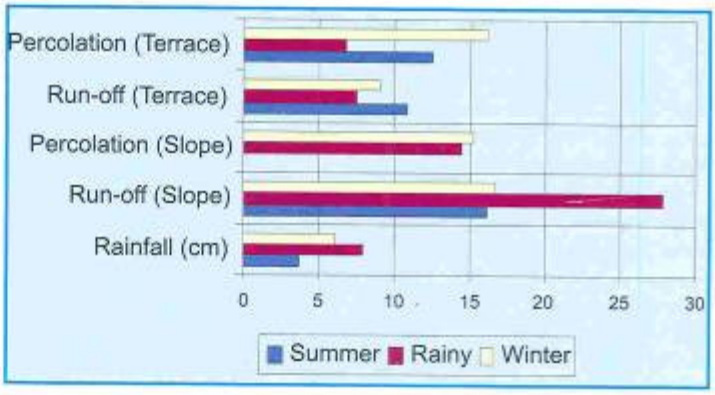


Fig. 1. Seasonal run-off (%) and percolation (%) losses from slope and terrace field in the Kullu valley from the similar amount of rainfall

Table 2. Some indigenous methods of soil fertility management used in Garhwal Himalaya

Method	Advantages (SWC)
Cattle camping in the crop fields before rabi crop for fixed interval in each plot by rotation	This practice improves the soil nutrients and saves labour to transport FYM from cattle shed to the fields
Dry leaves collected from nearby forests (mainly pine) are spread over the crop fields and put to fire	Due to fire the weed and seed/root stock is burnt. The remains of fire (ash) fertilizes the fields
After first plough the remains of crop/weeds etc. are collected, allowed to sun dry and put to fire	This practice is also used to increase the soil fertility and reduction/control of weeds in the crop field
Leaves collected from the nearby forests are used in the cattle sheds. These along with the remains of stall-fed fodder are transported to crop fields and put to fire	This practice is also used to improve soil fertility by addition of ash in the crop filed. Another benefit of pest control is also obtained

3.1.3. People and Resource Dynamics in Mountain Watersheds of Hindu-Kush Himalaya (PARDYP)

Background

People and Resource Dynamics Project (PARDYP) is a regional collaborative programme which involves community institutions, National organizations and International (Univ. of Berne, Univ. of British Columbia, Univ. of Zurich, Chinese Academy of Sciences, Pakistan Forest Institute, HMG of Nepal and GBPIHED) partners. Second phase of its operation has successfully completed in December 2002 and entered in its IIIrd phase (2003-2005). In the second phase of this project, emphasis has been laid on people's priorities and perceptions on development through addressing on-farm activities, demonstrations, community based natural resource management, and conservation programmes etc., and towards improving the livelihood conditions of the marginalized groups and families. Skill improvement through trainings, exchange visits and participatory execution, monitoring and evaluation was also exercised. Efforts have been made to approach the research for development by ensuring active participation of the community and different stakeholders.

Objectives

1. To build on and generate knowledge and facilitate the exchange and dissemination of information and skills in the middle mountains of HKH region.
2. To generate relevant and representative information about water balance and sediment transport related to degradation on watershed basis.
3. To enhance the capacities and options of families and communities, especially marginalized people, in the use and management of natural resources in mountain watersheds to increase household and community benefits.

Results and Achievements

1. Hydro-meteorological (Fig. 2) and erosion plot studies conducted in the Bhetagad watershed for the year 2002 showed that the highest surface runoff and soil loss was generated by bare land (154.19 mm and 20.96 t/ha, respectively). In terms of bio-mechanical methods, the water and soil conservation values are lowest for open pine forest (26.19 and 92.34, respectively). Modelling of runoff-rainfall-soil and nutrient losses performed for experimental plots of different major land uses revealed that the open pine forest generated maximum runoff for a known input of rainfall. Soil and organic matter losses were found to be the maximum from tea plantation area while other nutrient (N, P & K) losses were the maximum in rain fed agricultural land.
2. Participatory on-farm experiment conducted with biofertilizer *Azotobactor chrocoocum* W_5 strain on two

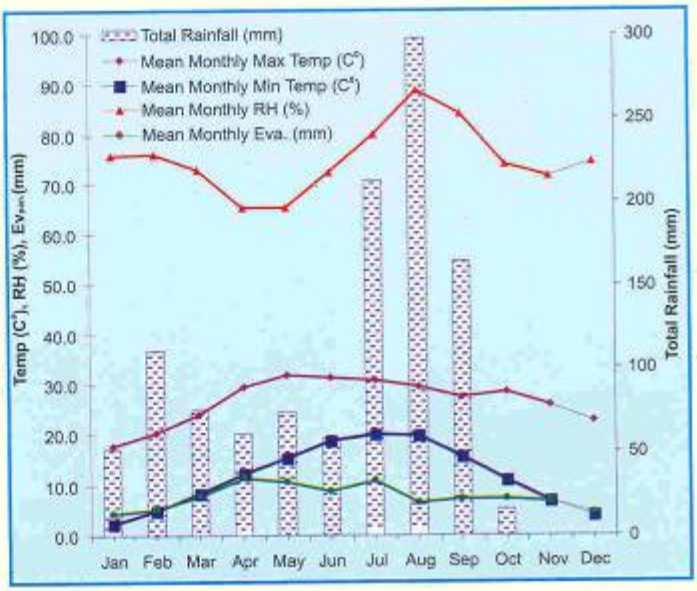


Fig. 2. Merterology observation in Bhetagad Watershed (2002)

varieties of wheat (local and VL-738) at different altitudes increased the total biomass of local variety up to 17.5% and grain yield by 16.6 to 17.4%; whereas in case of VL-738 it was about 13.7 in total biomass, and 12.2 to 16% increase in grain yield. Biofertilizers had a significant effect in production of bean (+14.2 to +17.6%), Soyabean (+21.6%) and Urad (+11.1%). Similar trends were recorded in production of a few vegetable like Pumpkin, Brinjal, Capsicum, Tomato and Cucumber where the increase ranged between 12.4% to 21.1%. Local and improved variety of paddy raised with VAM fungi (Nutri-link) show the similar increasing trend in production.

3. Trainings were imparted on pisciculture and apiculture to key farmers and 8 farmers adopted bee farming and more than 30 farmers adopted fish farming for improved livelihood. Based on the successful demonstrations and training programmes, more than 74 farmers adopted off-season vegetable cultivation and seedling production in polyhouses and earned a net profit of up to Rs. 21,557.00 during the year.

3.1.4. Hydrometery and Estimation of Sediment Load of Gangotri Glacier in Garhwal Himalaya (Uttaranchal)

Background

There is an increasing demand for more detailed scientific information for snow cover and glacier drainage for an optimal utilization of water resources and management of the environment including innovative regeneration strategies for this unique high altitude environment. The Gangotri glacier, the largest glacier in the Bhagirathi basin was selected for the study considering its socio-economic and cultural importance. It is 30.2 km long and its width varies from 0.5 to 2.5 km. A Number of small sized glaciers join the main Gangotri glacier. This study was initiated in year 1999 with financial support from Department of Science and Technology. Continuous monitoring is being done for last four years.

Objectives

1. To collect hydrometeorological data of Gangotri glacier and study of the relationship between discharge variations and meteorological parameters

2. To measure the melt water discharge and quantum of suspended sediment load of the glacier and their relationship during the melt water season and to assess the rate of erosion of the glacier through suspended sediment load

3. To evaluate the sediments source area, production mechanism, and transport pathways of the suspended and dissolved load of the glacier

Results and Achievements

1. In 2002 ablation season, the variations in discharge were very high (CV = 0.64). The meltwater discharge of Gangotri glacier during previous three ablation seasons 1999 to 2001 showed almost similar variations on the seasonal scale (CV = 0.54, 0.57, and 0.60, respectively) (Fig.3). In this year, peak mean daily discharge was recorded as 120.79 cum/s in July.

2. Maximum suspended sediment (SS) concentration was recorded

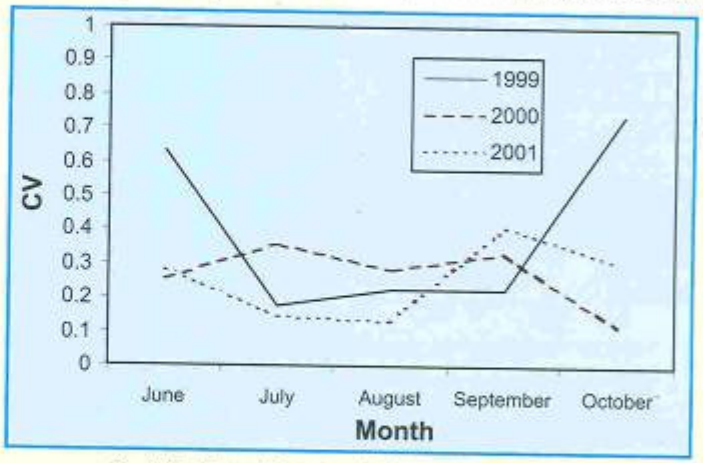


Fig. 3. Coefficient of variation - discharge of Gangotri glacier

in July (14.22 g/l) and the minimum in October (0.08 g/l). Maximum SS values were generally recorded with the high discharge events, however, peak discharge in July showed lower SS concentration.

3. On diurnal scale both discharge and SS values showed similar trend in July and August. Peak discharge and SS was observed in late evening in most of the days. SS peak corresponds to the discharge peak indicating positive correlation.

3.1.5. Quantification of Tectonic Deformation Field in Kumaun Himalaya -A Basic Framework for Landslide Hazard Modelling Using Sub-Cm Precision GPS Surveys

Background

Himalaya is a seismically and tectonically sensitive domain. Stability of the fragile ecosystem of Himalaya depends upon the delicate balance between the moving tectonic units. A disturbance in this balance cause changes that rapidly assume alarming proportions. Landslides are a common occurrence throughout the geodynamically active Himalaya. In Kumaun Himalaya alone, the annual cost of losses caused by landslides amount to several crores of rupees. These losses can be reduced by following knowledge-based approaches to land use on Himalayan slopes. This activity addresses the problem of modelling the time evolution of the landslide process on some highly vulnerable slopes in Kumaun Himalaya with the final objective of being able to forecast the future state of hazardous slopes. The approach to this problem is to map with sub-centimetre accuracy the time deformation field along N-S profile of some conspicuous hill slopes in Kumaun Himalaya using Global Positioning System (GPS) surveys.

Objectives

1. To determine the annual strain rate field in Kumaun Himalaya from Dung (north of Milam) to Almora and Malpa to Pithoragarh
2. To monitor the temporal evolution of some potentially damaging landslides using Kinametic GPS survey

Results and Achievements

1. The first phase of fieldwork was done in September-October 2002 along Almora-Dung S-N profile. The differential GPS survey was conducted at 14 sites in lesser and higher Himalaya to determine the deformation rate (strain) distribution in the Kumaun Himalaya.

2. Data generation and archiving was done for permanent station located at GBPIHED Campus.

3.1.6. Performance and Adaptability Analysis of "SWEET" in the Hills of Kumaun Himalaya

Background

Most of the wastelands in the Kumaun Himalaya are highly degraded in terms of productivity, due to various factors like over grazing, large-scale deforestation, topsoil erosion, moisture deficiency and low productivity, etc. Abandoned agricultural land also forms a large part of wasteland, which can be reclaimed. Under this project such village community land was proposed to be rehabilitated through SWEET technology for direct benefits such as, fodder and fuel wood and SWC, etc. as well as other associated benefits.

Objectives

1. To identify potential sites for wasteland development that can successfully be treated for SWC in Kumaun Himalaya

2. To test the performance and adaptability of SWEET through field demonstrations and to generate awareness and skill among the farmers and extension workers for reclamation of wastelands

3. To modify and suggest appropriate technology package based on performance report and cost-benefit ratio for future application in wasteland development and SWC programme in the Himalayan region

Results and Achievements

1. About 49 ha of community wasteland and 25 ha of private wasteland was taken for extension of SWEET model in Almora district. In these selected villages the farmers had to depend upon adjoining community lands for their fodder and fuel wood

requirements, which caused degradation and making the land prone to soil erosion.

2. The villagers with the help of technical guidance and proper training were involved in the selection of species. The survival of species ranged from 66-69 per cent (Table 3).

Table 3. Performance of plantation in selected villages

Village	Year of plantation	Number of species	Number of plants	Average survival (%)	Av. height of seedlings (cm)
Munso	2001-2003	17	3210	67	57.6
Udiyari	2002-2003	11	2240	69	100.4
Katarmal	2002-2003	18	3560	66	88.1
Panchgaon	2002-2003	16	3240	66	93.3

3.1.7. Ecology of Reduced Tillage and Mulching in the Central Himalayan Cropfields

(Summary of completed project)

Background

Maintenance of soil fertility and soil moisture in the mountain rain-fed farming is a challenging task. Traditionally massive amounts of leaf organic matter collected from nearby Oak and Pine forests is allowed to decompose in the cattle shed and the farm yard manure (FYM) is transferred to the crop fields for soil fertility replenishment at every cropping season in this region. Under the monsoon rains the vital soil nutrients are lost through runoff leaving the cropfields nutrient-poor and dry. These non-remunerative rain-fed terraces are left uncultivated and become prone for the invasion of weeds, such as *Lantana camara*. Attempts were therefore made to use *Lantana* as organic matter mulch to increase soil fertility and ensuing SWC benefits as compared to FYM application.

Objectives

1. To quantify runoff, soil loss, crop yield and nutrient loss through runoff and soil loss under different treatments of tillage and mulching as compared to traditional farming practice

2. To suggest better practices of tillage and mulching for improving soil fertility, crop yield and conservation of soil and water in rain-fed farming

Results and Achievements

1. Soil nutrients (total N, NH_4-N, NO_3-N, P, K, OC and OM) were found highest under *Lantana* mulched plots during kharif season. During rabi season only total N, NH_4-N and K were found highest under *Lantana* mulched plots. Most of these soil nutrients were found minimum under control (without mulch) plots.

2. Experimental plots (Fig. 4) tilled twice and mulched with *Lantana* recorded maximum yield of wheat. Yield of rice was found maximum under once tilled pine mulched plots and minimum under traditional farming practice.

3. Both soil loss and runoff were found high under traditional practices of farming during rabi

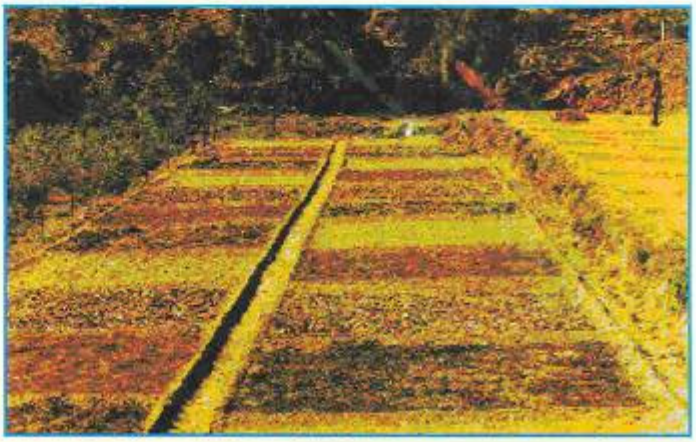


Fig. 4. Experimental agricultural plots mulched with Oak, Pine and Lantana leaf litter

season. During kharif season control plots recorded highest runoff and soil loss. Loss of N through silt and runoff was found maximum under traditional practices during kharif crop.

4. Lantana was found better mulch as compared to traditionally used organic matter (oak, pine and FYM) for soil fertility improvement.

3.1.8. Technical Assistance, Supervision and Monitoring of Catchment Area Protection (CAP) Work in SWAJAL Villages of Uttaranchal

Background

Catchment Area Protection (CAP) work carries the potential of reversing the declining trend of water sources and resolving the uncertainties associated with the water supply schemes. It can help in meeting the household water needs of the people and may also get their participation at the catchment level. Keeping this in mind the CAP works are proposed in selected SWAJAL villages. Threat to the water source, people's willingness to participate, and technical feasibility may be the main criteria for the selection of these villages. It is expected that after realizing the benefits other villages may also follow CAP work.

Objectives

1. To increase discharge of the water source tapped for water supply in the SWAJAL village to a minimum of 15 litres per minutes and achieve consistency in source discharge for water supply, where variations up to 50% have been recorded

2. To protect the water supply scheme structure threatened due to soil erosion and landslide problems and to protect the catchment area of the water sources tapped, which has considerably degraded and causing threat to the water supply system of the SWAJAL Project

3. To build the capacity of village community, by involving them in the process of implementation of CAP works with the assistance of Support Organization

Results and Achievements

1. The CAP activities were completed in all 165 villages in December within the stipulated time frame. The activities were broadly divided into two categories, namely, community items and individual items. Community items included forestry activities mainly focused on biological measures, such as plantation of suitable species after land preparation and physical measures, such as protection of catchment area from through-fare by fencing and digging of staggered contour trenches to catch rainwater, making check dams and soil erosion control structures, etc. Several individual items were also included to mobilize villagers towards CAP works such as grass patches, NADEP compost pit, health and LPG camps, etc.

2. About 763.42 ha land was treated within the catchment area of water supply sources. The activities included plantation of 6.5 lakh tree saplings (more than 60 % survived the worst dry period of recent times), contour trenches (84.58 km length) with rain water storage capacity more than 2029 m^3, 1871 minor and medium check dams and 539 *khals* and tanks for rain water storage.

3.1.9. Integrated Natural Resource Management in Takoli Gad Watershed in Garhwal Himalaya

Background

In Central Himalayan region almost all the watersheds are being subjected to a variety of drastic changes due to rapid extraction of all the available natural resources. In fact, the different types of developmental interventions that adversely affect the environment cause depletion of the natural resources from the watershed. The Takoli Gad watershed in the Garhwal Himalayan region is one such watershed where the loss of natural resources has affected the entire population. Therefore, an integrated natural resource management strategy is required to meet these challenges.

Objectives

1. To collect primary and secondary information related to socio-economic conditions,

agriculture, livestock, water resources, irrigation, natural resource utilization pattern, employment etc.

2. To develop planning and management approaches with emphasis on the needs of local people for integrated natural resource management of the watershed

Results and Achievements

1. The cost-benefit analysis of the ginger cultivation under various land use system (i.e. rainfed, irrigated and kitchen garden) and its contribution in the local economy has been worked out.

2. In-depth study particularly of livestock sector of the watershed are being conducted in relation to its linkages with natural resources, cultivation practices and livelihood systems etc.

3.2. SUSTAINABLE DEVELOPMENT OF RURAL ECOSYSTEMS

The Programmes under the mandate of this core are designed to provide some solutions to location specific problems of natural resource management. Focus is to study the availability, use, requirements and prospects of managing currently available resources more judiciously so as to reduce the pressure on limited resources. In Himachal the ability of pine forests to provide required organic resources needed for crop production and horticulture are being studied. In Uttaranchal efforts are continuing to assess the impact of restoration models on soil physico-chemical characteristics to test the suitability of selected species for agroforestry systems. A focused study on Nanda Devi Biosphere Reserve buffer zone villages was undertaken on people's utilization of agricultural diversity and landuse/cover change database for analyzing its impacts. Similar strategies are being tested in a development block (Hawalbagh block in Almora district of Uttaranchal) where conservation priorities are not imposed to assess the natural resource based planning prospects.

3.2.1. Sustainable Resource Management Strategies for Rural Development in the Himalaya

a) Natural Resource Management for Sustainable Development

Background

This study is in continuation to the work done in past on the natural resource management for sustainable development by the tribal communities in North East India. West Kameng district (HQs. Bomdila) was selected for the detailed study as this area comprised diverse tribal groups, forest types, landscapes, vegetation types, NTFPs and wildlife. The area has been focus of the development in recent times, and while doing so resources are exploited to such an extent that degradation become visible frequently at many places, therefore the area deserves suitable strategies for sound and sustainable management of the natural resources. In this report we are presenting data on Land use pattern and community dependence on natural resources by Monpa community of the West Kameng district of Arunachal Pradesh.

Objectives

1. To assess community structure and their natural resources, and sustainable management practices among selected tribal communities
2. To quantify the status of resources, its utilization patterns, socio-cultural dimensions and traditional ecological knowledge
3. To assess village institutions and effectiveness of Customary Laws in system functioning

Results and Achievements

1. The West Kameng district has five major tribes, namely, Monpas, Akas, Sherdukpen, Bugun/Khowas and Mijis. Besides two minor groups, viz. Lishpa, Chugpa are also present. The total population of district is 74,595 persons as per 2001 census, with a population density of 10 persons km^{-2} and a growth rate of 32.21 during 1991-2001.
2. The total area of Dirang circle is 1399.40 km^2, and a major share of land (64%) is under forest cover. However, due to extensive use of forest resources considerable area (31%) is degraded. The agriculture activity is confined to 5.51% of total land area, 8.50% land is under barren/rock/steep slope/ snow, and 0.12% area under other uses.
3. Land ownership is either with community or clan or an individual family. Land holdings are small and fragmented. Per capita cultivated land is only 0.54 ha. Nearly 10 cft wood/household/ annum is consumed in the study area. A total net wood requirement of 519633 cft (firewood, agriculture implement, furniture, fencing and ritual and timber) was estimated for whole Dirang circle (Table 4).

b) Land Use Models for Himalaya

Background

Land degradation is a major problem all through the Himalayan ranges. Plantations of multipurpose trees alone or combined with agricultural crops would be an effective land rehabilitation strategy. In agroforestry systems, litterfall

Table 4. Average quantity of forest produce consumed annually in the Dirang circle

Parameters	Dirang circle	Per household
Bamboo use for house construction (culms)	71389.2	21
Bamboo use for fencing (culms)	36830.2	11
Bamboo use for agriculture equipment (culms)	9821.4	3
Firewood (q)	261683.1	76
Kerosene (liter)	170959.5	50
Coal (kg)	13755.0	42
Agricultural implement (cft)	24553.5	7
Furniture (cft)	4910.7	2
Fencing poles (cft)	17187.4	5
Timber use for house (cft)	36843	11

from the trees acts like a mulch which reduces soil erosion and increases soil fertility through the input of nutrients and organic matter. The synchronization of the nutrients release from the decomposing litter with nutrient uptake by crops is considered vital for improving the efficiency of nutrient uptake through the plants. The purpose of the present study was to estimate the litterfall, litter decomposition, nutrient return and nutrient release patterns of some, multipurpose tree species in a mixed agroforestry plantation done basically for rehabilitation of degraded (abandoned) of agricultural land.

(i) Central Himalayan Case Study

Objectives

1. To identify agricultural land use practices suited to the ecological and socio-economic attributes of the area and their implementation in the field on experimental basis
2. To evaluate the acceptability of the identified management practices by the people
3. To undertake fundamental researches so as to design refinements in the existing / identified agricultural land use practices for sustainable development

Results and Achievements

1. Differences between species were most marked in polyphenol and N concentrations. *Albizzia lebbek*, *Alnus nepalensis* and *Dalbergia sissoo* showed higher N (2.62, 2.51 and 2.19%, respectively) but lower polyphenol concentrations (3.2, 4.7 and 4.5%, respectively) than *Boehmeria rugulosa*, *Ficus glomerata* and *Ficus roxburghii* (1.16, 1.97, 0.96% N and 5.68, 7.1 and 11.64% polyphenol concentration, respectively). *B. rugulosa* and *F. roxburghii* had the highest C/N, lignin/N, polyphenol/N and lignin+polyphenol/N ratios. *A. lebbek* and *A. nepalensis*, and *D. sissoo* and *F. glomerata* had similar C/N and polyphenol/N ratios but differed in respect of lignin and lignin+polyphenol/N ratios.
2. Monthly mass loss was positively related with rainfall and temperature but these linear relationships were not significant ($P>0.05$) for temperature in all species and for both temperature and rainfall in *F. roxburghii* (Table 5).

Table 5. Annual decomposition constant (k) for mass and nutrients for leaf litter of multipurpose tree species planted in degraded land at Banswara

Attributes	Species						Least significant difference (P=0.05)
	Albizia lebbek	*Alnus nepalensis*	*Boehmeria rugulosa*	*Dalbergia sissoo*	*Ficus glomerata*	*Ficus roxburghii*	
Mass							
K	10.2	1.16	0.74	0.99	0.99	0.63	0.03
R^2	0.89	0.92	0.98	0.93	0.93	0.97	
Nitrogen							
K	0.83	0.91	0.22	0.71	0.66	0.05	0.03
R^2	0.87	0.89	0.80	0.91	0.91	0.25	
Phosphorus							
K	0.73	1.09	0.63	0.83	0.78	0.53	0.04
R^2	0.79	0.92	0.98	0.93	0.85	0.98	
Potassium							
K	4.66	4.04	3.84	4.28	3.70	3.64	1.30
R^2	0.96	0.95	0.97	0.98	0.97	0.96	

3. The highest decomposition constant (k) was observed in *A. lebbek* and the lowest in *B. rugulosa*, *F. glomerata* and *F. roxburghii*, with no significant (P>0.05) difference between them.

(ii) Northeast Himalayan Case Study

Objectives

1. To evaluate impact of contour-hedgerow-farming-system-technology on crop yields and overall land productivity

2. To evaluate performance of locally growing N_2-fixing hedgerow barrier species against pruning intensity, their nitrogen fixation ability and mulch biomass production

3. To assess cover and barrier effect of hedgerows on soil properties, and control of runoff, soil erosion and nutrient loss

Results and Achievements

1. Four nitrogen fixing hedgerow species (viz. *Tephrosia candida*, *Flemingia macrophylla*, *Desmodium rensonii* and *Indigofera anil*) are being monitored for their performance in different soil types. It was recorded that N_2-fixing species perform much better in the soils of secondary forests, recent landslide, 2nd year jhum and rainfed agriculture. It also proves that using these hedgerow species in such stress soils may lead to faster recovery of their nutrient status and thus could rejuvenate degraded lands.

2. Impact of contour hedgerow intercropping on maize crop was estimated, and an increase of yield by 210%, 141%, 118% and 75% was recorded in plots treated with hedgerow+mulch, hedgerow only, green mulch only, and forest litter, respectively than the control plots.

3. The enzymatic activity of soil also improved with application of mulch with hedgerow species. Total N increased by 8.7, 13.4, 17.4, 13.0 and 13.3%; total P increased by 21.3, 28.7, 45.7 36.0%; dehydrogenase by 34.0; 21.9, 52.3, 72.3, 65.5 and 28.8%, and urease activity increased by 50.3, 78.9, 24.6, 103.9 and 90.0% when plots were treated with hedgerow only, green mulch only, hedgerow+ mulch, forest litter and jhum treatments, respectively, than the control plots.

3.2.2. People-Centered Landuse Development in the Shifting Agriculture Affected Areas in Arunachal Pradesh

Background

This project focuses on designing strategies for sustainable livelihoods of traditional hill societies, and linking environmental concerns with sustainable development in selected locations in Arunachal Pradesh. It is a multi-institutional project, and GBPIHED is working in the West Kameng district (area 7422 km^2) that has many key features. The area is surrounded by international boundaries, it is an important corridor for many animals (elephant pass) and plants, and comprise the Outer, Lesser and Higher Himalayan ranges with diverse vegetation types in an elevation gradient of 100-7090 m above sea level. The forests are categorized into 3 broad legal categories, i.e. Reserve Forests (RF), Anchal Forests (ARF) and Unclassed State Forests (USF). Shifting cultivation, fire, grazing, timber collection, poaching, and NTFPs harvesting are perceived as major threats to rich flora and fauna of the area. The project aims to design and develop site-specific *in situ* strategies, explore *ex situ* conservation possibilities by bringing together scientists, managers, planners and local communities to achieve community development.

Objectives

1. To study community structure, land use-land cover change and role of shifting cultivation in socio-economic development of the communities

2. To understand forest ecosystem dynamics of different legal forest types (Reserve Forest, Anchal Forest and Unclassed State Forest) and impact of secondary forests on livelihood

3. To identify and estimate the quantum of NTFPs harvests and their potential for future use. Also see the possibility of value addition to a few NTFPs.

Results and Achievements

1. West Kameng district has five major tribes (Monpa, Sherdukpen, Aka, Bugun and Miji) and all these have been selected for the study. The agriculture is the main economy of the region. More than 90% population is dependent on it, and 57% income is generated from this sector only. Agriculture practices varied from settled in western region, combination of settled with shifting agriculture in mid-southern zone to purely shifting cultivation in eastern region of the district.

2. In Dirang and Kalantang circle of Monpa and Sherdukpen communities agricultural land use system is transformed into horticultural system, and many fruit species, such as apple, orange, pineapple, pomegranate and kiwi fruits have been introduced in the area and most of them are performing well. Besides, cultivation of large cardamom, black pepper has also been sown. At selected places even the wasteland is also being converted into apple orchards (particularly in Zimithung village) and orange plantation (as in Yewang village).

3. Legal forest categories showed that the RF had a tree density of 434 individuals/ha, USF 537 individuals/ha, while ARFs has 254-341 individuals/ha, which can be attributed to the biotic pressure at the site.

3.2.3. An Assessment of Agriculture Production an ' Strategy for Sustainable Development of Bioresources

Background

The Himalaya constitutes a unique geographical and geological entity comprising of a diverse social, cultural, agro-economic and environmental setup. In this region limited life supporting activities are available; land constitutes the most precious resource for its inhabitants as it is the main source of livelihood. The ever increasing population of human and livestock in this region, has made it imperative to assess the production of bioresources such as agricultural, fuel and fodder in the different geo-environmental conditions. With this in view, Hawalbagh development block of Almora district was selected as a sample, and is being studied in detail. The entire block has been divided into three altitudinal zones (i.e, less then 1400m, 1400-1600m and more then 1600m), and forty villages of the block are being studied. During this year various informations on fodder (availability, sources, type, uses, etc.) were collected and analyzed.

Objectives

1. To study the different sources of fodder

2. To quantify the total production and consumption of fodder in the different geo-environment condition

Results and Achievements

1. In all the three altitudinal zones it was found that the nearby forests are a major source of fodder; as the rural inhabitants are grazing their cattle (cow, ox, goat, etc.) throughout the year and also collected fodder during rainy and winter seasons.

2. It was found that broad leaf trees are the main sources of fodder during winter season whereas grasses during the rainy season.

3. The fodder requirement increases with increasing altitude. Because the inhabitants of the higher areas keep more livestock compared to the inhabitants of the lower areas. It was found that the average livestock was about 3 per households in the higher areas and about 1.5 per households in the lower areas.

3.2.4. Farmers Field School-Cum-Training Programme

Background

Current development policies have led to much rethinking of the role of extension in rural development. The NGOs, farmers' associations, commercial enterprises and rural communities are assuming a more prominent role in the development process. Together with the various stakeholders (such as the owners of the development process), the appropriate technology demonstration, dissemination and extension services increasingly need to focus their attention on the

facilitation of communication, negotiation, commitment and collective decision-making among rural peopleers. This implies that extension services will have to become intermediary change-oriented organizations, geared to creating the necessary maneuvering space for participation, collective decision-making and community-based management.

Objectives

1. To develop simple field manuals for farmers
2. To train trainers in technologies described in the manuals
3. To impart training through participatory learning methodology

Results and Achievements

1. At the Institute HQs fourteen training courses (each for three days) focused on "*Krishak Vikas Evam Arthik Utthan*" for various line departments of State Government were organized and a total of 654 person (472 men and 182 women) were trained. Similarly, five training courses for different farmers and NGOs working in Uttaranchal were organized and a total of 871 (291 men and 580 women) were trained.
2. About 45 farmers of more than 15 villages and 5 representatives of various NGOs of the Virhi valley and adjoining areas have been given training and also encouraged for medicinal plant cultivation.
3. Field exposure on natural resource management was given to more than 80 high school science background students belonging to 30 schools of the Garhwal region in two training programme each of 5 days.

3.2.5. Promoting Cultivation of Medicinal Plants Through Biotechnological Inputs in the Nanda Devi Biosphere Reserve and Adjacent Niti Valley of Garhwal Himalaya for the Socio-Economic Development of the Bhotyia Tribe

(Summary of completed project)

Background

In recent time the demand of medicinal and aromatic plants (MAPs) has increased rapidly in the global market. The domestic sales are growing at a rate of 20% per annum, while the international market for herbal products is estimated to be growing @7% per annum. Due to rapidly increasing demand of MAPs, the number of species known to have become rare, endangered, threatened and extinct. Every year thousands of tones of these plant resources are being exploited from the natural habitat either legally or illegally without fair benefits accruing to the local people. IHR is the storehouse for the MAPs. However, management and conservation of these MAPs in their natural habitat require active involvement of the local communities at every step. Therefore, effective training and capacity building focused on domestication/cultivation and conservation, improved marketing systems and processing/semi-processing, bioprospecting and value addition are the appropriate short- and long term solution to assure conservation and management and sustainable livelihoods to the local communities.

Objectives

1. To identify appropriate site for the establishment of demonstration models for cultivation of medicinal plants having huge economic potential and market
2. To develop agro-technology for economically suitable species and also document indigenous agronomic practice and uses of these medicinal plants which are under cultivation
3. To work out cost-benefit analysis of cultivation and their role in local economy

Results and Achievements

1. Biomass and yield was assessed in one and two year old plantlets of *Allium stracheyi, Angelica glauca, Arnebia benthamii, D. hatagirea,* and *Rheum emodi* under different microclimatic conditions such as open, polyhouse and shade conditions. The maximum biomass accumulation was recorded for *Dactylorrhiza hatagirea* and *R. emodi* under open condition, for *A. stracheyi* and *A. benthamii* under polyhouse conditions, and for *A. glauca* under shade condition.

2. Cost-benefit analysis was carried out for different MAPs like *A. humile*, *A. stracheyi*, *A. glauca*, *Carum carvi*, *D. hatagirea*, *Megacarpaea polyandra*, *Pleurospermum angelicoides* and *Saussurea costus*. The total monetary input recorded maximum for *S. costus*, whereas it was least for *C. carvi*. The monetary input/output ratio was found high for *C. carvi* (25.0) and minimum for *M. polyandra*.

3. Thousands of seedlings of 14 MAPs species have been raised in the different demonstration sites and about 90,000 seedlings of different species with maximum number of *Allium spp.* have been distributed to interested farmers, NGOs and GOs at free of cost.

3.2.6 Augmenting Food and Economic Security of Tribal Communities, Particularly Women in Arunachal Pradesh through Simple and Low Cost Technological Intervention

Background

Tribal communities in North-East India are intimately dependent on natural resources for their survival. In recent times there has been tremendous pressure on natural habitats and many useful plants have come under the threat category. There is an urgent need to screen out more information on useful plants, document indigenous knowledge about their utilization and management and taking necessary step for their *in situ* conservation and suggesting ways for encouraging *ex situ* cultivation and rearing of selected and preferred edible wild plants and other high value species within or around the homestead using poly-pits, polyhouses, and in their jhum fields and fallows using shrub and tree species as hedgerows. The present project focuses on evaluating the traditional knowledge for use of food resources that play a vital role in proper nourishment of all including the nursing and expectant mothers of the Nyshi community in the Papumpare district of Arunachal Pradesh.

Objectives

1. To increase the accessibility of the rural populace to traditional food and nutritional resources, particularly those, which are important supplementary dietary sources of protein, minerals and vitamins for expecting and nursing mother

2. To augment agricultural productivity by introduction of simple soil fertility enhancement measures such as by the introduction of bio-composting and high value crops

Results and Achievements

1. To determine the reproductive health status of local women and to identify some of the traditional wild edible plants commonly preferred and consumed on a regular basis household surveys were conducted in 6 villages, viz. Midphu (I and II), Sopo, Chiputa, Rose, Rono and Mani under Doimukh circle of Papumpare district in Arunachal Pradesh.

2. So far 59 most prominently used species have been screened that are used by the community in the study area. A large variety of tuber crops are used, i.e. Cassava (*Manihot esculenta*), Sweet Potato (*Ipomoea batatus*) and different *Colocasia* species. Generally all the species had high phosphorus and protein content.

3. The village survey reveals that there are least avenues to increase crop production until some special effort are made. To increase the income of farmers a multi-tier cropping system has been introduced consisting of fruit trees (jamun) as upper storey with *Piper longum*, large cardamom-Colocasia–Pineapple-Tomato-Brinjal at middle storey, and Sweet Potato just above the soil surface. The performance of each of the crop is being monitored.

4. Trials are being done on the growth and productivity of some important root-tuber crops also, such as Sweet Potato, Cassava and Colocasia as effected by mulching as well as modifying their agronomic practices. All these species are planted by digging trenches of 30 cm wide and 5 m long. The yield increased by 3-5 times recording a yield of 32.31±8.45, 62±4.5 and 74.0±5.7 t ha^{-1} for Sweet Potato, Colocasia and Dioscorea, respectively (Fig.5).

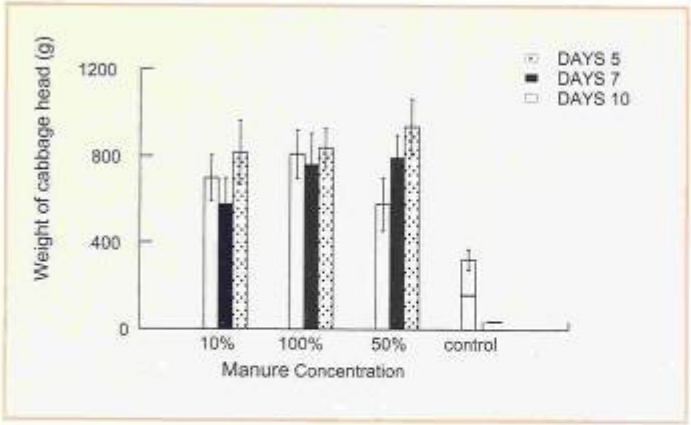


Fig. 5. Cabbage yield (kg) as influenced by liquid manure application

3.2.7. ENVIS Centre on Himalayan Ecology

Background

The Environmental Information System (ENVIS) on Himalayan Ecology was setup as a part of ENVIS network in India by the Ministry of Environment & Forests, the nodal agency in the country to collate all the information from these Centres to provide national scenarios to international setup INFOTERRA Programme of UNEP. ENVIS essentially help in handling of huge and varied information relevant to environmental management and development.

Objectives

The ENVIS Centre on Himalayan Ecology is the sole Centre in the entire Indian Himalaya, which is trying to integrate the available information in the ready to use form for the users of remote hilly regions in particular, and for regional developmental planning in broader perspective. The Centre currently engaged in collecting, compiling and disseminating information through viable databases.

Results and Achievements

1. ENVIS Bulletin Volume 10 No. 1 and 2 were published.
2. 202 queries were handled during the year 2002 to provide response services.

3.2.8. Tropical Soil Biology and Fertility (TSBF) Programme – South Asian Regional Network

Background

The TSBF is a programme of collaborative research with the overall objective of determining the management options for improving the fertility of tropical soils through biological processes. The South Asian Regional Network (SARNET) of this programme is co-hosted by this Institute and Jawaharlal Nehru University, New Delhi since 1993 and is facilitating center for information collection and dissemination.

Objectives

1. To conduct/encourage collaborative research with/ among participating scientists.
2. To coordinate research networks and projects.
3. To develop test methods and identify appropriate sites for long term experimentations and monitoring of below and above ground biodiversity and their impact on soil fertility improvement.

Results and Achievements

1. Compilation of abstracts and bibliography.
2. Project proposal on conservation and sustainable management of belowground biodiversity in and around Nanda Devi Biosphere Reserve (NDBR) presented and has been approved by expert committee in the start-up/ planning workshop.

3.2.9. Impact of Multipurpose Contour Hedgerows Intercropping on Productivity and Soil Fertility in Shifting Agricultural (Jhum) Fields in the North East India

Background

The Contour-Hedgerow-Farming-System-Technology

(CHFST), which is based on planting N_2-fixing hedgerow species in contours all along the slope at certain intervals and allowing alleys to produce crops, is found very effective and relevant as an alternative for the slash and burn agricultural system of North east India. It is low cost and simple innovation to land rehabilitation and holds tremendous potential for developing a long-term sustainable agricultural strategy while simultaneously ensuring environmental conservation. This project is aimed for testing efficacy of multipurpose hedgerow species on land productivity and fertility in North East region.

Objectives

1. To study selected hedgerow species for their biomass accumulation, pruning, and frequency and assess impact of mulching on soil moisture and weed proliferation.
2. To assess impact of hedgerow species on crop production.
3. To assess nutrient release from leaf litter and mulch biomass.

Results and Achievements

1. Weed diversity, density and biomass in control plot having 30 species with an average density of 280 plants m^{-2} and a biomass value of 37-140 g m^{-2} in different months were significantly higher than the mulch applied plots.
2. The highest yield of tomato was recorded with high quality mulch (8.68 t ha^{-1}), followed by mix-quality mulch (6.96 t ha^{-1}), low quality mulch (4.74 t ha^{-1}) and minimum in control plots (4.31 t ha^{-1}).
3. Nutrient release from four different hedgerow species (viz. *Desmodium rensonii, Tephrosia candida, Flemengia macrophylla*, and *Indigofera anil* and forest litter indicated that *D. rensonii, I. anil* and *T. candida* had very fast decomposition. Mix leaves, *F. macrophylla* and forest litter took relatively longer time in decomposition.
4. Impact of different quality of mulching viz., high-quality mulch (green leaves of hedgerow spp. applied @ 40 kg N ha^{-1}), low-quality mulch (rice husk applied @ 40 kg N ha^{-1}), and mix-quality mulch (green mulch and rice husk each applied @ 20 kg N ha^{-1}) on soil N- mineralization exhibited greater rates of NH_4^{++}-N and NO_3^{-}-N mineralization under high quality mulch, showing that mulching of N_2-fixing hedgerow species significantly improves soil quality (Fig. 6).

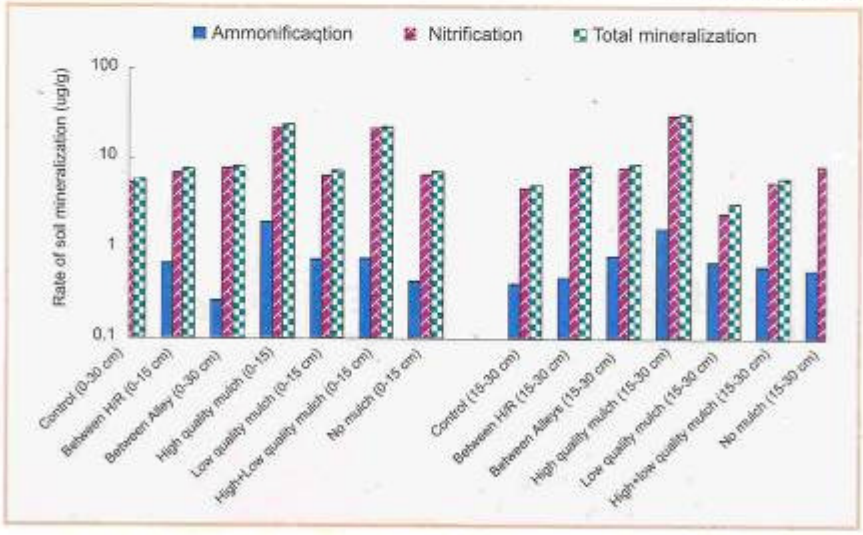


Fig. 6. Impact of different quality mulching on soil N mineralization.

3.2.10. Commercial Utilization for Sustainable Rural Development and Conservation of Some Potential Wild Edible Oil Plants of Garhwal Region of Uttaranchal

Background

Wild fruits, edible oil, medicinal value, etc have played a prominent role in the socio-economy of human beings, particularly in the tribal and rural areas of the country for thousands of years. Although the wild plants of food and other values are not consumed in large quantities, their role in local communities cannot be ignored. The forest of the Garhwal region produce many wild edibles of huge economic potential and are oftenly used by the local population. There is also a variety of still unappreciated species in the forests whose economic value is yet to be exploited. Fuller utilization and domestication of many forest species could supply food and edible oils and also improve the economy of the region. The *Prinsepia utilis* (locally called Bhenkal), *Prunus armeniaca* (Chulu), *Prunus persica* (Kirol) and *Litsea consimilus* (Chirad) are some important wild edible oil yielding plants of this region, which require immediate scientific and technological interventions.

Objectives

1. Inventory of wild edible oil plants, distribution patterns and their contribution in the local diet and traditional health care system
2. To document indigenous knowledge of oil extraction, consumption pattern and uses, and comparison of oil extraction from traditional and modern techniques
3. To analyse the nutritional, physico-chemical properties, fatty acid composition and medicinal values of the oil and scope for their value addition

Results and Achievements

1. Surveys in several remote and isolated valleys of the Garhwal region were conducted and potential sites of these species identified.
2. Analysis of secondary information (literature survey, traditional healers and knowledgeable persons), revealed that wild plants which yield various edible products have a high energy content, and enormous medicinal potential.
3. Documented indigenous knowledge related to seed collection, seed processing, oil extraction, consumption pattern and mode of uses.

3.3. CONSERVATION OF BIOLOGICAL DIVERSITY

The importance of maintaining Himalayan Biodiversity not only for the present but also for posterity is now well recognized. The core is strengthening its activities by developing both short (location specific) and long (broader spatial scale) term programmes. All activities are responsive to contemporary global thinking on the subject matter. It is in this context that the frame work of different projects is developed as per the guidelines provided by National Action Plan (NAP) and AGENDA 21 in conjunction with the convention on biodiversity. It aims in harnessing potential bio-resources equitable and also in halting the increasing pressure on biological assets. Following research programmes are under progress: Documentation and prioritization of important components of biological diversity; identification and monitoring the processes and activities responsible for depletion of biodiversity; and identification of priorities for maintenance of existing biodiversity in the Himalaya and assessing threats to biodiversity in selected protected areas. Efforts are also on to complement *in situ* conservation with the help of *ex situ* methods and ensure people's participation in biodiversity conservation.

3.3.1. Studies on Biodiversity, Habitat Fragmentation and Conservation in the Protected and Ecologically Sensitive Habitats of the Himalaya

Background

The identification and characterization of habitats of the Himalaya, especially those supporting sensitive biota is of paramount importance for identifying the disruptions and magnitude of pressures leading to habitat degradation and extirpation of important species. Index of change in a system can effectively be monitored and conservation measures adopted when habitats are taken as study units. The project was initiated to study the habitat diversity, distribution pattern of native and non-native species, resource utilization pattern, and monitor changes in protected and unprotected areas of the Himalaya.

Objectives

1. Identification, classification and mapping of important habitats that support important taxa
2. Identifying degree of biotic and anthropogenic pressures causing habitat fragmentation
3. Narrowing the gulf between *in-situ* and *ex-situ* conservation by developing techniques for enhanced economic utilization of *in-situ* resources in *ex-situ* situations

Results and Achievements

(a) Biodiversity studies of sub-tropical and temperate forests

1. Selected villages (Khania, Bhanolia and Chaukuni) of upper Siraunt gad catchment (Ranikhet) were surveyed for domesticated diversity, resource utilization pattern and extraction trends of fodder and fuel species. Over 30 species were utilized by the inhabitants of the villages for medicine, food (wild edibles), fuel, fodder, house building, agricultural tools, fibre and various other purposes.

2. Detailed floristic surveys were conducted in Airadeo Reserve Forest, West Almora (Table 6). Of the total recorded plants, 265 species fall under different use categories, i.e., medicine (121), wild edibles/food (107), fodder (57), fuel (22), agricultural tools (12), house building (9), fiber (5), religious (7), and various other purposes (15 spp.). 21 species have multipurpose utility. Considering the habitat preference, distribution range and population size of species, 59 species have been identified as rare-endangered.

(b) *Biodiversity studies along disturbance gradient*

1. Demographic profiles of identified forest types under different disturbance intensities were developed. Overall similarity in population structure was apparent in most cases. Relatively greater seedling density in degraded and semi degraded conditions was characteristic of all the forests (Fig. 6).

2. Compositional features of forests at different disturbance intensities were compared: (i) *Pine forest* - tree density patterns exhibited significant ($p<0.05$) difference across disturbance intensities. The tree density ($r=-0.985$, $p<0.001$) and tree basal cover ($r=-0.617$, $p<0.05$) showed significant negative correlation with increasing disturbance level; (ii) *Mixed forest* - the tree density ($r=-0.851$, $p<0.01$), mean basal cover ($r=-0.754$, $p<0.05$), seedling density ($r=-0.702$, $p<0.01$) and sapling density ($r=-0.872$, $p<0.01$) exhibited significant negative correlation with increasing disturbance level. However, herb density ($r=0.731$, $p<0.01$) showed significant increase; (iii) *Oak forest* - with increasing disturbance level a significant

Table 6. Plant diversity of Airadeo Reserve Forest (west Almora)

Taxonomic Groups	Families	Genera	Species	Life Forms			
				H	Sh	T	Pt
Angiosperms	112	358	484	326	84	74	-
Gymnosperms	2	3	3	-	-	3	-
Pteridophytes	21	34	59	-	-	-	59
Total	135	395	546	326	84	77	59

Abbreviations used: H= Herb; Sh= Shrub; T=Tree; and Pt=Pteridophytes

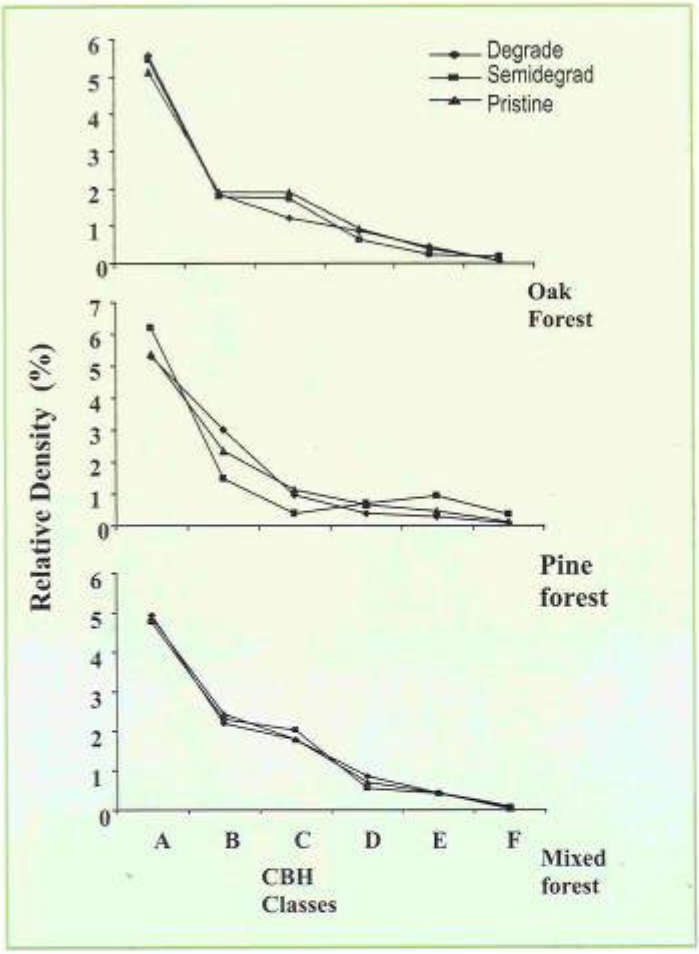


Fig. 6. Population structure across disturbance gradient in different forest types.

reduction in tree density (r=-0.985, p<0.01), tree mean basal cover (r=-0.617, p<0.1), and concentration of dominance (r=-0.737, p<0.05) was observed. A significant increase with increasing disturbance level was apparent in case of shrub density (r= 0.944, p<0.001).

(c) *Studies in sensitive habitats - timberline*

1. With increasing altitude, tree density, tree basal area, diversity index, seedling density, sapling density, shrub and herb density tended to decline in all sites. However, decline was significant only in case of tree density (r= - 0.872, p<0.05), tree basal area (r= -0.905, p<0.01) in Tungnath area. Among others, seedling and sapling density (r= 0.998, p<0.01) in Pindari; tree density and seedling density (r= 0.897, p<0.005), total basal area and seedling density (r= 0.948, p<0.01) in Lata showed significant positive correlation. Other relationships were non-significant.

2. Study conducted to investigate the response of plant species/ community at forest fringe (i.e. boundary between forest and meadow) in three sites viz., Phurkia (Pindari), Nagtal area (Valley of Flowers) and Kheron valley, revealed following community attributes (Table 7).

(d) *Kanawar Wildlife Sanctuary-KWLS (H.P.)*

1. Population study of *Podophyllum hexandrum* was made across fourteen sites in Kanawar Wildlife Sanctuary and its surroundings in Kullu district. On average, a minimum 0.1 individuals/m^2 and maximum 1.9 individual/ m^2 were recorded amongst different sites, where pH ranged from 4.5 to 7.2. About 67 % quadrates appeared with one individual and only 1.19 % and 0.59 % had 5 and 6 individuals, respectively. Most common availability (13 sites) of taxa was recorded under tree canopies (density up to 1.92 ind./m^2; frequency up to 72.3%). Rotten logs, moist - grooves, pastures, were other important micro - habitats.

2. Potential population assessment for *P. hexandrum* was also made

Table 7. Compositional features at forest fringe in three sites

Sites	Phurkia		Nagtal		Kheron	
Parameters	Interior	Boundary	Interior	Boundary	Interior	Boundary
Density/ha	280	120	760	580	860	1140
TBA M^2/ha	35.08	18.50	16.75	76.39	31.96	60.77
Diversity index (H')	0.64	0.44	0.38	0	1.46	0.76
Con. Dominance	0.53	0.71	0.76	1	0.238	0.583
Seedling Density/ha	5200	2000	5200	6800	20000	14400
Sapling Density/ha	4000	2000	6800	10,800	6800	7200
Shrub Density/ha	1500	4100	1420	8220	5300	7240

using plant morphology and biomass data. For different sites, a minimum of -16.0 cm and -7.0 mm to a maximum of -60.0 cm and -16.0 mm average plant height and rhizome diameter, respectively, was recorded.

3.3.2. Bioresource Inventory of the Himalaya

Background

Adequate base line data on biological resources of any biogeographical region help in the identification of species, population, communities, habitats, landscape elements and ecosystems. As such, it is imperative to develop a computerized data base of existing bioresources of the Himalaya. So far, comprehensive baseline data for the Himalayan bioresources is not available. Therefore, preparation of inventory of bioresources (family wise, rare-endangered, ethnobiological including medicinal plants and sacred plants, endemic species, *etc.*,) has been initiated.

Objectives

1. Develop a computerized database of all species and their habitats
2. Draw information about various attributes of specific habitats/species
3. Prioritization of species and sites for conservation

Results and Achievements

1. Inventory of Medicinal Plants of Uttaranchal was prepared (Table 8). Amongst the families Asteraceae (51 spp.), Fabaceae (43 spp.), Lamiaceae (33 spp.), Apiaceae (21 spp.), and Orchidaceae (20 spp.), were dominant. Analysis revealed 178 species as native to Himalayan region, 09 species as endemic and 104 species as near endemic. Seven species (*i.e., Allium stracheyi, Berberis affinis, Dioscorea deltoidea, Nardostachys grandiflora, Picrorhiza kurrooa* and *Pittosporum eriocarpum*) have been recorded in the Red Data Book of Indian Plants. Following IUCN criteria, 64 species (critically endangered - 18 spp., endangered -17 , vulnerable -22, low risk-near threatened - 6 and low risk-least concern - 1) have been identified as threatened.

Table 8. Diversity of Medicinal Plants of Uttaranchal State

Taxonomic Groups	Families	Genera	Species	Life Forms			
				H	Sh	T	Pt
Angiosperms	140	487	688	421	134	133	-
Gymnosperms	3	5	6	-	1	5	-
Pteridophytes	6	6	7	-	-	-	7
Total	149	498	701	421	135	138	7

Abbreviations used: H= Herbs; Sh= Shrub; T=Tree; and Pt=Pteridophytes

2. Information on sacred plants of IHR was compiled. A total of 155 species (70 families and 125 genera) of vascular plants (trees: 59 spp., shrubs: 30, and herbs: 66) have been recorded as sacred plants. Of these, 33 species were native, one species (*i.e., Pleurospermum densiflorus*) endemic and 14 species near endemic to IHR.

3. Inventory/assessment was made for 133 medicinal plant species (59 families), of H.P. These species constitute 17% trees, 23% shrubs and 60% herbs. Of the total defined taxa, 53% are native to the Himalayan region and 34% endemic (Indian Himalayan Region). Use pattern, nativity and endemic status of the species were explored. Family Apicaceae, Asteraceae and Ranunculaceae are under major threats for having 10 TMPs each. Over 50% species under ethno-medicinal and commercially medicinal use category indicates high pressure on them. Destructive nature of species use pattern, i.e. root (60%), whole plant (16%), bark/wood/resin (19%) further indicates high intensity of threats from harvesting.

3.3.3. Establishment and Maintenance of Functional Arboreta in the Himalaya

Background

In order to develop a germplasm bank of Himalayan species and ensure *ex-situ* conservation, enrichment of germplasm in arboretum at Kosi-Katarmal (Kumaun Himalaya) and maintenance of *Rhododendron* arboretum at Sikkim are continuing. The project is envisaged to be extended to Himachal Pradesh and North-East region of Indian Himalaya. The activity will not only serve as a gene bank of different Himalayan life forms but also provide opportunities for facilitating research, training and development activities.

Objectives

1. Developing a gene bank of Himalayan species including economically important taxa

2. Developing propagation protocols for locally acceptable species for sustenance and conservation value

3. Large scale multiplication of species and making the saplings available to local people and also for rehabilitating degraded lands

Results and Achievements

(a) *Strengthening of arboretum, Kosi-Katarmal*

1. Maintenance of the nursery and further extension for the establishment and maintenance of germplasm of native tree species including wild edibles, medicinal plants, orchids and ferns was conducted. Propagules of over 35 species were collected and accessioned. Over 4,000 seedlings of various species were planted in the arboretum sites and Institute premises. Seedlings of multipurpose species were distributed to local inhabitants.

2. Seeds of *Celtis tetrandra, Melia azedarachta, Leucaena leucocephala,* and *Heynea trijuga* showed comparatively high percentage of germination (*i.e.*,> 65 %). *Sapindus mukorossi* and *Euonymus tingens* showed a very low percentage of germination (*i.e.*, < 10 %). *Albizia chinensis, A. procera, Emblica officinalis, Terminalia chebula, T. bellerica, Dalbergia sericea, Bauhinia variegata,* and *B. vahlii* were found susceptible to frost.

3. Seeds and seedlings of over 35 rare endangered, endemic and otherwise important species were collected from different locations.

(b) *Propagation protocols for MPTs*

1. Seed germination experiments of *Corylus jacquemontii* (Family Betulaceae), which shows infrequent or poor natural regeneration revealed gradual decrease in percent germination with increasing seed storage time at room temperature. Species showed asynchronous seed germination (Fig. 7).

2. Pre-chilling (60 days) showed best responses. In particular, under this treatment, relatively heavy seeds (>1.2 gm per seed) showed higher percent germination (65%) as compared to 40% seed germination in case of lighter seeds (<1.2 gm per seed). Over

350 seedlings obtained were transplanted at Institute Arboretum (Kosi-Katarmal) and near natural population Lata (NDBR).

showed various level of germination. Above 90 % stolon of *Pircrorhiza kurrooa* were successfully propagated in poly-house.

Fig. 7. Asynchronous seed germination/growth of seedlings *Corylus jacquemontii*

(c) Strengthening Herbal Garden and Medicinal Plant Nurseries in H.P.

1. Medicinal plants nursery (Kasol-Kullu) and Herbal Garden (Mohal-Kullu) were improved and evolved as a forum for visitors from different sectors of the society for training and education. Medicinal plant gene bank enriched up to 209 accessions of > 76 high value and endangered medicinal plants (this includes 21 species and 56 accessions in 2003).

2. Experiments on seed germination revealed that in nursery beds, *Angelica glauca* (20-25 %), *Heracleum candicans* (up to 70 %), *Selinum sp.* (up to 25 %) and *Saussurea costus* (above 90 %)

3. Periodical phenology of medicinal plants was recorded in Herbal Garden, identifying 16 parameters. Special focus was made on *Angelica glauca, Acorus calamus, Arctium lappa, Bergenia* sp., *Podophyllum hexandrum, S. costus, Valeriana jatamansi, Viola* sp., *etc.* Changing pattern witnessed from that of natural habitats; monitoring continued.

(d) *Propagation protocols for medicinal plant (H.P.)*

1. Propagation package was established for *Valeriana jatamansi* using 6 rootstock-categories (3-size and 3-position) and 2 types of stem segment under polyhouse and open nursery conditions. One season's growth and biomass studies indicate that plants grown in poly-house produce significantly higher biomass over plants in open nursery.

2. Using 17 pre-soaking chemical treatments to seeds one and a half-year seedling growth and biomass in *Hedychium spicatum* was evaluated under nursery condition. Over 6 treatments proved significantly useful to enhance early rootstock growth.

3. To develop propagation packages of *Selinum tenuifolium* 17 pre-soaking chemical treatments were used; 9 significantly stimulated seed germination (up to 77%) over control under lab conditions. GA_3, KNO_3 and $NaHClO_3$ treatments were amongst best.

3.3.4. Initiating Biodiversity Conservation Through Peoples' Participation in the Himalaya

Background

Biodiversity conservation programs are being pursued across the Himalaya by both the Government and Non-Government agencies. Presently, such initiatives are restricted to identification of sites, surveys, inventorization of biological resources, strengthening the network of Protected Areas, conservation of threatened species and *ex-situ* germplasm maintenance. It has been argued that conservation action needs to be promoted and implemented by bringing local people into the conservation movement and considering them as potential allies. Since these aspects are not adequately focused in the

Himalaya, an initiative in this direction was taken to bring the target groups in to the conservation movement.

Objectives

1. Promote and strengthen interactions with the target groups
2. Promote conservation science especially among School/ College students
3. Impart on site training on collection, storage and propagation methods of target species focusing on teachers and students
4. Obtain and analyze response of different target groups with respect to location specific conservation option/priorities

Results and Achievements

1. A two days Training Workshop (IX of this series) was organized at Government Inter College, Kanda, Bageshwar. Over 63 participants (21 teachers and 42 students) representing 19 educational institutions of district Bageshwar participated in the Workshop.
2. Different aspects of biodiversity conservation i.e., definition and dimensions of biodiversity, status and threats to biodiversity, linkages of biodiversity with environmental factors, impact of developmental projects on biodiversity, techniques of *in situ* and *ex situ* conservation, value of biodiversity and value addition, application of remote sensing in biodiversity conservation were introduced to the participants through deliberations and demonstrations. A special module on high value medicinal plants was also introduced (Fig. 8). Participant's inputs, through interactions, group discussions, were obtained to identify area specific biodiversity related issues.
3. A special meeting with teacher participants was conducted during the Workshop and possible strategies for strengthening the activity in different institutions were discussed. Teachers advised to organize an Orientation Camp for teacher participants, so that those teachers can independently take-up the work of resource person for future Workshops. A two-day orientation camp for teachers was subsequently organized.

3.3.5. Dynamics of Structural and Functional Features of Biodiversity in Relation to Disturbance Gradient in Forests of Kumaun Himalaya

Background

Understanding the ecological consequences of habitat fragmentation has been identified as one of the challenging areas of research in 21st century. In the context of Indian Himalaya human pressure on natural communities has been recognized as a major cause of biodiversity loss. However, lack of authentic datasets on these issues is major gap area in the region. In view of this, the project emanated with an objective to identify and characterize responses of biodiversity in forests with respect to different levels and types of anthropogenic disturbance. Three distinct forest types across

Fig. 8. Participants of orientation camp were exposed to approaches of biodiversity assessment

the elevational gradient, representing two climatic zones of the region, have been identified for detailed investigation.

Objectives

1. To assess biodiversity patterns (structure/ composition) across various disturbance intensities of identified forests

2. To analyze impact of disturbance on ecosystem properties (*i.e.*, productivity; phenology of major taxa, litter fall, decomposition and nutrient release, etc.)

3. To examine the relative role of forest disturbance on recovery and maintenance (regeneration) of species diversity in different forest ecosystems

4. To identify linkages between patterns of faunal (mammals, birds and insects) diversity and 1-3 (above).

Results and Achievements

1. Reconnaissance survey for selection of study sites was conducted in different parts of Kumaun.

2. Group discussions to finalize the approach for field study and development of appropriate data sets conducted. Standard data sets developed for field studies.

3.3.6. Khangchendzonga Biosphere Reserve – Landscape Change, Resource Status and Human Dimensions

Background

Recent conversion of the Khangchendzonga Biosphere Reserve (KBR) in Sikkim through the up-gradation of the erstwhile Khangchendzonga National Park has opened up a completely new horizon calling in attention and concern from more multi-pronged approach. So far, the biosphere area is virtually undisturbed, rich in natural diversity and falls in one of the globally recognized biodiversity hot-spot, namely the Eastern Himalayan region. For a clear understanding of the total biosphere system functioning, insight into various inherent natural cycles and its associated auxiliary cycles is essential. Towards this, holistic understanding of KBR is planned through this research project.

Objectives

1. Assessment of landscape change and man-animal-biosphere interaction on specific places.

2. Specialized habitat monitoring for identification of keystone species with respect to habitat change and functional understanding of vegetation types based on altitudinal distribution.

3. Evaluation of buffer and manipulation zones for sustainable resource management.

Results and Achievements

1. Based on IRS 1C LISSIII satellite data maximum part of KBR was covered by snow/ glacier (30.55%), whereas rivers/streams/lakes/exposed soil had minimum cover (1.27%). Land use/cover classes of KBR are depicted (Figs. 9 & 10).

2. The Normalized Difference Value Index (NDVI) values were derived from IRS 1C WiFS satellite data. This varied in different land use/cover of KBR and was high in dense mixed/conifer forest (>0.27) and lowest in rivers/streams/ lakes/exposed soil (<0.01) besides intermediate values for other classes of land use/cover.

3. Around buffer/fringe area forests, basal area (m^2 ha^{-1}) of tree species was recorded highest (40.05) in the DS (disturbed stand) of Sakyong-Pentong and least in the UDS (un-disturbed stand) of Sakyong-Pentong (26.45). The basal area values had decreased from DS to UDS through PDS (partly disturbed stand). Shannon-Weiner's tree diversity index (H') increased from the DS to PDS followed by UDS in all the study areas. Standing forest (wood) biomass of tree species decreased in the DS compared to UDS. Highest (1572.8 Mg ha^{-1}) standing forest (wood) biomass was calculated in the UDS of Uttaray followed by PDS (714.0 Mg ha^{-1}) at Uttaray and least (125.0 Mg ha^{-1}) in the DS of Lachen. Forest floor litter depositions were conspicuously more in the UDS of Lachen whereas DS of Yuksam had less (0.67 Mg ha^{-1}) deposition.

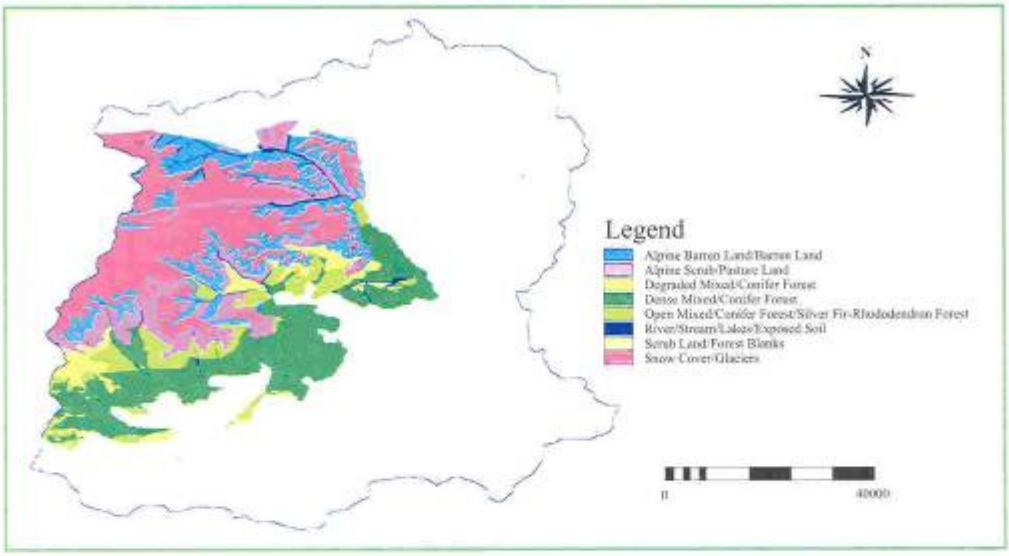


Fig. 9. Land use/cover classes of Khangchendzonga Biosphere Reserve (KBR) in Sikkim derived from IRS 1C LISSIII satellite digital data of 1999.

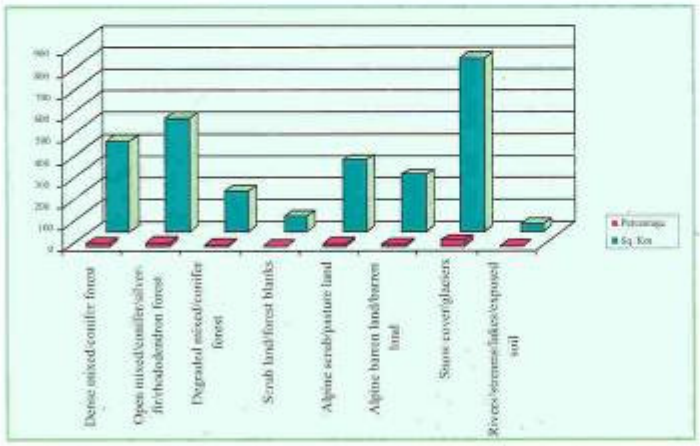


Fig. 10. Spatial distribution of land use/cover classes of KBR derived from IRS 1C LISSIII satellite data of 1999.

3.3.7. Evaluation and Propagation of Selected Endemic Medicinal Plants of the Himalaya

(Summary of completed project)

Background

The Himalaya is known to support a large number of endemic medicinal plants. Such taxa possess maximum number of attributes for priority conservation initiatives. Considering the conservation importance and to harness the economic potential of these endemic medicinal plants, the project envisages to assess population density, analyze inter-population variability and evolve conventional and *in vitro* methods of propagation of selected (*i.e., Angelica glauca, Swertia angustifolia, Arnebia benthamii* and *Saussurea obvallata*) species in west Himalaya.

Objectives

1. To quantify and assess population size of selected species in natural habitat
2. To analyze morphogenetic variability in selected species
3. To identify constraints in conventional methods of propagation

4. To develop *in vitro* propagation protocols in selected species particularly those of narrow geographic range

Results and Achievements

1. Status of target species - *Arnebia benthamii* (12 populations), *Angelica glauca* (8 populations), *Swertia angustifolia* (9 populations)and *Saussurea obvallata* (5 populations) were assessed in natural sites.

2. Studies on morphological and genetic variability (protein profile and isozyme) of *A. benthamii, A. glauca, S. angustifolia* and *S. obvallata* were conducted. Also, the seed germination protocols were standardized for target species - *A. benthamii* (Thiourea, 96% germination), *A. glauca* (IAA, 91% germination), *S. angustifolia* (GA_3, 96 % germination) and *S. obvallata* (25 °C temperature, 95 % germination).

3. Vegetative propagation through terminal growing point of root has been achieved in *A. benthamii* (40 days chilling, 75% rooting) and *A. glauca* (IBA, 71 % rooting). *In-vitro* propagation protocols for target species have been developed.

4. Live specimens and seedlings of *A. benthamii, A. glauca, S. angustifolia* and *S. obvallata* raised through conventional methods are maintained at arboretum. Further, seedlings of *A. benthamii* and *A. glauca* are being maintained at high altitude village Lata (district Chamoli).

3.3.8. Lead/Coordinating Institution for Nanda Devi, Manas, Dibru-Saikhowa and Dehang-Debang Biosphere Reserves

Background

To advice and oversee implementation of various research projects in designated and potential sites, Central Government has constituted a National Expert Advisory Group. Various relevant organizations have been encouraged to develop innovative, interdisciplinary research proposals for Biosphere Reserves (BRs) including modeling system for integrating social, economic and ecological data. The Central Government has designated Lead/ Coordinating Institution for each existing BRs to serve as a focal point for formulation of research projects and collection and dissemination of research based information for use in better management of Biosphere Reserves. G. B. Pant Institute of Himalayan Environment & Development, Kosi- Katarmal, Almora had been identified as a Lead/Coordinating Institution for Nanda Devi, Manas, Dibru-Saikhowa, Dehang-Debang, and Kanchendzonga BR.

Objectives

1. Collection, synthesis and dissemination of research based information in respect of BRs from all sources

2. Interaction with regional research organizations for development of suitable research projects

3. Interaction with BR Managers to assess the research needs and crucial issues requiring research efforts

4. Publications of compendium of upto date information and bringing biannual publication aimed at educating stakeholders

Results and Achievements

1. Information on above mentioned BRs was obtained from libraries of the State and Central Government Organizations and various experts working in Government and Non-Government Organizations. The information was compiled, synthesized and documented.

2. Based on the available information and inputs from BR manager's gap areas for each BR was identified. Project proposals were invited from various Experts on the identified gap areas of the Himalayan BRs. The document on Nanda Devi Biosphere Reserve for UNESCO MAB net was revised and submitted to UNESCO through MOE&F, New Delhi.

3. The Himalayan Biosphere Reserves Biannual Bulletin Vol. 4 (1&2) was published. The Bulletin includes information on vegetation dynamics and livestock rangeland linkages in

Kanchendzonga; wild edible plants, entomofauna, and threatened birds of Dibru-Saikhowa; amphibian and insect fauna, galliform species, mammalian fauna, strategies for conservation and cultivation of medicinal plants, and traditional biodiversity conservation and management system in Dehang-Debang.

3.3.9. Studies on Species and Community Responses to Habitat Alterations in Timberline Zone of Proposed Uttarakhand Biosphere Reserve: Management Implications

Background

On account of the sensitivity to climate change, uniqueness in biodiversity elements, along with the socio-religious significance, the Timberline Zone (TLZ) of west Himalaya has been identified as potential biodiversity "hot spot". However, due to regular intervention of human and natural factors, the natural habitats at TLZ are changing fast and consequently affecting the various biodiversity patterns. Studies, so far conducted in TLZ, are subjective in nature and lack effective data base for specific issues like habitat biodiversity relationships. The present investigation attempts to address this issue.

Objectives

1. To identify and characterize TLZ habitat relationship with biodiversity elements focusing on floristics
2. To assess habitat alterations and consequent change in native and non-native biodiversity elements
3. To identify and prioritize sensitive TLZ habitat and biodiversity elements

Results and Achievements

1. Density-distribution curves were prepared for different forest types and conditions (Fig. 11). Seedling density (P - 68, SD- 26.6, D- 34.9%) was considerably higher under

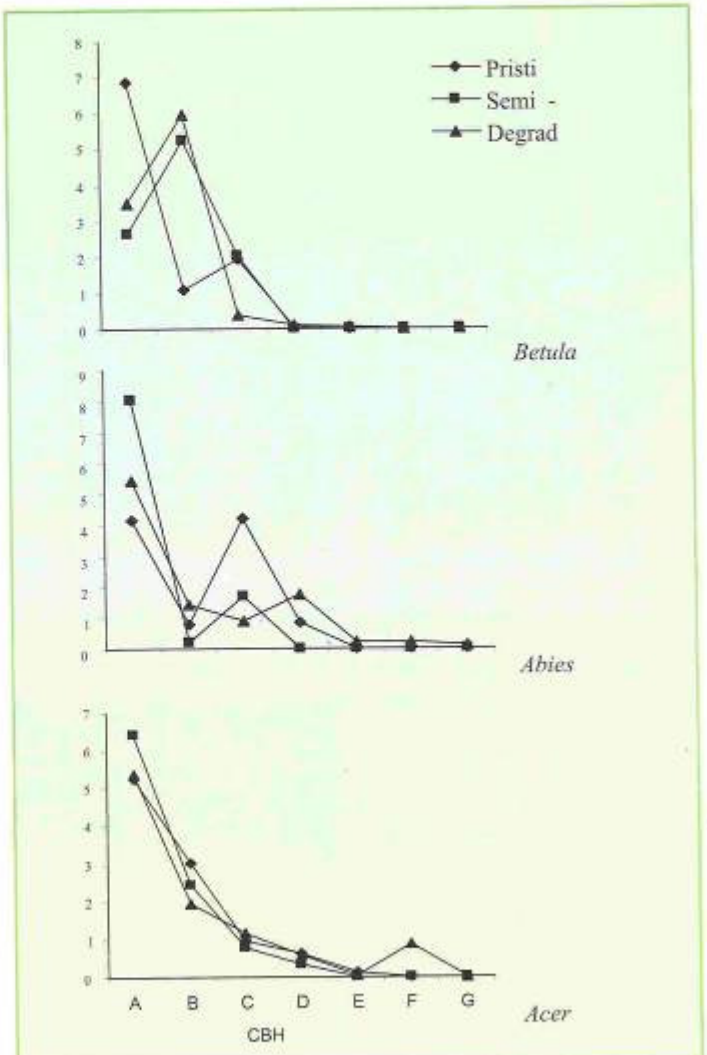


Fig. 11. Structure of Forests under different forest and disturbance conditions

pristine condition of *Betula* forest, whereas sapling density was recorded highest under degraded forest (P- 11, SD- 52.7, D- 59.6%). Under *Abies* and *Acer* mixed forests seedlings perform better under semi degraded condition (*Abies pindrow* forest: P- 49.0, SD- 80.4, D- 54.5%; *Acer* mixed forest: P- 52.5, SD- 64.1, D- 53.7%). *Betula utilis* and *Abies pindrow* forests showed greater accumulation of young tree individuals in pristine condition, whereas *Acer* mixed forest exhibited higher accumulation in larger size class under degraded condition.

2. Physico-chemical properties of soil, across various disturbance intensities (see Previous Annual Report) were investigated. Some of the features include: (i) pH remains acidic in all the forests across different disturbance intensities, (ii) moisture content was highest (52%) under semi-degraded condition and lowest (15%) under degraded condition of *B. utilis* forest, (iii) organic carbon percentage was high on surface soil and gradually lower in deeper soil. *Acer* mixed (pristine condition) showed highest (11.9%) and *B. utilis* (degraded condition) was poor in organic carbon (5.6%), (iv) pristine site of *A. pindrow* forest showed highest (0.53%) and *B. utilis* (degraded condition) lowest (0.19%) soil nitrogen values.

3. Monthly litter fall samples have been collected and analysis of variations in litter fractions under different disturbance intensities of three identified forests is under progress.

3.3.10. Establishment of Herbal Garden at Kosi-Katarmal, Almora

Background

The use of Medicinal and Aromatic Plants (MAPs) in Ayurvedic, Unani and other traditional systems has increased demand of most of the high value species growing in the Indian Himalayan Region. The increasing demand of MAPs has increased pressure on most of the wild populations of these species. This has resulted in the depletion of populations in most cases. In this context, to maintain and conserve the germplasm of high value MAPs, establishment and maintenance of herbal gardens at various locations have been encouraged by the Department of Agriculture and Cooperation, Ministry of Agriculture under Centrally Sponsored Scheme for Development of MAPs through various organizations.

Objectives

1. To identify suitable species of Medicinal and Aromatic Plants for cultivation

2. To establish and maintain herbal garden at Kosi- Katarmal

Results and Achievements

1. Extension of nursery area and maintenance of the MAPs was carried out. Propagules of over 30 MAPs were collected from various localities and introduced in the Herbal Garden (Fig. 12).

2. Cultivation trials of commercially viable MAPs such as *Acorus calamus*, *Mentha piperata*, *Valeriana wallichii*, *Asparagus racemosus*, *Hedychium spicatum*, *Rubia cordifolia*, *Salvia lanata*, *Coleus forskohlii*, etc., have been initiated.

3. Interaction with the farmers was done for the cultivation of MAPs. Various Groups of trainees including NGOs, students, teachers, farmers

Fig. 12. Introduction of MAPs in herbal garden at Kosi-Katarmal

including women groups and others were exposed to different aspects of herb cultivation.

3.3.11. Socio-Economic Upliftment of Rural Community of Himachal Himalaya, particularly Women, and Biodiversity Conservation Through Cultivation of Medicinal Plants using Low Cost and Simple Techniques

Background

The demand of natural medicines has increased dramatically over recent years. Currently, *in-situ* harvesting from wild meets the major market demand of medicinal plants raw material. Owing to decreasing population of medicinal plants in wild, the villagers find herbs collection a tough task in recent years. *In-situ* harvesting of medicinal plants shall not only deplete the wild stocks but in several cases the consequent declining habitats of native taxa, can no longer be able to meet the expanding market demand of medicinal plant products. Hence, it will no longer be a sustainable income generating source for rural folk, particularly in remote villages. As such, cultivation is the only way to provide medicinal plant material without further endangering the survival of those species, as well as to support the socio-economic upliftment of rural community, particularly women for her major involvement in farming, in Himachal Himalaya.

Objectives

1. Promoting accessibility and empowerment of rural women on economic resources and traditional health care by introducing ex-situ cultivation of medicinal plants
2. Enhancing soil fertility through introduction of improved bio-composting techniques
3. Introducing appropriate and simple, low-cost technological interventions to supplement ex-situ cultivation
4. Training to target population on agro-techniques, nursery development, water harvesting, biocomposting, crop harvesting and drying and marketing, etc.

Results and Achievements

1. In addition to numerous one to one basis interaction and several small group meetings, over 100 villagers (representing majority HHs) were formally trained for medicinal plant cultivation and supporting technologies. In addition, 3- training and 2 formal meetings were organized for the farmers of village Silha and Shat of Kullu district. Over 35 HHs adopted MP cultivation (0.025 to 6 Bigha size plots, mostly along high slopes). The propagule/ seedlings of 7 species were distributed to > 30 families as an initial incentive.
2. A total of 10 species, *viz. Aconitum heterophyllum, Angelica glauca, Dioscorea deltoidea, Dactylorhiza hatagirea, Hedychium spicatum, Heracleum candicans, Picrorhiza kurrooa, Podophyllum hexandrum, Saussurea costus and Valeriana jatamansi* were tried for cultivation, which are adopted by ~4 % *(H. spicatum)* to 73 % *(A. heterophyllum)* HHs (Fig. 13).

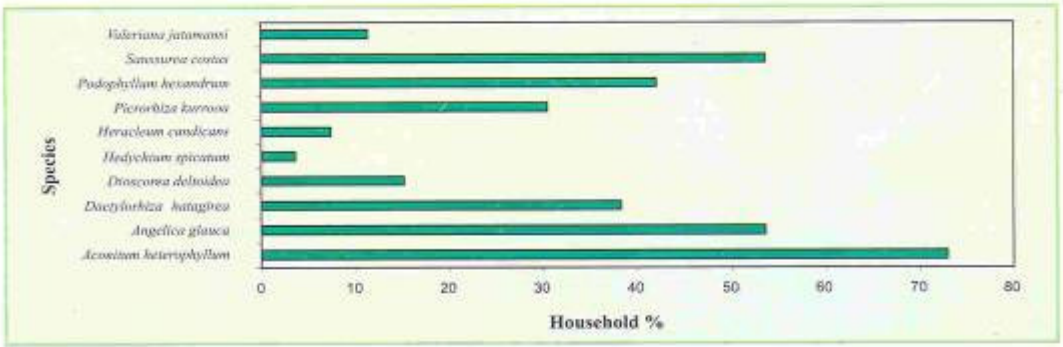


Fig. 13. Medicinal Plant Species Cultivation in Targeted Villages of Kullu district, H.P.

3. At 1800m a ltitude, *S. costus* cultivation showed significantly higher below ground dry weight (-92 g/plant to -174 g/plant) using different substrates after 58 weeks of seed sowing. Growth and productivity observations were made for *V. jatamansi* in village Silha (2200 m). In compost used fields, significantly higher below ground dry weight (-67 g/plant) was obtained over FYM (-52 g/plant) after 64 weeks. In *H. spicatum*, using full rhizome nodal segment significantly higher dry weight (16.4 g/plant) was achieved over a quarter segments (5.8 g/plant) after 10 months of sowing. For *A. heterophyllum*, plant height was significantly higher (71.4 cm) in compost treated fields over FYM (44.4 cm). Encouraging results obtained for *A. glauca, H. candicans, P. kurrooa, etc.*

3.3.12. National Biodiversity Strategy and Action Plan: Uttar Pradesh

(Summary of completed project)

Background

Conservation of Biological Diversity has received greatest attention among all aspects of nature conservation. In view of importance of biodiversity Ministry of Environment and Forests, Government of India has undertaken an initiative to develop National Biodiversity Strategy and Action Plan (NBSAP) at National, Eco-region, State, and Local levels for conserving biodiversity, sustainable utilization of biological resources, achieving equity and fair benefit sharing in such uses. The NBSAP has been conceived of by Ministry of Environment and Forests after extensive consultation.

Objectives

1. To review the socio-economic status and biodiversity of Uttar Pradesh
2. To identify biodiversity rich areas, fragile ecosystems and indicators of loss of biodiversity
3. To develop strategy and action plan for the State

Results and Achievements

1. The final SAP document developed, which contains the introduction, profile of the area, current range and status of biodiversity, statements of the problems relating to biodiversity, major actors and their current roles relevant to biodiversity, ongoing biodiversity related initiatives, gap areas, major strategies to fill up these gaps, required actions to fill up these gaps and in the last the follow-up/action plans.
2. Two major Biodiversity Related Issues in UP have been identified as follows: (i) just a little over 7% of land area in the State is under forest cover; (ii) rapid depletion and fragmentation of natural habitats leading to threats to natural populations of species — species not receiving desired conservation inputs from State/ Central Government; (iii)heavy livestock pressure (283 animal per km^2); the productivity level is low due to poor quality animals; indigenous animal germplasm is depleting fast; (iv) intensification of agriculture (wheat, rice and maize received more attention); traditional crops like pulses, barely, jowar, etc. exhibit decline. Focus on high yielding varieties has caused depletion of traditional varieties; (v) the conservation initiatives, especially PAs coverage (< 3%) is far less than the desired norms; (vi) since most of the Biodiversity rich forests also contain the mineral wealth and also the best sites for water impoundment, mining and development projects in such areas have often led to destruction of habitats.
3. Major actors and their current roles relevant to biodiversity, role of governmental organizations, citizens' groups, NGOs and local communities including rural and urban, donors and industries and corporate sectors have been analyzed. Also, various ongoing biodiversity related initiatives, under taken by the government (i.e., policy and legal measures, administrative measures, programs and schemes, integration into economic/social sectors, etc.); NGOs; communities and people's movements have been reviewed.
4. Gaps in knowledge and approaches, i.e., gaps in information - existence and

availability to key actors; gaps in vision - inability to look in the long term, or consider the inherent value of biodiversity; gaps in policy and legal structure and gaps in institutional and human capacity have been documented.

3.3.13. National Biodiversity Strategy and Action Plan: Wild Plant Diversity

(Summary of completed project)

Background

The ongoing process of National Biodiversity Strategy and Action Plan (NBSAP) aims to produce a comprehensive ready-to-act strategy and action plan on biodiversity. Among 14 thematic working groups (TWG), the wild plant diversity constitutes an important TWG. India has a very wide taxonomic range, in proportion to the enormous diversity of the ecosystem and geographical condition. This enormous diversity at the species, sub species and variety levels is a result of evolutionary processes. However, in the last couple of centuries and in particular in the last few decades, this diversity has faced increasing erosion. Habitat loss, hunting over-exploitation, introduction of exotics, poisoning and other factors including progressive disempowerment of local communities, destabilization of their traditional management systems have caused this loss. The dimensions of the loss are as yet unclear, as baseline data, research and monitoring are poorly developed in the country. Therefore, the TWG on wild plant diversity considered the diversity at different levels/groups to prepare a comprehensive document for India's plant diversity. Also an attempt was made to identify priorities for conservation and suggest a practicable strategy and action plan for conservation and sustainable utilization of plant diversity elements.

Objectives

1. To review the status of wild plant diversity of the Country
2. To identify the mode of selecting special groups such as medicinal, rare, endemic etc. for collating and analyzing the available information
3. To identify the gaps and develop strategy and action plan

Results and Achievements

1. The Thematic Working Group (TWG) on Wild Plant Diversity (WPD) attempted to review the overall status of information pertaining to this group, identify the major gaps and frame strategies for bridging the gaps. Review of information on status reveals the following: (i) reported number of flowering plants in the country varies between 16,500–19,400 taxa (including intraspecific categories) under 247-315 families, which represent roughly 7% of the described species in the world; (ii) across biogeographic zones in the country richness of floristic diversity varies between approx. 8000 spp. (Himalaya) to 500 spp (Coasts). Among states, Tamil Nadu (5640), Sikkim (4500), J&K (4252), U.P. (4250) and Arunachal Pradesh (4007) are the rich plant diversity states. However, Sikkim, Himachal and Goa score high in species richness per sq. km.; (iii) the diversity of non-flowering plants is as follows: Gymnosperms (48); Pteridophytes (1135); Bryophytes (2850); Lichens (2021); Algae (6500) and Fungi (14500 spp.); (iv) nearly 1000 species have food value, 525 - fiber yielding, 400 - fodder value, 300 - yield gums and dyes, 100 - different types of scent and essential oil, 300 - poisonous and 700 - traditionally used in social and various religious ceremonies. More importantly, over 3000 species are used as medicine in the country.
2. Some of the facts highlighting the severity of threats associated with WPD include: (i) nearly 10% (>1700 species) of flowering plants in India fall under various threat categories. As per the IUCN RED list of threatened plants, 19 species are now extinct, 41 are possibly extinct in the wild, 152 - endangered, 102 - vulnerable, 251 - rare and 690 - indeterminate; (ii) maintenance of 550 (88.7% of total RDB taxa) endemic Red Data Book species is most critical issue; (iii) among reported 5725 endemic plants, nearly 2500 (43.66%) fall under threatened

category. Of these 1950 (34.0%) species are narrow endemics and subject to high risk.

3. TWG on WPD proposed following strategies: (i) Establish complete authentic national database on WPD; (ii) Strengthen *in-situ* conservation mechanisms; (iii) Strengthen *ex-situ* conservation initiatives; (iv) Strengthening participatory mechanisms; (v) Review and strengthen policy interventions. Appropriate action plans under each strategy have also been proposed for conservation and management of WPD in the country.

3.3.14. Documentation on Agrotechniques and Post Harvest Processing of Medicinal Plants of the Indian Himalayan Region

Background

Indian Himalayan Region (IHR) is a rich repository of Medicinal Plants. The unique diversity of MPs in the region is manifested by the presence of a number of native, endemic and threatened elements. The MPs of the region are highly valued on account of their potential to deliver novel biomolecules and larger quantity of active compounds. The pharmaceutical industries rely more on exclusively wild forms. This, accompanied by the fact that most of the material is collected through "destructive mode" of harvesting, suggests high incidence of threat on identified MPs. Moreover, to meet quality specifications of the raw material, the domesticated material is preferred in comparison to their wild counterparts. Unfortunately, in spite of efforts made through agro-technological innovations and progress in biotechnology only a few Himalayan MPs are under cultivation. However, a considerable knowledge base exists with the indigenous communities, which traditionally cultivate MPs for their domestic use. Realizing the need of consolidating research and indigenous knowledge on cultivation and post harvest processing of MPs in IHR the present study has been undertaken.

Objectives

1. To compile available scientific information on agro techniques and post harvest methods relating to MPs in IHR
2. To generate information on indigenous practices of medicinal plant cultivation and post harvest processing
3. To identify who is who in the commercial cultivation of medicinal plants in IHR

Results and Achievements

1. Information was compiled from published (technical and non-technical) records. In addition, various areas were surveyed for collection of first hand information from farmers and users.
2. The details of agrotechniques and post harvest processing of 31 species from trans/north west Himalayan region were compiled, synthesized and documented. Agrotechnique for five important medicinal plants of Himachal Pradesh was compiled in more specific terms. Also, popular harvesting techniques for 17 medicinal plants of the trans/northwest Himalaya were compiled.
3. A detailed list of commercial cultivators of Medicinal Plants in the region with their focus species and areas has been compiled (33 Govt Agencies: 10 non Govt Agencies: and 121 farmers Uttaranchal, 113 farmers from HP). Farmer's views on prospects and constraints on medicinal plants cultivation documented. In addition, expert's opinion on possibilities of medicinal plant cultivation in the region was generated through questionnaire survey.

3.3.15. Studies on the Forest Vegetation and Resource Utilization Pattern in Nanda Devi Biosphere Reserve of West Himalaya

Background

The Biodiversity of the Himalayan Biosphere Reserves has been poorly studied. In most of the cases, comprehensive studies are required to understand the species composition, community structures and resource utilization patterns of the area. Over the past few years the increase in human and livestock population has caused manifold increase in the demands of fuel, fodder, medicine, timber, food (wild edibles), etc., which in turn

has been responsible for the over exploitation of these resources. As a consequence many species, which were abundant in the past have been now restricted to pockets and facing danger to extinction. In view of the increased biotic pressure in the region particularly for fuel, fodder, timber, medicinal and wild edible plants, etc. the studies, which could supply information regarding the extent and magnitude of extraction and availability of these resources, are essential.

Objectives

1. To study the forest vegetation of Nanda Devi Biosphere Reserve and plant resource utilization patterns
2. To identify nativity and endemism of the species
3. To identify rarity and prioritize species for conservation and management

Results and achievements

1. A detailed literature survey was conducted in order to know the existing state of knowledge. Sites/ habitats were selected based on the physical characters and dominance of the vegetation in Rishi Ganga catchment extending from temperate to sub-alpine zones in buffer zone of Nanda Devi Biosphere Reserve. The field surveys and samplings have been carried out within the selected sites/ habitats for trees, seedlings, saplings and shrubs.
2. Extensive surveys were conducted to prepare the inventory of vascular plants. The fresh samples of each species have been collected and identified with the help of florulas, research papers and technical reports. For each species, information on the altitudinal range, life form, habitat, etc. have been collected.
3. Three representative villages i.e., Walla Reni, Palla Reni and Peng were selected. The base line information on human dependence was generated through Participatory Rural Appraisal (PRA) technique.

3.3.16. Assessment of Existing Stock and Scaling up Productivity of Selected High Value Himalayan Medicinal Plants through Biological and Biotechnological Approaches

Background

Himalayan region is a major repository of medicinal plants, which are used in several formulations by the pharmaceutical industries. The Himalayan native medicinal plant species have high price in international market. Considering the high value of Himalayan medicinal plants, the project envisages to address the implementation of likely increase of the demand of specific drugs of plant origin especially those occurring in high altitude areas of Uttaranchal in the Indian Himalayan region (IHR). Further, understanding the life strategies of the target species and the potential of putting them under cultivation will enable us in developing conservation and utilization strategies.

Objectives

1. To quantify the availability of identified species in selected representative sites of Uttaranchal Himalaya
2. To develop propagation protocols through conventional and *in-vitro* approaches
3. To develop herbal garden of propagated plants for conservation and awareness

Results and Achievements

1. 11 populations of *Picrorhiza kurrooa* and 6 populations of *Aconitum balfourii* have been investigated in Uttaranchal Himalaya for understanding distribution patterns and assessing the existing stock
2. Morphological variability study in selected population of *Picrorhiza kurrooa* and *Aconitum balfourii* have been initiated.
3. Live accessions collected from different population of both the species were maintained in the arboretum (Kosi-Katarmal). Activities have been started to establish herbal garden at different altitudes. Also, experiments to develop propagation protocols through conventional and *in vitro* methods are in progress.

3.3.17. Assessment of Plant Diversity and Human Dependence for the Conservation of Alpine Meadows in Nanda Devi Biosphere Reserve, West Himalaya

Background

The alpine meadows of the Himalaya are very important from the point view of species diversity. They support a rich diversity of medicinal, native, endemic and rare endangered plants and, also support a number of migratory sheep, horses and goats during the summer season. The inhabitants have also been dependent on alpine meadows for a numbers of medicinal and edible plants. The increasing grazing pressure combined with exploitation of plants by inhabitants for their own use and trade has caused a decrease in the population of many species. Some of the species have already been listed in the Red Data Book of Indian Plants and/or IUCN rare threatened categories. In spite of the richness of biodiversity and high conservation values of alpine meadows there is very limited information available. This study attempts to fill this gap.

Objectives

1. To assess and compare the vegetation of alpine meadows of NDBR
2. To identify human dependence on alpine meadows
3. To identify nativity and endemism of the species

Results and Achievements

1. The available literature on the ecology, floristics, resource use patterns, rarity, etc. was collected. The sites were selected in Badrinath Valley of the Nanda Devi Biosphere Reserve. The habitats/plots were selected on the basis of physical features in all possible aspects for the quantification of vegetation.
2. Through extensive discussions with experts, sampling designs have been finalized for the quantification of alpine vegetation and human dependence.

3.4. ECOLOGICAL ECONOMICS AND ENVIRONMENTAL IMPACT ANALYSIS

Development in the IHR involves conflict between man and nature. The focus on economic growth, at times, disregards the fragile ecosystem and socio-cultural matrices especially in the context of IHR. This leads to depletion and marginalization of natural and human/cultural resources, through loss of vegetal cover, indigenous species, soil and its fertility, and water quantity and quality. Social losses include degradation of community culture and deterioration in knowledge base regarding sustainable use of resources. Environmental costs in the Himalayan region, therefore, need to be integrated with traditionally practiced cost-benefit analysis. Identification of strategies for ameliorating environmental damage and looking at alternate pathways for development are important aspects of environmental cost-benefit analysis. Keeping this in view, all development and intervention activities in the region need to be evaluated and monitored in terms of comprehensive Ecological Economics and Environmental Impact Assessment framework. The activities this year focused on aspects of solid waste characterization and air pollution monitoring in and around tourist destinations of Kullu, evaluation of hill slope instabilities in Sikkim region, integration of developmental approach for the Siwalik region of north-west Himalaya, monitoring of commercial cultibation of vegetables and tea in Kumaon region, social infrastructure in the Himalayan region and socio-cultural aspects of communities in terms of their resource use pattern and fertility behaviour of women.

3.4.1. Carrying Capacity Assessment of Kullu-Manali Complex: A Case Study of Tourism Sector

(Summary of completed project)

Background

Keeping in view increasing pressure of tourism in the Kullu valley, this study was initiated in 1993-94, to formulate a sustainable tourism plan. In earlier stages of the study, assessments regarding accommodation and tourist inflow by different means of transportation were made. Later, it was realized that Kullu and Manali spots in Kullu valley are facing infrastructural constraints. As a result, solid waste is becoming a major environmental problem. During 1994-95, recommendations regarding waste management and other amenities in local situations were finalized on the occasion of Kullu Dussehra. The recommendations were submitted to district administration for implementation. The impact of the recommendations was assessed after a gap of 5 years during the Kullu Dussehra of 1998. It showed a positive progress towards provisioning of basic amenities. A solid waste study in semi-rural environment at Mohal was also conducted to know the role of women in waste management at household level. Municipal solid wastes (MSW) from point sources (waste collection points) and non-point sources (dumping sites) were studied at Manali and Kullu and it was found that major point sources are hotels and hospitals.

Objectives

1. To assess tourist pressure in the Kullu- Manali tourist centres
2. To find solid waste composition and suggest waste management options

Results and Achievements

1. About 1,335 kg per day solid waste is generated at Rohtang Pass during summer season. The largest share consists of non-biodegradable waste (68%).
2. Comparative waste characterization results of star and non-star categories of hotels showed that readily biodegradable waste (RBW) was above 55% in Manali resort and 63.2% in Zarim hotel, while biodegradable waste (BW) was 31% in star category and 13.6% in non-star category. The non-biodegradable waste (NBW) was higher in non-star category rather than star category hotels.
3. The results of chemical parameters of solid wastes showed pH value: 6.6-7.5, conductivity: 0.910-2.260 ms/cm, carbon/nitrogen ratio: 18-55, potassium: 0.3-0.8%, phosphorous: 0.5-0.9% and calorific value: 633-2190 KCal/Kg. The average compostable waste was noted to be approximately 54% and recyclable around 24%.

3.4.2. Ambient Air Quality Monitoring in Kullu Valley

(Summary of completed project)

Background

Kullu valley is an important tourist destination in western Himalaya. This study was started primarily with the measurement of total suspended particulate (TSP) matter during 1994-95. Later, TSP monitoring was also extended to other sites to cover Mohal (1100 m), Manali (2058 m), Kothi (2530 m), Palchan (2320 m), and Jagatkush (2040 m). During 1996-97, monitoring was done at Mohal and Manali. In 1997-98, Palchan south to Kothi was the monitoring site, which was shifted to Jagatkush in 1998-99. The monitoring in the surroundings of Kullu and Manali was carried out to get the true estimates of background particulate matter and other air pollutants. In 2000-01, TSP monitoring was done at Mohal, Kullu and Jagatsukh whereas monitoring for rainwater collection for pollution assessment was taken up at Mohal, Jagatsukh and Kothi.

Objectives

1. To assess background concentrations of air pollutants
2. To pinpoint some atmospheric chemical transformations in the Himalayan ecosystem

Results and Achievements

1. The TSP showed 35.8 $\mu g/m^3$ on 8 August, 172.9 on 28 May and 254.2 on 27 September at Mohal. The TSP values remained between 31.36 $\mu g/m^3$ (20 June) to 266.5 $\mu g/m^3$ (8 April) at Jagatsukh. On the occasion of Kullu Dussehra 2001, the TSP values ranged

from 126.4 to 1023.2 µg/m³. These values were 10 times higher than the permissible standards.

2. The concentration of SPM ranged between 14 and 153 µg/m³ within the selected monitoring stations. This was based on weekly/bimonthly observations carried out at Mohal, Manali and Kothi. Monthly average SPM values were within 39 and 93 µg/m³, which were under specified limit of 100 µg/m³. The highest average SPM concentration was detected as 115 µg/m³ in May and the lowest was as 41µg/m³ during July. Average SPM concentrations at Kothi were obtained to be very close to pristine levels.

3. Amongst trace gases, concentrations of sulphur dioxide and oxides of nitrogen were within 12-29 µg/m³ and 16-28 µg/m³ at Mohal (Kullu), 12-40 µg/m³ and 12-34 µg/m³ in Manali. The concentrations of sulphur dioxide and oxides of nitrogen were in excess of specified 24 hrs standard for sensitive areas (15-30 µg/m³) during the summer season in Manali. The ammonia concentration was obtained 7-10 µg/m³ at Mohal, 2-4 µg/m³ at Manali. Ozone gases were found to be 20-28 µg/m³ at Mohal during the summer season.

3.4.3. Impact of Economic Condition and Education on the Fertility Behaviour of Women of Central Himalaya

Background

Fertility, is determined by a variety of socio-economic, biological and demographic characteristics. Increasing the cultural and socio-economic well being of women in terms of their education, economy and economic independence and personal autonomy, reportedly, has direct as well as indirect effect of reducing the fertility rate. This relationship has been stated as the fertility decreasing effect of increasing the status of women. The women in Central Himalayan region of India are backbone of its economy. By virtue of their accountability to the agricultural system, they do enjoy certain work-autonomy. The level of literacy amongst the females is also comparatively high. However, the nature of economy, the level of literacy and the status of the women in this region vary considerably from community to community and in different altitudinal zones. Keeping this in view, an effort is made in this study to determine the impact of economy and education on fertility behaviour of women in different communities across altitudinal zones.

Objectives

1. To determine the variations in economic conditions and levels of education among women of different communities in different altitudinal zones.

2. To determine impact of these variations on fertility behaviour of women.

Results and Achievements

1. Cross comparative data have been collected through primary survey from eight villages, including three tribal villages, and one urban town Almora. As many as 455 households inhabit in these eight sample villages out of which 244 are tribal households. Almora town is predominantly inhabited by Hindus, in addition to Muslims and Christians. Muslims, Christians or other religious groups were not found in rural sample villages.

2. The respondents (females of reproductive age), include 181 from non-tribal (rural) caste communities and 48 from tribal (rural) communities. As much as 357 urban respondents from different religious communities including 206 Hindus, 103 Muslims, 40 Christians and 8 others, have been studied in the Almora town.

3. Close relation between altitude and fertility was observed as rate of fertility gradually decreased with increase in altitude. Clear variations in fertility between tribal and non-tribal communities were observed. Fertility rates were low in non-tribals (Table 9). Distinct variations in fertility amongst various caste groups were apparent (Table 10). Fertility was found higher in rural areas in comparison to urban areas. Rate of total conception in rural area was 3.54 against 2.94 in urban areas.

Table 9. Fertility among tribal and non-tribal communities

Communities	Total respondents	Total conception		Total children ever born		Total surviving children	
		Number	Rate	Number	Rate	Number	Rate
Tribal	48 (8.20%)	160	3.33	153	3.19	146	3.04
Non-tribal	538 (91.80%)	1681	3.12	1537	2.86	1442	2.68
Total	586 (100.00%)	1841	3.14	1690	2.88	1588	2.71

Table 10. Fertility among different caste communities

Communities	Total respondents	Total conception		Total children ever born		Total surviving children	
		Number	Rate	Number	Rate	Number	Rate
Brahmin	128 (33.10%)	374	2.92	344	2.69	327	2.55
Rajput	122 (31.54%)	359	2.94	332	2.72	314	2.57
Scheduled caste	137 (35.40%)	465	3.39	438	3.19	406	2.96
Total	387 (100.00%)	1198	3.09	1114	2.87	1047	2.71

3.4.4. Vegetable Cultivation in Khairna Valley and its Impact on the Environment

Background

Khairna valley, in Kumaun Himalaya, is predominantly a rural regime, which comprises of 190 settlements spread over an altitudinal range of 900m to 2000m amsl. Agriculture is the mainstay in the valley. Off late, the agriculture in the valley has been witnessing a departure from its traditional mould towards commercialization, mainly, through intensive cultivation of seasonal and off-season vegetables. Several underlying factors viz., favourable agro-climatic conditions, connectivity to roads or market centers, landholding structure, size of household workforce, irrigation, policy and extension etc. have been identified as the driving forces that have been precocious in precipitating this change. An analysis of these factors would help understanding the critical factors affecting farmers' decision psychology, and making policy suggestions. The concomitant changes in life style, land use, cropping patterns, socio-economy and environment, that would have transpired, as a result of this switch, are also unknown. The implications involved are many; hence a scrutiny into causal factors and impacts was carried out.

Objectives

1. Assessment of the scale and extent of vegetable cultivation and land use changes
2. Identification and analyses of the driving factors responsible for successful vegetable cultivation in the valley
3. Study of the management practices adopted for vegetable cultivation

Results and Achievements

1. Questionnaire based primary information on 777 households reveal that 86.39% of the rural households are engaged in vegetable cultivation, and 82.32% practice it for commercial purpose (Table 11). The average gross area under vegetables per household is 39.60% of the land holding size.
2. Analogous to the prevailing scenario in the Kumaon Himalaya, agriculture in the Khairna valley is mainly rainfed, as only 17.31% of the land is irrigated. 65.36% of the households do not own any irrigated holdings. The seasonality, mainly the rainy season has key role in agriculture, including the cultivation of vegetables (Table 11).

Table 11. Khairna valley – a synoptic view

Settlement	Predominantly Rural
Villages	190
Altitudinal spread	900-2000 m
Average household size	7.16
Average landholding size	0.54 ha
Irrigated holding	17.11%
Households without irrigated holdings	65.36%
Vegetable cultivation	86.39% households
Commercial vegetable cultivation	82.32% households
Respondents	N = 777 households

3. Analyses of driving factors indicate that: (i) Irrigation is not a prompting factor helping in adoption of vegetable cultivation. The rainfed areas of middle hills (1200-1500 m altitude) are the more preferred sites for vegetable cultivation, and (ii) size of workforce and landholding shows a positive impact on vegetable cultivation. It is more pronounced in large landholdings, and amongst the larger households (work force). Connectivity upto 2 kms distance from the road-head also has an impact, where vegetable cultivation is more intensive compared to the areas at larger distance.

3.4.5. Ecological Economics of Tourism in Kumaun Central Himalaya

Background

Himalaya is endowed with natural bounties which provide a natural realm for the growth of tourism. The tourism is developing as a major economic activity, investments made towards creation of tourist facilities and growth of related enterprises endorse to this fact. Government policy imperatives also stand in its support. Tourism, in established tourist destinations like Nainital-Bhimtal Lake Region, is proving a very lucrative enterprise and also making in-roads to many unexplored areas. But, this growth of tourism also has its diseconomies. Increased cost of living, encroachment on commons, pollution of water bodies, overcrowded settlements, defilement of aesthetics, deforestation, erosion etc. are some of the perceived negative impacts of tourism development in hills. Further, the benefits of tourism are usurped by a handful of people while the costs are borne by a wider section of the society. A study of tourist destinations would help understanding the process and nature of tourism in the region. The findings will also help in formulating policy guidelines and in analyses of alternative ways to sustain and conserve its benefits.

Objectives

1. Study of process and nature of tourism
2. Identification of impacts and assessment of ecological economics of tourism
3. Appraisal of management options for sustenance of tourism

Results and Achievements

1. Reconnaissance work in few areas was done, and some unstructured interviews were made for orientation of the tourism process and identification of impacts. Some impacts of tourism and tourism induced activities have been identified.
2. Baseline information from secondary sources on population, tourist traffic etc, is being collected and compiled.

3.4.6. Geo-environmental Assessment of Landslide Hazards in Parts of Sikkim Himalaya for Mountain Risk Engineering Evaluations Using RS and GIS

(Summary of completed project)

Background

The occurrence of landslides due to heavy rainfall and cloud bursts is very common in Sikkim. The terrain conditions in terms of geology, physiography, and the allied genetic factors also greatly add to these processes. Therefore, the study was undertaken to assess and analyze the *in-situ* conditions of landslides/mass-wasting and their mitigation. Parameters in line with the concepts of Mountain Risk Engineering (MRE) were envisaged for

evaluation for their application possibilities. Remote Sensing (RS) data were used to derive relevant terrain characteristics, and for synthesis and analysis, Geographical Information System (GIS) based techniques were used. It was perceived that this would help evolving an approach, which could be more dynamic and interactive.

Objectives

Inventorying major problematic zones towards assessment of the geo-environmental factors associated/ responsible for landslide occurrences

Generating thematic spatial as well as attribute data for significant parameters of the investigation areas

Development of mountain risk engineering evaluation approach on a GIS framework with respect to landslide hazards

Results and achievements

1. Selected road corridors for detailed investigation were Gangtok-Rangpo stretch of national highway (NH31A) in East Sikkim with annual average daily traffic (AADT) range of 500-2000, followed by Melli-Jorethang State Highway (SH) in South Sikkim, Geyzing-Nayabazar SH, and Nayabazar-Sombaria SH in West Sikkim; all with an AADT range of 200-500.

2. Total road length and area covered within the project is approximately 200 km and 543 sq km respectively with ridge top to the valley section on both sides through slopes. Thus, fullest geomorphological details in contiguity were generated. These road corridors fall in two elevation zones (i.e., 300 to 1200m amsl and 1200 to 2600m amsl.

3. Landslide hazard susceptibility zonation (LHSZ) was done (Figs.14 & 15) taking into account the role of each host geo-environmental parameter in the active landslide of the area with statistical weight assignment accordingly. Final inventories and details organized and generated around a GIS core are perceived to fulfill the requirements of MRE on landslide hazard susceptibility aspect for an important mountain infrastructure like roads.

3.4.7. Development of Comprehensive Siwalik Development Strategy

(Summary of completed project)

Fig. 14. LHSZ map with road and settlements orientation along Gangtok-Rangpo stretch of NH31A, East Sikkim

Background

The Integrated Watershed Development Programme (IWDP) funded by the World Bank was initiated in the Siwalik region under the supervision of the Ministry of

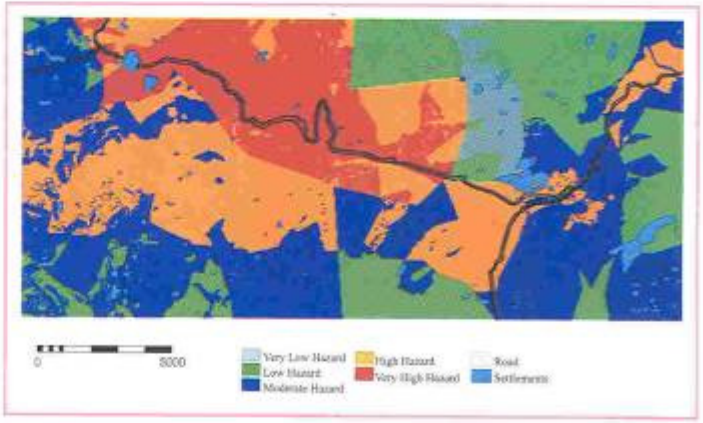


Fig. 15. LHSZ map with road and settlements orientation along Gangtok-Rangpo stretch of NH31A, East Sikkim

Agriculture, Government of India, New Delhi and is being implemented in the states of Jammu and Kashmir, Himachal Pradesh, Haryana, Punjab, and Uttaranchal, thus covering the Siwalik region in the entire North West Himalaya. Each project implementing state had developed implementation plan and a state level strategy document. Consequently, the Ministry of Agriculture and the World Bank felt it desirable to have a Comprehensive Strategy Document prepared, based on the broad framework of eco-restoration and socio- economic development. The assignment, therefore, is to put together an analytical compilation of the existing data, information based on the experiences of participating Siwalik states, and synthesis of various issues to integrate the individual working plans in a uniform manner so as to provide the broad guidelines for the project implementation.

Objectives

1. Synthesis of available reports in the five states for the Shiwalik zone of Jammu & Kashmir, Haryana, Punjab, Himachal Pradesh and Uttaranchal

2. Development of a uniform strategy that is environmentally and socially sound, could arrest degradation of the Shiwalik zone and enhance simultaneous economic development

Results and Achievements

1. Amongst the various watershed development projects undertaken thus far in India, Siwalik watershed development programmes can be considered a good representative of diverse and complex interlinkages that exist and influence developmental initiatives in the mountainous region. This zone is considered as eighth most severely degraded ecosystem in the country. It may be noted that basic research and subsequently large-scale replication of various components of watershed management have evolved from the pioneering work done in the Siwalik region.

2. Under this activity an attempt was made to highlight the experiences gained during the course of developing a comprehensive strategy for the Siwalik region in the five participating states. The effectiveness of SWC measures on watershed level for reduction of soil erosion rates as well as conservation of water is the basis of eco-restoration.

3. Present investigation reveals that in respect of IWDP-Hills II programme currently underway in the five states. In addition to the basic issue of eco-restoration versus socio-economic development of the region, the other important concerns that need further attention for the development of a region adopting watershed approaches are identification of eco-regions, size and selection criterion for watersheds, planning approach, selection of components for watershed treatment, implementation Strategy, selection of implementation agency, support organizations and their role vis-à-vis peoples' participation, and a well planned withdrawal strategy.

3.4.8. People, Gender and Indigenous Knowledge in the Use and Conservation of Resources in the Central Himalayan Region of India: An Empirical Study

(Summary of completed project)

Background

The Central Himalayan region supports remarkable cultural, ethnic and biological diversity. The cultural influence of the people on use and conservation of resources is quite significant; indigenous culture and traditions have helped evolve adaptive strategies to make effective use of natural resources. Important productive sectors like land, agriculture, forestry, animal husbandry, agro-based cottage industry, etc. are adequately maintained by traditional knowledge system. It is assumed that women's role in preservation of these traditional knowledge systems is remarkable. Though, the role of indigenous knowledge is pivotal in sustainable use and conservation of resources, they are fast disappearing due to adoption to technological changes and other factors. Therefore, in this study, an effort was made to document indigenous knowledge systems (IKS) in parts of Central Himalaya amongst the ethnic communities.

Objectives

1. Inventorying of resource bases and estimation of degree of participation, i.e., access, contribution and control of women over these resource bases, and identification and quantification of anthropogenic and other pressures on resources

2. Review and analyses of the existing information/data on traditional knowledge and indigenous practices

3. Documentation of indigenous knowledge on use, conservation and management of resources and role of women in change and preservation of traditional knowledge system

Results and Achievements

1. Ten sample villages located across the Indian Central Himalaya (ICH) on altitudes varying from 1000 to 3600m asl have been studied. Data were collected through empirical investigation from more than 500 respondents; almost half of the respondents were females.

2. As the study reflected, the social institutions in ICH are rich depositories of IKS. Intercommunity relations, gender relations, occupational diversifications, housing, food habits, dressing pattern, etc., were governed by the society ecology. People have developed unique indigenous practices not only for storage of food grains but also for storage of cooked foods for consumption during lean period. Some examples are mutton related food items like *Geema* and *Arjee* prepared by Bhotia tribal community (Fig. 16).

3. Ethno-medicine and ethno-veterinary practices are prevalent all across the ICH. More than hundred indigenous treatments for animal health and also equal number of treatments for human health were recorded. These indigenous knowledge and practices, based on locally available bioresources, play a vital role in ensuring physical well being, promoting the economy and conserving the resources.

Fig. 16. *Geema* being prepared only to be stored for consumption during lean period

3.4.9. Access to Social Infrastructure and Human Development: A Situation Analysis of Indian Himalayan States

(Summary of completed project)

Background

It has been well realized that to combat poverty and attain human development on a sustainable basis in the IHR there is no better alternative than making available essential social infrastructural facilities and services. While economic growth could be achieved with the development of an excellent infrastructure, human development is possible through provisioning of social infrastructure (i.e., access to education, health care facilities, drinking water, etc.). The essential social infrastructures are critical in fostering human development and creating opportunities for people to be better equipped to graduate from the threshold of poverty. If poverty needs to be addressed through infrastructural development, which has the potential to meet livelihood challenges and could provide for economic and social security, it is essential to have base-line information on the current status of social infrastructure and strategies based upon the gaps and constraints identified. With this background, this study was aimed at compilation of data and essential information on

the current status of social infrastructural provisions in the states of IHR and identification of appropriate strategies to improve upon the current situation.

Objectives

1. Assessment of the current situation in access to social infrastructure of the states in Indian Himalayan region
2. Analyses of the social institutional and local governance issues
3. Recommendation for policies, strategies and programs aimed at improving access of social infrastructure for the target groups

Results and Achievements

1. Data have been compiled at state level as well as district level of selected states on social infrastructure, i.e., housing, education, health, drinking water and electricity. State-wise disparity in social infrastructure was quite high. Infrastructure relating to primary education was better in Sikkim followed by Meghalaya and Himachal Pradesh as one Junior Basic School (JBS) served about 328, 433 and 486 people, respectively. Poor infrastructure was found in the West Bengal hills preceded by Tripura and Manipur as one JBS served 1677 people in WB hills and 1341 and 1241 people in Tripura and Manipur, respectively. In IHR, one JBS served about 880 people.
2. While, on average, 21.98% of the villages in IHR have medical facility, Mizoram was found to have good medical infrastructure while Meghalaya had very poor medical infrastructure. As much as 64.94% of villages in Mizoram have medical facility followed by Tripura (53.27%) against only 3.80% in Meghalaya and Assam hills (4.17%). The percentage of households having safe drinking water facility among states of IHR varied significantly from 77.34% in Himachal Pradesh to 16.21% in Mizoram.
3. In the IHR as much as 65.90% of the households were electrified. Maximum households (93.28%) were electrified in H.P. against a minimum (23.03%) in Assam Hills. Considering the current situation with respect of social infrastructure Sikkim and Himachal Pradesh appeared to be well served while Assam hills and Meghalaya appeared to be poorly served.

3.4.10. Carrying Capacity and Impact Assessment Studies on Tea Cultivation in Uttaranchal Hills

Background

Tea cultivation in Uttaranchal hills promoted by the State Government has recently come up as an important land management activity for income and employment generation. The novelty associated with this venture is not only limited to the above mentioned two vital issues, but also address the problem of restoration of the ever growing wasteland, which otherwise mainly provide poor quality fuel wood and foraging grounds for cattle. However, despite the acceptability and enthusiasm of the natives attached with this activity, fact remains that many of the well established tea gardens during the British period are now abandoned (Fig. 17). The reasons behind this have to be

Fig. 17. Overview of an abandoned tea garden at Berinag in Kumaun hills

understood and the lessons learnt from the past should be taken care of to foster tea cultivation in this region. Similarly, the environmental impacts of this activity on soil and water quality, biodiversity, socio-economic changes and gender issues has to be taken care of to expand this activity in an environment-friendly way.

Objectives

1. Understanding income and employment generation opportunities and socio-economic concerns of tea cultivation

2. Understanding ecological, economic and biodiversity concerns of traditional land use *vis-à-vis* tea plantation

Results and Achievements

1 A total of 198 families have raised tea plantations so far in 182 ha land in abour 50 villages of Almora and Bageshwar districts in different phases starting from 1995, under the technical and financial support from Tea Development Directorate, Uttaranchal. The impact of tea cultivation on the land use is evident in the study area (Table 12). Of the total land available with the households, 36.5% of the rainfed cropland and 83.5% of the grasslands have been converted to tea gardens so far. Out of a total of 112 households surveyed, 90 households look after the tea gardens themselves and the rest partly participate in this activity.

Table 12. Impact of tea cultivation on land use in the surveyed area

Land use	Before tea plantation in 1997 (ha)	After tea plantation in 2002 (ha)
Total land holding	153.6	153.6
Cultivated land	93.3	59.0
Grass land	52.1	8.3
Land under tea	0	78.1
Miscellaneous	8.0	8.0
Total	307.0	307.0

2 Reduction in cropland and grasslands due to tea cultivation is acknowledged as one of the major reason behind the reduction in livestock size, particularly immature livestock by 54% households (Table 13). A tendency to dispose off the immature livestock is rising among the tea cultivators.

Table13. Impact of tea cultivation on livestock population in the surveyed area

Livestock type	Number before tea cultivation	Number after tea cultivation	Percent decline
Cow	114	83	27.2
Ox	165	119	27.9
Buffalo	122	88	27.9
Immature	244	64	73.8
Goat	94	77	1.8
Total	739	431	41.7

3 A strong positive correlation was found between land holding of the households and land planted with tea ($r=0.66$; $P<0.01$), however for the other parameters the correlations were found weak. A weak negative relationship between age of the tea cultivator and land offered for tea indicates that the younger generation is more interested towards this activity.

3.4.11. Environmental Services and Ecological Economics of Oak and Pine Forests in the Central Himalayan Region

Background

Oak (*Quercus* spp.) and Pine (*Pinus roxburghii*) are two major forest types in the middle montane belt in the Central Himalaya and provide a range of ecosystem services. Oak forests are socially valued and face high biotic pressure due to their quality fuel wood, availability of round-the-year green fodder, manuring leaves and minor forest products. They are also home of rich biodiversity. Pine leaves are unpalatable and provides inferior quality fuel wood. However,

economic benefits from Pine forests, such as resin and minor timber are considerable. The Pine forests also produce better ground forage. Among the indirect services, Oak forests are considered best for soil and water conservation and soil fertility enhancement. Whereas, Pine forests are accused for promotion of forest fire, depletion of soil moisture and degradation of soil quality. Pine is a stress-tolerant, fast growing conifer and survives in soils poor in moisture and fertility, where Oak fails to survive. Therefore, there are certain advantages and disadvantages associated with these two forest types. This study will highlight the relative importance of these two dominant forest types of the region with regard to environmental services and ecological economics for their future conservation and management planning.

Objectives

1. Tangible and intangible goods and environmental services provided by these two forests types and economic valuation of these goods and services
2. Ecological economics of these two forest types for management imperatives in this region

Results and Achievements

1. Forest Department records show that the reserve forest area under Oak and Pine forests in Almora District is 8793.3 and 42732.6 ha, respectively.
2. Based on literature/field survey in the region a summary of environmental services and goods provided by these two forest types is summarized in Table 14.

Table 14. Some environmental services and goods provided by Oak and Pine forests

Environmental services and goods	Oak forests	Pine forests
Fodder	Year-round	Non-palatable
Fuelwood	Good quality	Inferior quality
Seed	Edible	Edible
Medicinal Value	Some	Some
Small Timber	Rarely used	Frequently used
Agricultural implements	Frequently used	Rarely used
Resin	No	Yes
Bark of tree	No specific use	Used by blacksmiths
Manuring leaves	Good quality	Inferior quality
Other use of leaves	None	Roofing / Brooms
Biomass production	10-20 t/ha/yr	Comparable
Ground herbage yield	Low	High
Biodiversity	High	Low
Minor forest products/edibles	Many	Few
Soil & water conservation benefits	High?	Low?

3.4.12. Environmental Assessment of Hydropower Projects in the Beas Valley of Himachal Pradesh

Background

In the recent decade, hydropower projects in Himachal Pradesh, particularly, in the Beas valley of the Kullu district have come up in large numbers. The majority of them are under construction stage and only a few have started operating. The agricultural land and forestland in some villages have been acquired for these projects. Yet, these have not caused any displacement of human settlements so far. Local communities of the area see such developments as a possible way for their socio-economic upliftment and overall development of the region. But, they are also apprehensive of their negative impacts on the environment. The project proponents have still to do a lot in meeting the expectations of local communities and towards the promises made earlier at the time of public hearings for obtaining environmental clearance.

Objectives

1. To assess the positive and negative environmental impacts of upcoming hydropower projects
2. To find the ways of strengthening benefits from these projects from the standpoint of local communities

and to suggest mitigative measures

Results and Achievements

1. Of the total households surveyed in and around hydropower projects, 91% depend on agriculture while only 1% are engaged in hydropower project related activities. About 84.5% local people were are of the view that that they have lost their land property, particularly cropped land due to these projects.

2. The positive impacts that the local communities perceive from hydropower projects in the region are employment, economic benefit, and development of infrastructure and tourism recreation resources. Around 80% of the surveyed population expects employment benefits from these projects, and 32.1% of the local communities in ten studied villages are of the opinion that these hydropower projects would be economically beneficial to them.

3. With regard to adverse impacts of hydropower projects on the surrounding environment, about 91% people feel increase in dust and air pollution, while 88% people perceive deforestation and fuel wood scarcity as a major environmental problem after the introduction of these projects. Debris deposition and solid waste problem was ranked in the third place. Incidents of landslides, threat to wild life, and loss of medicinal plants in the region, were the other problems noticed by the people.

3.4.13. Workers' Exposure to Air Borne Dust and Other Pollutants in the Kullu Valley

Background

Factory Act 1948 as amended in 1986-87 clearly lays down a requirement of regular scientific monitoring of workers' exposure for air borne dust and other pollutants. Workers' exposure measured in terms of total suspended particulate matter does not indicate its criticality in terms of health effects. It is the respirable fraction of total dust that has direct relation to health hazards. It is, therefore, important to measure the exposure of workers and other populations to respirable dust in their working environment to know the level of air borne pollution and chances of health risks in them.

Objectives

1. To measure background values of the total respirable air dust (PM 10) in ambient air, to know different workers' exposure to air borne dust, and to conduct a survey about the state of health condition of the workers

2. To suggest preventive measures to minimize health risks

Results and Achievements

1. The background values for particulate matter or PM 10 (particles below 10 micrometers) were measured close to two important hills stations - Kullu and Manali. The highest values of PM 10 were 93.7μg/m^3 in January 2003 at Mohal, and 53.1μg/m^3 in July 2002 at Kothi. The lowest values for PM 10 were recorded 19.7μg/m^3 in September at Mohal and 12.6μg/m^3 in October 2002 at Kothi.

2. The reasons for high concentration in a particular season at both the sampling sites could be biomass burning during winter and vehicular emissions during peak tourist season.

3.4.14. Demonstration of Silvi-Pasture Model for Wasteland Restoration in Western Himalaya

Background

In the western Himalayan mountains people depend upon community lands for fodder and fuelwood needs for subsistence living. Due to increasing pressure in many areas the community lands have degraded and have turned into wastelands supporting only inferior trees and grasses. Therefore, such areas has to be brought under silvi-pasture management introducing promising fodder species for wasteland restoration and fodder production to support livestock component. The aim of this project is to demonstrate wasteland restoration through silvi-pasture approach for wider extension by the local people.

Objectives

1. To monitor growth, survival and biomass of fodder trees and grasses planted in wastelands in the western Himalayan mountains.

2. To study soil fertility, soil and water conservation impact of the plantation.

3. To impart training on silvi-pasture management to the village communities.

Results and Achievements

1. A 10 ha culturable wasteland of Dobh-Srikot village of Pauri district was planted with 2174 saplings of different fodder trees and the soil physico-chemical characteristics of this site were analyzed.

2. A training programme on sylvi-pasture development was conducted for the farmers of Dobh-Srikot village and seed of fodder grass were distributed among them.

3.5. ENVIRONMENTAL PHYSIOLOGY AND BIOTECHNOLOGY

A thorough understanding of the factors that govern the productivity and functioning of plants, the primary producers, is of paramount importance, especially in the light of severe climatic conditions prevailing in the Himalaya, and current concern about the global climatic change. The application of conventional techniques with the sophistication of biotechnology will greatly help in increasing efficiency and productivity as well as improving environmental health. Microorganisms play a significant role in improving plant growth. A number of bacteria (isolated from soil) have been developed as inoculants and shown to be beneficial for plant growth as well as for increasing seed germination. Microorganisms obtained from various experiments are being maintained using appropriate methods. Efficiency of N_2 fixing *Alnus nepalensis* for improving productivity of large cardamom (a cash crop) has been demonstrated. In order to supplement production of quality planting material, propagation protocols have been developed using vegetative as well as *in vitro* techniques for some plants. Significant improvement in seed germination could be achieved following chemical treatments, which also included plant growth regulators. In view of the various environmental stresses, the physiological and biochemical basis of adaptation is being studied. Increased biotic pressure (mainly in terms of logging, crown removal, etc.) has threatened the survival/existence of Himalayan yew, an important medicinal plant; evaluation has been made to assess performance of tree in terms of taxol level in the bark. The importance of establishment of resources (demonstration and training) centers in the hilly regions has been realized and some of the hill specific technologies, namely, polypit, polyhouse, biocomposting, vermicomposting, biofencing, protected cultivation, clonal propagation, etc. are being demonstrated for extension by the farmers.

3.5.1. Rhizosphere Microbiology of Himalayan Plants

Background

With a view to understand the microbial communities in Himalayan soils, a number of projects have been initiated under this programme. The major projects so far initiated are: (1) Rhizosphere microbiology of tea, (2) Rhizosphere microbiology of Himalayan trees, (3) Microbial diversity in Mamlay watershed, Sikkim, (4) Plant-microbe interactions in conifers, and (5) Development of microbial inoculants for hills.

Objectives

1. Isolation, characterization and selection of beneficial microorganisms
2. Plant-microbe interactions in rhizosphere of Himalayan species
3. Maintenance of microbial cultures of Himalayan region

Results and Achievements

1. Three bacterial species, viz. *Bacillus megaterium, B. subtilis* and *Pseudomonas corrugata*, originally isolated from temperate locations, were examined for their growth promotion ability using both pot and field based assays. A local variety of rice was used as test crop. The three bacterial species exhibited *in vitro* phosphate solubilising activity in the following order: *P. corrugata*> *B. megaterium* > *B. subtilis*.
2. The bacterial treatments resulted in improved plant performance. Inoculations also stimulated the rhizosphere associated bacterial and actinomycetes populations and suppressed the fungal flora. Colonization of roots by mycorrhizal fungi improved in all the treatments.
3. Microbial inoculations were conducted in cutting raised, seed raised and tissue culture raised tea plants. The inoculations resulted in improved growth of tea and also improved survival rate in case of tissue culture raised tea.

3.5.2 Large Scale Propagation of Location Specific Elite Plants Using Conventional and Biotechnological Methods

Background

One of the major constraints in undertaking large scale plantation work with regard to rehabilitation of degraded/wasteland, afforestation programmes and introduction of high value plants are the lack of sufficient quantities of good quality planting material. For this, conventional methods of seed germination and vegetative/ clonal propagation are equally important, which can be supplemented by the development of newer technology of plant tissue culture for target taxa of each region.

Objectives

1. To identify physical and chemical treatments, including plant growth regulators, for successful rooting of cuttings and to standardize techniques for large-scale application
2. Developing *in vitro* protocols for selected plant species
3. Conservation of endangered/ threatened species

Results and Achievements

1. Complete plantlets were regenerated from the hybrid pods developed from crosses between *Cymbidium alolifolium, C. giganteum and C. masterii*. The regenerated plants have been successfully transferred to the pots.
2. Complete regeneration protocols have been developed for important Himalayan endangered orchid species, namely, *Vanda cerulea* (Fig. 18) and *Paphiopedilum insigne*. The regeneration plants have been successfully transferred to the pots.
3. Based on PAGE, SDS- PAGE and isozyme markers, the hybrid nature of the plants regenerated from pods developed from the cross between *C. mastersii and C. elegans* has been established.

Fig. 18. Plantlets of *Vanda cerulea* growing in culture.

3.5.3. Impact of Environmental Changes on Growth Performance of Plants

Background

The ability of plants to grow and survive in a particular environment depends upon their photosynthetic capacity. Plants can exhibit optimal performance with regard to photosynthesis and growth/productivity if growth conditions are favourable. Under natural conditions, however, plants experience different kind of stress that result in irregular and/or regular diurnal and seasonal variations in their physiological and biochemical attributes, which in turn influence their growth and productivity. However, plants respond differently to these varying environmental conditions. Therefore, understanding the underlying mechanisms (physiological and biochemical) used by plants to resist the stresses generally encountered under natural conditions can be useful to gain insight into how plants can be managed to increase their yield and productivity under a given set of environmental conditions. In this context studies have been initiated in tea, an important plantation crop of India.

Objectives

1. To determine the variation in photosynthesis and growth in relation to environmental stresses

2. Comparison of seed-raised and clonal tea plants in terms of their superiority

Results and Achievements

1. Both clonal and seed-raised tea plants showed seasonal variation in their relative growth rate. Among the various clones (clone UPASI-9, T-78 and Kangra Jat), clone UPASI-9 and T-78 were found better in terms of their relative growth rate measured across the seasons.

2. Of the two seed-raised tea plants (BSS 449 and BSS 520), BSS 449 showed better relative growth rate.

3. It was observed that the relative growth rate of seed-raised tea plants was considerably better than clonal plants when grown in the same habitat.

3.5.4. Study of Plant Performance, Ecology and Interaction in the Himalayan Region

Background

Due to dramatic differences in elevation (within a map distance of 100-200 km), climate, physiography and soil, the Himalaya harbours, perhaps the premier vegetational gradient on the earth and it supports large plant diversity including various medicinal plants. Amongst various high value medicinal plants, *Taxus baccata* L. subsp. *wallichiana* (Zucc.) Pilger has gained considerable importance due to the valued source of the anti-cancer drug taxol ®. It is a medium sized, slow growing species and is used in traditional systems of Unani and Ayurvedic medicine. In recent years information has been collected on some other aspects of this species, however, there is general paucity of information on its biomass and productivity. Therefore, a study was carried out for its biomass accumulation and productivity in relation to age series.

Objectives

1. Biomass accumulation in different above and below ground components of *T. baccata* trees in relation to tree age

2. Productivity estimation in different components

3. Estimation of net production efficiency of the leaf surface and nutrient supply efficiency of the root system based on the ontogenic development of tree

Results and Achievements

1. The dry weight of different components increased with increasing tree age (27 and 136 years) and total biomass in 136-year-old tree was 144.23 kg. Within an individual tree the tree canopy biomass was concentrated towards the upper part of canopy. Allometric equations relating biomass of different components with circumference at breast height were obtained.

2. The root: shoot ratio ranged from 0.28 to 0.38 whereas total photosynthetic: non photosynthetic biomass ratio was recorded between 0.15-0.08, and this value decreased with age.

3. The maximum current biomass production for all the components, except for branch occurred at the age of 101 years. The mean annual production increased with increasing age except for bole and root system where it first increased and then showed constant value after attaining certain age. Maximum production efficiency per unit leaf area (Fig. 19) and fine root biomass was observed during 28-36 years.

Fig. 19. A current year shoot of *T. baccata* with an immature 'seed'

3.5.5. Effects of N_2-Fixing *Alnus* on the Mechanisms of Accelerated Phosphorus Cycling in Large Cardamom Agroforestry in the Sikkim Himalaya

(Summary of completed project)

Background

Mixtures of N_2-fixing and non-N_2-fixing species differ from other sets of species by the direct and indirect effects of increased nitrogen supply. Nitrogen cycling in such stands has been observed to accelerate which is attributed to nitrogen fixation. The rates of phosphorus have also been shown to increase under the influence of N_2-fixing species, however there is no understanding on the mechanisms that give rise to greater availability and accelerated phosphorus cycling. The project envisages filling the above gap. The work emphasizes to test the following 2 hypotheses related to the mechanisms on ecosystem biogeochemistry as an effect of N_2-fixing species: (1) increased availability, and cycling of phosphorus under the influence of *Alnus* may cause a shift from sparingly available geochemical pools to rapidly cycling organic phosphorus pool, and (2) soil acidification due to rapid accumulation of nutrient cations in biomass may cause soil exchange complex to become more dominated by H^+. Nitrate leaching may also cause accumulation of H^+ in the soil. These hypotheses are tested in large cardamom based agroforestry system where N_2-fixing *Alnus nepalensis* is extensively planted as associate shade tree. *Alnus* has a symbiosis with *Frankia* and is efficient in N_2-fixation. Large cardamom (*Amomum subulatum*) is the most important perennial cash crop of the Sikkim Himalayan region.

Objectives

1. To estimate the shift of sparingly available geochemical pools to rapidly cycling organic pools of phosphorus under the influence of *Alnus*

2. To characterize the major pools of phosphorus and examine the processes involved in the rate of

release of phosphorus from the above pools

3. To quantify the level and causes of soil acidification in *Alnus-Amomum* plantations, and to correlate with phosphorus availability

Results and Achievements

1. Three different stands with age plantation treatments of *Amomum* spp. and N_2-fixing tree mixed of young (10 years), medium (20 years) and old (40 years) were studied. A control plantation of *Amomum* spp. and non N_2-fixing tree mixed consisting of old mixed natural trees was also selected.

2. Total-P values ranged from 0.50-1.18 mg/g soil in *Alnus* stands and 0.85-1.08 mg/g soil in mix tree species stands. Overall the total-P value was more in old *Alnus* stand followed by medium and the young *Alnus* stands. Occluded Iron-P values were found to be much higher in all the stands, seasons and soil types. Available-P values ranged from 4.6-60 µmg/g soil in the different ages of *Alnus*-cardamom stands. Highest available-P values were recorded in rainy season and lowest in the winter season in both rhizospheric and bulk soils in all the stands. Mix-tree cardamom agroforestry system (5.6-32 µmg/g soil) showed lower available-P than *Alnus*-cardamom stands.

3. Pooled data of microbial-P biomass and available-P from all ages of *Alnus* stand showed higher values when compared with non-N_2-fixing mixed tree stand. N_2-fixing *Alnus*-cardamom stand was more dynamic in terms of microbial-P and available-P. The microbial-P biomass in all situations was highest in winter and lowest in rainy season. On the other hand available-P was lowest in winter and highest in rainy season. This indicated that phosphorus was immobilized in winter by microbes, and acted as source during the growing season. Microbial-P biomass and available-P was inversely related. The magnitude of phosphorus immobilization and release as available-P by microbes in *Alnus* was greater than non-N_2-fixing stand. The beneficial role of N_2-fixing *Alnus* on soil nutrient availability especially phosphorus in cardamom system was recognized in this study.

3.5.6. Productivity, Energetics and Maintenance of Soil Fertility in Agroforestry Systems of Sikkim

(Summary of completed project)

Background

In Sikkim, there are mainly three types of agroforestry systems, i.e., (i) large cardamom based, (ii) mandarin orange based, and (iii) fodder-fuel tree based. Large cardamom is the most important perennial cash crop of the Sikkim Himalayan region that is cultivated in 26000 ha of Sikkim and Darjeeling between 600-2000 m elevations. Out of 23000 ha area of large cardamom cultivation in Sikkim state, 1316 ha of reserve forest is used for large cardamom cultivation on lease to farmers and remaining area is under private large cardamom based agroforestry. There is no information on large cardamom and *Alnus nepalensis* based agroforestry system with respect to aging of both cardamom and *Alnus*. Therefore, this study was planned to see the influence of both *Alnus* and cardamom age on the crop yield, biomass productivity and nutrient dynamics to examine the sustainability of the combination and practice.

Objectives

1. To study agronomic yield, biomass, productivity and energetics in age series of 5-, 10-, 15-, 20-, 30- and 40-years of *Alnus*-cardamom plantations

2. To study bio-geochemical cycling of nutrients, litter decomposition rates and nutrient release and back translocation in age series of *Alnus*-cardamom plantations

3. Estimation of N_2-fixation efficiency, nitrogenase activity and nitrogen accretion in *Alnus* (*Frankia* symbiosis) - *Amomum* spp. plantations

Results and Achievements

1. The total biomass contribution of the shade tree (*Alnus*) increased with stand age

(32.76, 64.61 and 129.36 t ha^{-1} in 5-, 15-, and 40-year plantation), whereas biomass contribution by the understorey cardamom increased from 5-year (8.72 t ha^{-1}) to 15-year (34.57 t ha^{-1}) and decreased with the lowest value at 40-year (2.90 t ha^{-1}).

2. Net stand energy fixation increased in the first three stand ages (321.61 in 5-year to 443.89 x 106 kJ ha^{-1} $year^{-1}$ in 15-year) and decreased along the ages (304.59 in 20-year to 154.0 x 10^6 kJ ha^{-1} $year^{-1}$ in 40-year). Analytical studies in terms of production efficiency, energy conversion efficiency and N_2-fixation in the age series suggest that younger plantations function as the most productive system, while intermediate and older were least and less productive. Energy fixation in understorey plant component (cardamom-leaf, pseudo-stem, and root/rhizome) increased in the younger stands, peaked at 15-year and declined in the older stands.

3. The active and inactive root nodule biomass build-up in different seasons showed an inverse relationship with the stand age. Active root nodule biomass increased with the stand age until 15-yr stand and decreased with increase in age. The difference in the root nodule biomass between the plantation stands in age series was an effect of plantation age, tree dimensions, stand density, and litter accumulation in the *Alnus*-cardamom plantation stand. The percent inactive root nodule contribution was highest in spring season and lowest in post monsoon period (autumn).

4. Seasonal nitrogenase activity varied significantly between the plantation stands, seasons and nodule age-classes. Highest activity was recorded in rainy and lowest in winter season. The highest nodule biomass production and nitrogen fixation during monsoon period (autumn) suggests that there is a greater requirement of warmer photoperiod than cool dark night, which directly corresponds to the nutrient requirement of cardamom.

3.5.7. Bioprospecting of Biological Wealth Using Biotechnological Tools: Chromosome Fingerprinting and DNA Bank-Net of Himalayan Endangered Species

(Summary of completed project)

Background

The Department of Biotechnology (DBT) sponsored a multi-institutional project on bioprospecting of biological wealth, concerned with application of conventional, molecular and flow cytogenetics approaches to fingerprint chromosomes for systematic, analytical and transparent investment in conservation and sustainable use of biodiversity programmes of high priority endangered species like *Podophyllum hexandrum*, *Gentiana kurrooa*, *Picrorhiza kurrooa*, *Aconitum* species and *Valeriana jatamansi* of medicinal, aromatic and other values. These investigations also provided potential guidelines for the concerned species recovery and genetic enhancement programmes. The research work related to molecular biology has been carried out at Delhi University and assisted by two satellite units, one in Solan (H.P.) and another at GBPIHED, Kosi-Katarmal, Almora.

Objectives

1. Plant collection, herbarium vouchers, initial field notes and ethnobotanical data

2. Storage of DNA rich materials and preliminary cytological studies

3. Breeding systems and phytochemical work

Results and Achievements

1. DNA rich material from various locations in alpine and sub-alpine regions of IHR, particularly the Kumaun and Garhwal Himalaya, and also from Sikkim and Himachal Pradesh were collected and maintained in the nursery at Kosi – Katarmal (1150m amsl) or in the field station at Khaljhuni (2450 m amsl). Seed samples of the target species have been deposited in NBPGR, New Delhi. Mitotic chromosome counts (2n) for various target species were assessed and no variation in basic chromosome counts were observed.

2. Quantification of podophyllotoxin in *P. hexandrum* from different plant parts (leaf, stem, rhizome and roots) collected from various geographical locations of Kumaun and Garhwal Himalaya revealed a wide variation between different morphological variants and different populations. Podophyllotoxin content of rhizome samples collected from different populations ranged from 0.007 – 5.45%, on dry weight basis, among morphological variants. The maximum value (5.45 %) was found in the rhizome samples collected from Kedarnath (3600 m amsl). Pseudoaconitine content in tubers (Fig. 20) of *A. balfourii* from different populations ranged from 0.06-0.62% on dry weight basis. Highest content (0.62%) was recorded in tubers collected from Phurkia (3430 m amsl). The amount of aconitine also varied and ranged from 0.13-0.83%. Like that of pseudoaconitine, highest levels (0.83%) were recorded in tubers collected from Phurkia.

3. Attempts were made to develop effective *in vitro* propagation protocols for *P. hexandrum, P. kurrooa* and *A. balfourii*. Using various types of explants, multiple shoots were obtained. These were subsequently rooted and plants were transferred to hardening trays. The growth performance of above mentioned *in vitro* raised plants was found to be normal.

Fig. 20. Tubers of *A. balfourii*

3.5.8. Selection of Plant Growth Promoting Microbes for Potential Use in Mountains

Background

The use of biofertilizers has been commercialized in tropical India with the development of carrier based cultures. However, no significant effort has been made for developing suitable microbe based fertilizers for hills. The Institute has initiated such studies has also also planned to explore the microbial wealth for both academic and applied reasons.

Objectives

1. Isolation, quantification and characterization of soil microbes from the rhizospheres of target species
2. Analyses of mycorrhizal associates of the target species
3. Characterization of the selected isolates for their beneficial properties

Results and Achievements

1. Roots and soil samples from the rhizosphere of five species of rhododendrons, namely, *Rhododendron arboreum, R. anthopogon, R. campanulatum, R. lepidotum* and *R. barbatum* were collected. Observations on colonization of roots by VAM fungi and their spore population(s) in soil were recorded (Fig. 21).

2. One hundred root segments were observed for root colonization and average number of intraradical vesicles. *R. arboreum* revealed maximum colonization (42%), followed by *R. barbatum* (40%), *R. anthopogon* (37%), *R. campanulatum* (33%) and *R. lepidotum* (28%). Maximum number of intraradical vesicles (12.5 cm^{-1} root bit) was recorded in *R. arboreum* and minimum (7.0 cm^{-1} root bit) in *R. barbatum*. No intraradical

Fig. 21. Mycorrhizae in *Rhododendron* sp.: A. *Glomus* sp. (x 50); B. intraradical vesicles (x 50) in *R. campanulatum*

vesicles were observed in *R. lepidotum*.

3. Out of six known genera of VAM fungi, five genera namely, *Acaulospora, Gigaspora, Glomus, Sclerocystis* and *Scutellispora*, all belonging to the order Glomales, were found to be associated with the rhizosphere soil of the rhododendrons. Maximum population of spores was detected from the rhizosphere soil of *R. anthopogon* (52 spores / 25 g soil) and minimum in *R. lepidotum* (32 spores / 25 g soil). Maximum number of species of VAM fungi (12) was obtained from *R. lepidotum*. A number of species of the genus *Glomus* dominated the rhizosphere soil of all the rhododendrons; *G. fasciculatum* being the most frequent and abundant species.

3.5.9. Microbes in Himalayan Soils: Biodiversity and Potential Applications

Background

Since 1993 a number of studies related to soil/rhizosphere microbiology have been initiated. Through these projects a large number of microorganisms have been isolated, purified and maintained for further study. In view of continuity of these studies the above-cited project has been formulated.

Objectives

1. Isolation of soil microbes from various locations including extreme conditions
2. Characterization and identification of the microbial isolates for taxonomical and biotechnological properties
3. Use of selected microbes for better establishment of seed, cutting and tissue culture raised plants

Results and Achievements

1. Soil samples collected from the two hot spring sites, Soldhar and Ringigad, both located in Garhwal Himalaya were analyzed for their physical, chemical and microbial components. The alkaline nature, total lack of carbon and nitrogen and high temperature of soil were the common characteristic features of both the sites. The optimum temperature for obtaining the highest microbial population from the soil samples of both sites was found to be 50 °C.
2. Microscopic examination revealed the presence of three types of microbial populations, i.e., bacteria, yeast and filamentous organisms. Out of 58 aerobic isolates, 53 were observed as gram-positive bacilli.
3. Soil dilution plates revealed the presence of antagonistic and phosphate solubilizing populations.

3.5.10. Genepool Preservation and Mass Propagation of Sikkim Himalayan Rhododendrons Using Biotechnological Tools

Background

Rhododendrons consists a group of plants which has a rich horticultural value. Asia is considered the homeland for rhododendrons and many species have been hunted out of the region during British rule. About 98% of the Indian species are found in the Himalayan region out of which 72% are found in Sikkim. Owing to several man-made reasons the natural populations of

rhododendrons of entire Himalaya are gradually diminishing. The major threats to rhododendrons are deforestation and unsustainable extraction for firewood and incense by local people. These alpine plants may be wiped out from the biota in short time if proper conservation measures are not made. Using both biotechnological and conventional methods this project strives to counter the threat on survival of these plants. The goal of the proposed project is to find out means of conservation, propagation and restoration of rhododendron.

Objectives

1. Tissue culture protocol development for the Sikkim Himalayan rhododendrons in particular, and Indian Himalayan rhododendrons, in general
2. Mass propagation of selected rare and endangered rhododendrons and hardening trials of mass propagated plants
3. Survival and fitness trials of seedlings raised through tissue culture in arboretum and fields

Results and Achievements

1. *In-vitro* experiments were conducted on *R. maddeni*. The sterilized seeds germinated under aseptic conditions, and 30-35% germination was achieved on hormone-free MS medium.
2. In *R. maddeni*, from five weeks old seedling, cotyledonary nodal part were used for shoots multiplication on Anderson media with antioxidants (PVP, Ascorbic acid and Citric acid) or without antioxidants containing 2iP (1.0-15.0 mgl^{-1}) and along with IAA (0.01-1.0 mgl^{-1}). At higher concentration of 2iP, the shoots induced were small, compact and no difference in nodes and internodes. Decreasing the level of cytokinins was suitable for multiplication and elongation of shoots on liquid medium with filter paper bridge. Shoot production in liquid filter paper bridge medium was 10-fold higher than that with agar and activated charcoal solidified medium.
3. Young leaves and stem explants were transferred on to various concentrations of media containing growth regulators and salt strength with antioxidants after sterilization. After 4-5 weeks, callus was obtained from 20% stem explants on B5 medium containing Ba and 2,4-D. The texture of callus was white-brown, soft and compact; all explants were transferred on to B5 medium containing NAA (0.1-2.5 mgl^{-1}), 2,4,5-T (0.1-2.5 mgl^{-1}) and BA (0.1-5.0 mgl^{-1}).

3.5.11. Establishment of Biotechnology Complex for Capacity Building and Economic Upliftment with Particular Reference to Women of the Indian Himalayan Region

Background

In the IHR majority of population is engaged in agricultural and allied activities, and more than 85% of the women workers are involved in such activities. Although, a number of technologies are available to increase land productivity, it is paradoxical that rural women are unaware of most of the advancements, current and easily available technologies/practices/methodologies applicable to this sector. Demonstration of technologies and the requisite training of users are two crucial steps in the transfer of technology. With this rationale in mind all available and suitable hill specific technologies have been demonstrated in the Biotechnology Complex at the Institute HQs. After providing training to the farmers, individuals from support organizations, training of trainers, etc., these technologies are also being extended to field in selected locations.

Objectives

1. Exploration, documentation and preparation of an inventory of indigenous and hill specific modern technologies
2. Setting up of demonstrations of improved/alternative and already available hill specific technologies in the Biotechnology Complex and at selected field sites
3. Capacity building through training/live demonstrations/field exercises of target groups, and training of trainers (TOT) on a regular basis

Results and Achievements

1. The available hill specific technologies have been documented and demonstrated at the Biotechnology Complex in the Institute at Kosi. Information folders (English as well as in Hindi) and a training manual entitled *Krishak Margdarshika: Aarthik Evam Paryavaran Samvardhak Saral Taknikein* has been published consisting of various simple and low-cost technology packages.

2. So far a number of training sessions have been conducted for different user groups covering a total of 346 villages and 55 NGOs in 11 districts of Uttaranchal (Table 15). Further, on-site training programmes and relevant technologies are being demonstrated on selected farmer's fields with active participation of people for further dissemination on "see and adopt basis". It was found that farmers are adopting such technologies in different areas (Fig. 22).

3. After providing training on various aspects, regular monitoring is being conducted to document feedback and to overcome any problem that the farmers face later on. To create and maintain awareness and interest of the villagers, technical guidance and material are continuously provided to them.

Fig. 22. Demonstration of polyhouse cultivation in a selected village

Table15. Training and Capacity Building (2001-2003)

Trainees	Total	Male	Female
Training of Trainers	70	55	15
Farmers of selected villages	333	76	257
Farmers selected by NGOs	953	330	623
Farmers selected by Govt. organizations	647	479	168
Students	1835	883	952
Army persons	27	25	02
Total	3865	1848	2017

3.5.12. Characterization and Improvement of Tea Through Biotechnological Tools

Background

India occupies a prestigious place in the world map of tea industry. There has been a quantum jump in production from 419 million kg in 1970 to 860 million kg in 1998. The production for the year 2005 AD has been targeted at 1000 million kg. At present there is hardly any additional land for tea cultivation and therefore any increase in crop production has to come necessarily from rapid improvement in the field of research through technological innovations combined with developmental activities. There is, thus, an urgent need to develop high yielding clones with superior quality and stress tolerance, and also to understand some of the physiological and biochemical parameters which may help in improving yield of existing plantations. In this context biotechnology assumes great significance.

Objectives

1. Complete characterization of existing clones using physiological, biochemical and molecular tools

2. Standardization of technology for *in vitro* propagation and field establishment of superior clones

3. Development and testing of complete package of microbial inoculants including VAM

Results and Achievements

1. A simple method of physiological assessment for early selection of tea clones using CO_2 uptake and chlorophyll fluorescence has been developed. Photosynthetic CO_2 uptake photochemical efficiency of photosystem II (Fv/Fm ratio) and shoot growth were recorded in several tea clones, originally from different agroclimatic zones of India to determine the suitability of using photosynthetic CO_2 uptake and Fv/Fm ratio as selection criteria.

2. A complete *in vitro* propagation protocol was developed using explants taken from local chinery bushes for large scale multiplication. Plant regeneration through somatic embryogenesis was developed following culture of immature cotyledons in MS medium supplemented with 5.0 µM BAP+ 1.0 µM NAA + 0.5 µM GA_3.

3. The above method is being used for mass multiplication of three identified superior clones, namely, (i) B/6/61 (UPASI-9), China hybrid, (ii) B/5/63 (UPASI-3) Sundaram, Assam hybrid, Triploid, and (iii) 6017 (Craigmore), China hybrid.

3.6. INSTITUTIONAL NETWORKING AND HUMAN INVESTMENT

Networking of the existing institutional infrastructure in the Himalayan region is critical for optimal use of the available scientific talent. Through Integrated Ecodevelopment Research Programme (IERP) of the Institute the infrastructure, expertise and scientific manpower available in the IHR are being complemented effectively. This programme is also complementing/achieving the mandate of the Institute and helping in the fulfillment of its broad objectives. Furthermore, this programme supports Institute's role as a facilitator of R&D programmes in the IHR as well as in establishing institutional linkages. During the year 2002-2003, 26 new projects were sanctioned and funded to various Organizations/Institutions/ Universities (for the execution of location-specific R&D activities in the states of J&K, H.P., U.A., Assam and Nagaland) under the IERP. Almost 77 projects were on going in 11 states of the IHR under the above-mentioned programme. Eighty two new books were added and one hundred and thirty two (132) periodicals (80 international and 52 national) were subscribed in the library during the year. Environmental awareness was created among various identified target groups by organizing on-site training programme. Besides this, one R&D project entitled " *Study of nutrient dynamics in traditional mixed cropping system*" was also completed successfully during the year.

3.6.1. Integrated Eco-development Research Programme (IERP) in the Himalayan Region

Based on the recommendations of the Project Evaluation Committee (PEC), following twenty six projects were sanctioned and funded during the year 2002-2003.

1. Studies on threatening root rot disease of *Cedrus deodara* by Dr. Lal Singh, Himalayan Research Group, Chotta Shimla, Himachal Pradesh. [Total outlay: Rs. 4,33,080/-].

2. Enhancing water yield in springs through recharge zone treatment in Deota Dhara micro-watershed (Jaunsar-Bhawar), Dehradun by Dr. D. Sati, En Net Development Society, Ballupur, Dehradun, Uttaranchal. [Total outlay :Rs. 5,42,800/-].

3. Mathematical modeling and functional analysis of village ecosystem with special reference to Kumaun Himalaya by Dr. H.S. Dhami, Department of Mathematics, Kumaun Univ. Almora Campus, Almora, Uttaranchal. [Total outlay : Rs. 4,00,000/].

4. Paramparagat vaidhyon dwara jari-booti ka sambardhan, sanrakshan evam vikas by Mr. H.S. Negi, Uttaranchal Yuva evam Gramin Vikas Kendra, Narayanbagarh, Chamoli Garhwal, Uttaranchal. [Total outlay : Rs. 2,00,000/-].

5. Traditional knowledge based system in practice surrounding sacred groves in Pithoragarh district in Kumaon Himalayas by Mr. C.S. Negi, Department of Zoology, Govt. P.G. College, Pithoragarh, Uttaranchal. [Total outlay : Rs. 2,89,900/-].

6. Application of facilitative role of plants to hasten recovery of degraded, eroded and unstable hill slopes by Dr. S.P. Singh, Department of Botany, Kumaun University, Nainital, Uttaranchal. [Total outlay : Rs. 5,87,240/-].

7. Accumulation of persistent organochlorine compounds in sub-Himalayan region of North India by Dr. V.K. Dua, Malaria Research Centre – Field Station, Ranipur, Hardwar, Uttaranchal. [Total outlay : Rs. 4,99,200/-].

8. Aausadhiya paudhon ka pradarshan model vikas kar janhit mei prasar karna by Mr. D.S. Panwar, Pawan Shiksha Evam Jan Utthan Samiti, Kheti, Chamoli Garhwal, Uttaranchal [Total outlay :Rs. 3,99,800/-].

9. Garhwal Himalaya mein ecotourism sansadhanon ka vishleshan evam samudayik sahbhagita by Mr. Pushkar Singh, Himalayan Foundation, Sartoli, Bagana-Nandprayag, Chamoli Garhwal, Uttaranchal. [Total outlay: Rs. 3,07,000/-].

10. Micropropagation and conservation of *Terminalia chebula* Retz. – a medicinal tree by Dr. A. K. Wakhlu, Department of Botany, University of Jammu, Jammu, J&K. [Total outlay : Rs. 4,95,280/-].

11. Assessment of anthropogenic impact on Kashmir Himalayan pastures and their sustainable management by Dr. Zafar A. Reshi, Department of Botany, University of Kashmir, Srinagar, J&K. [Total outlay : Rs. 3,49,600/-].

12. Investigations on the mycotoxicity of some important herbal drug plants of Jammu and Kashmir State by Dr. Geeta Sumbali, Department of Botany, University of Jammu, Jammu, J&K. [Total outlay : Rs. 4,49,200/-].

13. Exploration, evaluation and conservation of bryodiversity of Patnitop and its adjoining areas by Dr. Anima Langer, Department of Botany, University of Jammu, Jammu, J&K. [Total outlay : Rs. 2,50,000/-].

14. Conservation and propagation of traditional herbs of Jammu (J&K) by Dr. Shashikant, Department of Botany, University of Jammu, Jammu, J&K [Total outlay : Rs. 4,49,200/-].

15. Micro-zonation of slope instability using SMR approach – A case study along Rishikesh–Gangotri road (from Chinyalisaur to Uttarkashi),

Bhagirathi valley, Uttaranchal Himalaya by Dr. H.C. Nainwal, Department of Geology, HNB Garhwal University, Srinagar, Uttaranchal. [Total outlay : Rs. 5,34,400/-].

16. Sustainability of rural economy through a package of small scale fish farming integration with reference to economically backward classes by Dr. M.M. Goswami, Department of Zoology, Gauhati University, Guwahati, Assam. [Total outlay : Rs. 4,73,500/-].

17. Studies on diversity in traditionally fermented foods of Assam state and their microbiological nutritional and safety characteristics by Dr. Manab Deka, Department of Biotechnology, Guwahati University, Guwahati, Assam.[Total outlay : Rs. 5,58,095/-].

18. Conservation of productive land and promising flora of Majuli island in Brahmaputra river by Dr. B.K. Pandey, Rain Forest Research Institute, Deovan, Jorhat, Assam. [Total outlay : Rs. 5,31,070/-].

19. Biology and application of mycorrhizae in wastelands of Nagaland by Dr. (Mrs.) Talijungla, Department of Botany, Nagaland University, Lumami, Mokochung, Nagaland. [Total outlay : Rs. 5,48,550/-].

20. Assessment of biological diversity of various ecosystem and to establish methods for conservation in the Kaziranga National Park of Assam by Mr. P.K. Khatri, Department of Forest Ecology, Rain Forest Research Institute, Deovan, Jorhat, Assam. [Total outlay : Rs. 4,99,330/-].

21. Contribution of N_2 fixing plants on improvement of abandoned fallow in shifting cultivation by Dr. Jasbir Singh, Department of Shifting Cultivation Division, Rain Forest Research Institute, Deovan, Jorhat, Assam. [Total outlay : Rs. 4,98,180/-].

22. Commercially important medicinal and aromatic plants of Uttaranchal Himalaya: Their active constituents and activity by Dr. G.C. Shah, Department of Chemistry, S.S.J. Campus – Almora, Kumaun University, Almora, Uttaranchal. [Total outlay : Rs. 4,25,730/-].

23. Spread and impact of *Eupatorium adenophorum* on native flora under middle conditions of Himachal Pradesh by Dr. G.L. Bansal, Department of Biodiversity Centre, CSK H.P. Krishi Vishvavidyalaya, Palampur, Himachal Pradesh. [Total outlay : Rs. 4,99,744/-].

24. Identification and chemical exploration of plants of Garhwal Himalayas as natural pesticides by Dr. M.S.M. Rawat, Department of Chemistry, HNB Garhwal University, Srinagar, Uttaranchal. [Total outlay : Rs. 5,49,200/-].

25. Community awareness and participation in management of water resources in Shimla and Solan districts of Himachal Pradesh by Ms. Vandana Thapliyal, WWF-India (North Region), Khalini, Shimla, Himachal Pradesh. [Total outlay : Rs. 3,49,600/-].

26. *Janpad Rudraprayag ke vikashkhand Jakholi main swarojgar hetu mashroom utpadan taknikee pradarshan evam prasar ke madhyam se nirbal barg ke gramino ko prerit karna* by Mr. R. Kandwal, Gramin Sudhar Evam Shramik Sewa Sanstha, Budana, Rudraprayag, Uttaranchal. [Total outlay: Rs. 3,00,000/-].

In addition to the above, following activities were also carried out.

1. Twenty three fresh project proposals were obtained during the year and screened by the subject experts. Funds for 23 ongoing/completed projects and first installment for 26 newly sanctioned projects were also released during the year.

2. Annual Progress Reports (APRs) of 16 on-going projects were processed for evaluation and referred to the subject experts. Subsequently, the comments of the subject experts on the APRs were also communicated to the concerned PIs for follow-up action.

3. Final Technical Reports (FTRs) of 13 completed IERP projects, received by the Institute during the year, were mailed to the various Organizations/ Institutions/ Departments etc. for follow-up action on the recommendations of the project and also to the subject experts for their comments/ suggestions.

4. Executive summary of 15 completed projects were published by the Institute in its ENVIS Bulletin [No. 10(1), 2002 and 10(2), 2002]. Both the issues of the Bulletin were also distributed to various organizations/user agencies by the ENVIS Centre of the Institute.

5. Twelfth meeting of the Project Evaluation Committee (PEC) was organized/convened at the Institute HQs Almora on 12-13 March 2003 mainly for the finalization of almost 30 pending project proposals. Eight members (including two special invitees) attended the above-mentioned meeting of the PEC. Follow-up action on the decisions of the 11th PEC meeting was completed during the year and on the recommendations of the 12th PEC meeting it has been initiated (Fig. 23).

6. Follow-up action on almost 123 project files (old/fresh/on-going/miscellaneous etc.) was initiated/completed during the year and financial targets set for IERP for the financial year 2002-2003 (total available grant – Rs. 65.12 lakh) were also achieved.

Fig. 23. PEC meeting (12th) at GBPIHED, Kosi-Katarmal, Almora, U.A.

3.6.2. Environmental Awareness and Training Programmes

The main aim of this programme is to create environmental awareness (through on-site training programmes) among identified target groups. During this year, a three day on-site training programme (eleventh of its kind) on nursery development, tree plantation techniques, natural resource conservation and management, and low-cost farm based techniques was organized in collaboration with NIDHI (a NGO) at village

Fig. 24. Training programme at Kharkini village in Pithoragarh

Kharkini in Pithoragarh district of Uttaranchal during 24 to 26 February 2003. The target groups included rural women, farmers, ex-service army personnel, school children, teachers, representatives of village/forest panchayats, self help groups and Mahila Mangal Dals etc. Sixty nine local participants attended this short-term on-site training programme. The participants were trained successfully by the staff of PARDYP/INHI/LWRM Core of the Institute. Mr. Prakash Pant, Hon'ble former Speaker, Uttaranchal Assembly, Govt. of Uttaranchal, concluded the programme, which was considered successful in terms of dissemination of low-cost tested technologies, scientific knowledge and developing close linkages with the village communities (Fig. 24).

3.6.3. Strengthening and Maintenance of Central Library at the Headquarters

The Central library of the Institute at its headquarters is well furnished with significant collection of old, rare and latest books as well as journals, and equipped with Network Computer Systems. For the management of Central Library of the Institute, a network version of the software package PALMS was developed earlier by the Institute and by the use of this software package, the library of the Institute is providing many services namely, Article Alert, Current Awareness (CAS), Selective Dissemination of Information (SDI), Reprographic, Referencing and Indexing, Abstracting and Bibliographic, etc. for the development of human resource.

During the year 2002-2003, the central library of the Institute was maintained and strengthened properly at its headquarters. All the databases in the library were also updated in the computer by using network version of two software packages - PALMS and CAS. Eighty two (82) new books were added and 132 periodicals (80 international and 52 national) were subscribed in the library on the recommendations of the library committee of the Institute. The total expenditure on the purchase of the books and subscription of periodicals during the year was Rs. 40,02,198/- Year wise volumes of the research papers, popular articles and books published by the faculty of the Institute were also compiled during the year.

3.6.4. Dissemination of Information Through Networking

The main aim of this activity is to disseminate research and development (R&D) inputs of the Institute, through its regular in-house publications [namely, *Hima-Paryavaran* (a biannual newsletter) and Institute *Annual Report*], to various academic scientific/Govt. departments, NGOs and individuals working on various aspects of mountain environment and development. During the year 2002-2003, two volumes of *Hima-Paryavaran* [12(2), 2000/13(1&2), 2001] were distributed to almost 600 individuals/subject experts working at various academic and scientific institutions etc. Copies of Institute's *Annual Reports* (2000-2001/2001-2002) were also distributed to almost 950 individuals/subject experts. Besides above, Institute's folders/leaflets and other publications were also distributed to almost 1,240 individuals on the occasion of various workshops, meetings and seminars etc.

3.6.5. Study of Nutrient Dynamics in Traditional Mixed Cropping System

(Summary of the completed project)

Background

In much of the central Himalayan region knowledge about agricultural practices, soil properties and fertility levels is based on limited information that has been widely extrapolated. These generalizations can be misleading and provide little useful information to the farmers particularly in heterogeneous mountain landscapes. Soil data for specific fields and an understanding of the existing traditional agricultural systems in relation to nutrient dynamics is necessary to ensure efficient use of resources and calibration of soil fertility indices to help farmers maximize their returns on labour and other inputs. *Baranaaja* is a mixed cropping pattern practiced in the central Himalayan region. It involves cultivation of less than twelve or twelve and sometimes more than twelve food crops in synergetic combinations. This system is useful in meeting food requirements and preserving agrobiodiversity in the region and needs to be sustained as it is an example of 'conservation agriculture'. Despite the

importance of plant nitrogen acquisition to agricultural productivity, fundamental information about plant nitrogen relations for this system is meager. In view of above, a study was undertaken mainly to evaluate the N transformation rates, fluctuations in nitrifier population and microbial biomass with two major crops paddy and wheat when cultivated as sole and as mixed crops with foxtail millet and lentil, respectively.

Objectives

1. Evaluation of soil nutrient dynamics in plots planted to different crop combinations especially in relation to carbon and nitrogen status and other physico-chemical properties

2. Estimation of microbial biomass C, N, P and nitrifying bacterial population dynamics during the cropping season

3. To study phenology, allometrics and intensity of weed infestation in the mixed cropping system

Results and Achievements

1. Conversion of protected grassland to cultivated land resulted in significant increase in rates of N–mineralization, nitrification, ammonium and nitrite oxidizer population. The mineral –N pool in the cultivated soil remained significantly higher in comparison to adjacent grassland but ammonium–N was the major fraction hence N losses due to denitrification and/or leaching from the cultivated plots may not be significant.

2. Differences in rates of N–mineralization, nitrification and nitrifier bacterial population in mixed crop combinations and sole cropping demonstrated species specific controls on soil nitrogen dynamics. The microbial biomass and mineral –N fraction in soil declined as N– mineralization increased during vigorous plant growth period indicating N immobilized in microbes is an important source of N during the cropping period. The microbial biomass was lowest in the plots under mixed cropping than in sole cropped plots probably due to competition with plants for nutrients.

3. Total grain yield and biomass production was greater in the mixed crops than in the sole cropped plots. LER (Land Equivalent Ratio) based on dry matter production was always greater than 1, indicating that plant growth factors were used more efficiently by the mixed crops than by the sole crops. The paddy, foxtail millet and wheat lentil mixed cropping were found promising for food production with limited use of external inputs in comparison to sole cropping. Synchronization of microbial net N mineralization–immobilization and crop demand, which is central to any improvement in nutrient conservation in agroecosystems, was most evident under the mixed treatments than in sole cropping systems.

4. Twelve species of weeds belonging to nine genera and six families were identified during the kharif-cropping period. The mixed crop combination showed significantly lower weed infestation than the sole cropped plots.

3.7. INDIGENOUS KNOWLEDGE SYSTEMS

Mountain cultural heritage and traditional knowledge systems play a significant role in sustainable use, management and conservation of resources. Restrengthening of culture and indigenous knowledge base leads to an enhanced conservation practices in accordance with their immediate environment. Integration of indigenous knowledge with modern scientific knowledge and techniques is possible but it requires sound understanding and careful analysis of the two systems of knowledge. Value addition and validation of indigenous and traditional knowledge can create potential for enterprises, which in turn can lead to economic upliftment of the local people. To address these issues, the IKS Core has initiated documentation and the analyses of indigenous knowledge and management practices of high altitude societies, and analyses of indigenous agricultural practices in the light of their efficiency and sustainability. This integration will be an appropriate approach for sustainable development of Himalayan societies.

3.7.1. Documentation and Analyses of Indigenous Knowledge and Management Practices of High Altitude Societies

Background

The high altitude Himalayan region is characterized by diverse ethnic groups, which have developed their own cultures based on the available natural resources thus giving rise to a wealth of cultural diversity at par with the high level of biological diversity found in the region. The preparation and use of fermented food and beverages using local food crops and other biological resources is very common amongst the high land societies of the Himalaya, though the name of the products and the base material vary from region to region. The indigenous knowledge of fermented foods and making, of beverages in the high altitude regions of Kumaun Himalaya is an age-old practice and is well developed to meet the local requirement. The traditional method of Bhotiya food fermentation and beverage making has been devised in such a way, that it utilizes only those available crops, which do not constitute their staple food.

Objectives

1. Documentation of indigenous methods of preparing fermented food and beverages
2. Scientific analysis of various indigenous practices
3. Identification of possible options for value addition to their product

Results and Achievements

1. The traditional alcoholic drink called d*aru* is the distilled liquor containing ethyl alcohol in a much higher concentration as compared to other alcoholic beverages. Rice and jaggery are the common substrates used for preparation of *daru*. Apart from rice, cereals like koni (*Setaria italica*), chuwa (*Amaranthus spp.*), oowa (*Hordeum himalayans*) and wheat (*Troiticum aestivum*) are also used in the preparation of *daru*.

2. For prapering Daru cooked rice is mixed with the powder of *balam*.The proportion of *balam* powder required in the preparation of *daru* is much more higher than that required in *jann* (traditional soft drink) preparation (Table 16). This mixture is then kept in an airtight container for fermentation preferably kept in a comparitevirly warm place in the house . After about a week of fermentation, when the mixture is in a semi liquid state, it is distilled a distillation vessel. The distillate is the *daru*. The undigested white residue is called *chak* and can again be used for the preparation of *daru* by fortification with jaggary and fresh *balam* powder. *chak* can thus be recycled or reused in *daru* preparation. However, chate can not be used more than three times, and there after used as animal food .

3. The traditional of method distillation is still practiced in this region The indigenous set, which is quite simple, has three parts *parar, jokhal* and *tal*, as they are called in the local dialect (Fig. 25). The *parar* is a big saucepan like container with a flat bottom, and the *jokhal* is a flat wooden device like a dish having an elongated channel with a hole at the center. The *tal* is a simple cooking vessel, but

Fig. 25. The improvised method in a traditional distillation

Table 16. Comparative fermentation process of *daru* and *jann*

Characteristics	Jann	Daru
Optimum temperature	Room temperature 10° C– 15° C	30° C to 40° C
Fermentation nature	Anaerobic	Anaerobic
Fermentation container	Porous earthen ware	Non porous metallic ware
Fermentation rate	Slow fermentation is preferred (6-10 months)	Rapid fermentation; completed within 2 to 3 days
Taste	Vary according to the substrate used.	Constant irrespective of substrate used.
Yield	Ethyl alcohol <10% plus carbohydrate, amino acid, vitamins, etc., depending upon the substrate used.	Ethyl alcohol invariably to the quality of the substrate used.

the neck of the *tal* and the bottom of the *para are* of such demensions size that they can hold the *jokhal* perfectly. This whole system is kept on the fire. On being heated the alcoholic vapoar first evaporates and comes out through the central hole of the *jokhal*. But as soon as in contact with the cold bottom of *parar* the vapoar condenses into liquid. This liquid is collected in a container, and this distillate is the alcohol.

4. Traditionally *daru* is graded into three categories.The daru in the initial few bottles containing a high percentage of alcohol is called *pailefal*; the daru in the final few bottles containing very low contents of alcohol is called *piskani*, and the daru in the few bottles in between them containing moderate contents of alcohol is rated good for consumption. For making the *daru* attractive in appearance, a small quantity of turmeric is suspended at the very mouth of the distillation set through which the distillate is collected. This makes the colour of the beverage a light but brilliantly shining yellow.

3.7.2. Analysis of Indigenous Agricultural Practices in the Light of its Efficiency and Sustainability

Background

Himalayan agriculture is mostly characterized by predominance of rainfed conditions, subsistence economy, and dependence on natural resources for viability. Under these circumstances, varied topography and the climate, various local methods and techniques have been evolved in the agricultural practices to meet the area-specific and season- specific need. These indigenous practices have tuaditionally been continuing in the fields. The Documentation of these practices is important to save Intellectual Property Right (IPR) of the mountain farmers, and for most of the practices scientific rationale have not been explored.

Objectives

1. Documentation and scientific analysis of various traditional agricultural practices

2. Documentation of various landraces of traditional crops and their role in agricultural system

Results and Achievements

1. To leave the cropfields fallow for winter season is an age-old practice for soil fertility replenishment. During the fallow period a number of weeds come up in the crop fields. Diversity index (H') of the weed community was found highest (0.204) at the start of fallow period but it declined in the winter (Fig. 26). H'again increased at the transition phase and declined towards the end of the fallow period.

2. In the Munsyari area among the food grain crops 38 different landraces of paddy are in cultivation along with 7 landraces of wheat, 6 landraces of finger-millet, 5 landraces of barley, 4 landraces of naked barley, 3 landraces of maize and at least 2 land races each for *koni*, *chenna* and *chua*.

3. People having large landholdings but less manpower manage the time availability for agricultural activities through cultivation of selected landraces of a crop.

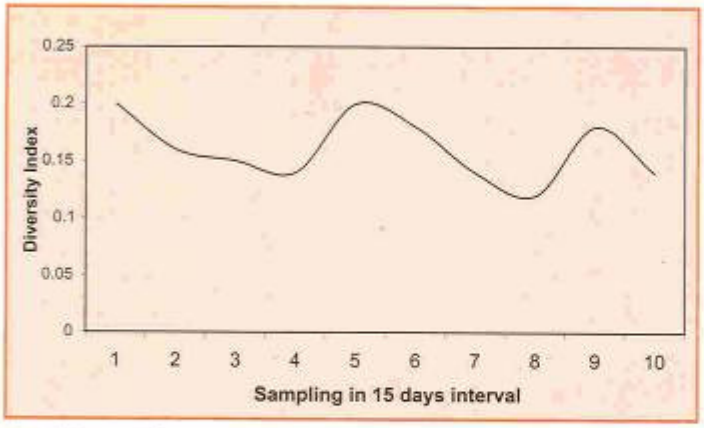


Fig. 26. Patterns of community diversity (biomass and density based) along the length of fallow period

There is a difference of about 15 days in crop maturation period of two local landraces of paddy. Farmers cultivate these two landraces to manage the limited manpower in crop harvesting activities.

3.7.3. Indigenous Knowledge and Uses of Medicinal Plants by Vaidyas in Uttaranchal Himalaya

Background

The centuries old traditional knowledge of therapy attained over the years threrogh experiments and experiences has sharply declined since the advent of modern allopathic drugs. This decline has resulted in the loss of knowledge on the use of many important plant species and techniques of preparing various medical formulations. A need was felt to document the knowledge on traditional therapy. Structured questionnaire survey was conducted among traditional *Vaidyas* of Uttaranchal state mainly on the use of medicinal plants and preparation of various medicinal formulations.

Objectives

1. Documentation of various formulations and ingredients used to prepare traditional medicine by *Vaidya*
2. To validate the efficacy of selected formulations with the help of *Vaidya*

Results and achievements

1. A total of 104 formulations, prepared by different traditional *Vaidyas*, have been documented. These formulations were used in curing 50 different ailments. The highest numbers of formulations documented were for curing cough and cold, followed by skin diseases, dysentery, and toothache.
2. A sharp decline in the number of recognized *Vaidyas* through generation has taken place. Of the 56 *Vaidya* interviewed 6 were young (16-25 years), 14 were adult (26-45 years) and 26 were old (>46 years). Of the interviewed *Vaidya* 37% had disciples to carry forward this traditional knowledge.
3. Among the various groups of ailments, the highest numbers of medicinal plants were used in curing general health problems and as hair tonic, followed by gastrointestinal disorders, general bodyache, skin diseases, respiratory disorders and reproductive disorders (Table 17).

Table 17. Number of plant species used in the cure for various classes of indigenous ailments

Group of ailments	# of medicinal plant used by *Vaidya*
Hair and health tonic	27
Gastrointestinal disorders	24
General bodyache	19
Skin diseases	16
Respiratory disorders	16
Reproductive disorders	11
Eye diseases	5
Mental/psychological disorders	8
Blood related ailments	8
Bone diseases	5
Others	7

3.7.4. Biodiversity Characterization in Munsyari with Special Emphasis to Bioprospecting

Background

A national project was launched by Department of Space and Department of Biotechnology, Govt. of India on Biodiversity characterization at Landscape level using RS & GIS in three regions of the country. The mapping scale was 1:250,000 for this activity. In the extended phase sites have been identified to carry detailed studies on finer scale (at 1:50,000).An total of 15 sites have been identified in India and due to rich traditional knowledge and high agrobio-diversity, the high altitude area of Munsyari (Distt. Pithoragarh) is one of them.

Objectives

1. Exploration of agrobiodiversity, landraces and natural ecosystems

Results and Achievements

1. Human induced modifications are confined to only 13% of the total area of the watershed and remaining 87% area is represented by natural habitats. Croplands account for 165.26 ha, however, fallow crop fields and barren land were spread in 456.86 ha (3.2%) of the area. In an area of about 1047 ha trees dominated crop fields are present and village woodlands are present in 190.65 ha of the total land.

2. Natural vegetation of the watershed dominates in 64% of the total area under natural landscape. Preponderance of temperate forest (49% of the total area) was observed. Alpine meadows (620.79 ha) in the high altitudes is a noticeable feature of the watershed. Other vegetation type are *Betula* mixed *Rhododendron* forest (1.3%), grasslands (50 ha), *Banj* oak forests (1.4%), *Alnus* mixed forests (283.65 ha). A detailed exploration of different vegetation types of the watershed enumerates 45 different trees species occur in the natural vegetation (Fig. 27). Total number of shrubs, herbs, grasses, and climber recorded in the natural vegetation was 22, 97, 22, and 1, respectively.

3. A large diversity in the agriculture crops was observed in the watershed as apparent from 11 food grain crops (cereals and millets), 10 different pulses, 3 oil seed crops including *Tegetes minuta* (medicinal crop), and potato. Besides these agricultural crops a number of other crops (21 vegetables and 4 spices) are also grown.

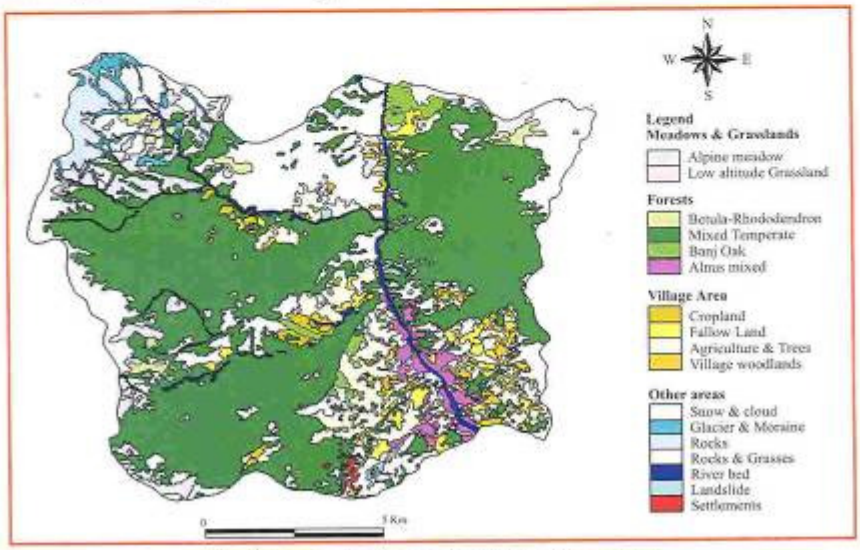


Fig. 27. Landuse/Landcover Map of Munsyari watershed

4. MISCELLANEOUS ITEMS

4.1. Membership of Professional Societies/Committees

Member, Executive Committee, Indian Society of Ecological Economics (U. Dhar)

Member, Steering Committee on "State of Environment Reporting" Uttaranchal (U. Dhar)

Life Member, the Indian Society for Ecological Economics, Delhi. (P.P.Dhyani).

Member, Steering Committee for "Conservation, Assessment and Management Prioritization (CAMP) of Medicinal Plant and Their Sustainable Utilization in Arunachal Pradesh", coordinated by FRLHT Bangalore and SFRI, Itanagar (R.C. Sundriyal).

Member, Executive Committee, State Council of Science and Technology for Sikkim, Department of Science and Technology, Govt. of Sikkim (A.P. Krishna)

Member, International Society for Tropical Ecology, Varanasi. (P. Ghosh).

Member, Indian Science Congress Association, Kolkata. (P. Ghosh).

Life Member The Indian Botanical Society (S.S. Samant)

Member, Sikkim Science Society, Gangtok, Sikkim (S. Sharma)

Life Member, Indian Society for Remote Sensing, New Delhi (S. Sharma)

Life Member, Indian Society of Agricultural Engineers (D.K. Agrawal)

Life Member, Indian Water Resources Society (D.K. Agrawal)

Life Member, National Institute of Ecology, New Delhi (G. C. S. Negi)

Life member, Indian Society for Ecological Economics (P.K. Samal)

Member, National Geographic Society (Kireet Kumar)

Life Member, International Association of Hydrological Sciences, UK. (B. P. Kothyari)

Life member, Indian Association of Soil & Water Conservationists (B. P. Kothyari)

Member, Indian Association of Soil & Water Conservationists (B. K. Joshi and P. K. Verma)

Life Member, Indian Society of Ecological Economics, New Delhi (R.K. Maikhuri)

Life Member, People's Association for Himalaya Area Research, Nainital (S.C. Joshi)

Life Member, Prof. H. S. Srivastava Foundation for Science & Society (S. K. Nandi).

Life member, People's Association for Himalaya Area Research (S. C. Joshi, H. C. Rikhari).

Member, Society of Economic Botany, Lawrence, KS, U.S.A. (H.K. Badola)

Member, Society for Environmental Communications, New Delhi (H.K. Badola, J.C. Kuniyal)

Life Member, National Association of Geographers of India (NAGI), New Delhi (J.C. Kuniyal)

Member, International Society for Tropical Ecology (SCR Vishvakarma)

Life Member, Indian Geological Congress (A.P. Krishna)

Member, East-West Centre Association, Hawaii, USA (A.P. Krishna)

Life Member, Society of Plant Physiology & Biochemistry, India (K.K. Singh)

Member, Project Technical Advisory Committee, INHERE and ICEF, New Delhi (G.C.S. Negi)

Member, International Association for Landscape Ecology (S. Sharma)

4.2. Award/Honour

Fellow, (LEAD International) Leadership for Environment and Development, UK (Kireet Kumar)

Young Scientist Special Certificate of Commendation (2001) by the Global Change System for Analysis, Research and Training, Washington DC, USA (R.K. Maikhuri)

Er. S.N. Mishra Award (2002) given by the Association of Resource Persons Aid in Need (ARPAN), Kurukshetra (R.K. Maikhuri)

4.3. Scientific Papers

(I) Scientific Journals

Agrawal, D.K., P.K. Samal, N.A. Farooquee and L.M.S. Palni (2003). People's perception about

participatory developmental programmes: Lessons from the Mountain Risk Engineering Program in the Indian Central Himalaya. *The Environmentalist* 23 (1): 39-47.

Badola, H.K. and **M. Pal** (2002). Endangered medicinal plant species in Himachal Pradesh. *Current Science* 83: 797-798.

Badola, H.K. and **M. Pal** (2003). Threatened medicinal plants and their conservation in Himachal Himalaya. *Indian Forester* 129: 55-68.

Chandra, S. and **S. C. Joshi** (2002). Diurnal and seasonal variation in CO_2 levels in the surface air of Garhwal Himalaya. *Indian Journal of Forestry* 25: 205-208.

Chandra, S. and **S.C. Joshi** (2002). Diurnal and seasonal variation in CO_2 levels in the surface air of Garhwal Himalaya. *Indian Journal of Forestry* 25: 205-208.

Chaudhury, D. and **R.C. Sundriyal** (2003). Factors contributing to marginalization of shifting cultivation in North-East India: micro-scale issues. *Outlook on Agriculture* 32: 41-55.

Dhar, U., R.S. Rawal, S. Airi, I.D. Bhatt and **S.S. Samant** (2002). Promoting outreach through conservation education programme-a case study from Indian Himalayan Region. *Current Science* 82(7): 808-814.

Dhar, U., S. Manjkhola, M. Joshi, A. Bhatt, A. Bisht and **M. Joshi** (2002). Current status and future strategy for development of medicinal plant sector in Uttaranchal, India. *Current Science* 83: 956-964.

Durgapal, A., **A. Pandey** and **L. M. S. Palni** (2002). Use of rhizosphere soil for improved establishment of conifers at nursery stage for application in plantation programmes. *Journal of Sustainable Forestry* 15(3): 57-73.

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4.4. Popular Articles

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4.5. Symposia/Conferences/ Training Courses/Workshops organized by the Institute

Training workshop on nursery development, plantation techniques and natural resource management & conservation organized at Aicholi (Pithoragarh), in collaboration with a NGO–NIDHI. February 24-26, 2002 (Convener: B. P. Kothyari).

International workshop "*Endangered medicinal plant species in Himachal Pradesh*", organized by GBPIHED, HP Unit, Kullu, H. P. March 18-19, 2002 (Convener: H.K. Badola).

Training to youths on "*Propagation/ multiplication Technology, Nursery Practices*" at Mohal-Kullu, H.P. April 18, 2002 (Convener: H.K. Badola).

Organized women farmer exchange visit to farmers' day at VPKAS, Hawalbag, Almora. April 20, 2002 (Convener: S.S. Bisht).

Meeting with the Forest Department officials at Joshimath. May 23, 2002 (Convener: S.S. Samant).

"A day with students" at GBPIHED, Kosi-Katarmal, Almora. June 5, 2002 (Convener : Kireet Kumar).

Organized "*National Workshop on Integrated Development of Mountain Watershed: Challenges & Options*" at Kausani. June 12–14, 2002 (Convener: B. P. Kothyari).

Farmers Training on "Sylvipasture development in mountain wastelands" at Dobh-Srikot village, Pauri-Garhwal. August 8, 2002 (Convener: G. C. S. Negi).

Training programme for school children of Patli, Deonai, Seema, Ratmatiya, Lawbanj and Kaulag. August 14-15, 2002 (Convener: S. K. Bhuchar).

Training Workshop organized on Counter Hedgerow Farming System Technology (CHFST) at GBPIHED, Itanagar and at Ziro, Arunachal Pradesh. August 18-22, 2002 and February 17-25, 2003 (Convener: T.C. Upreti and M. Dollo).

Training to villagers on "*Cultivation Technology of Medicinal Plants*", Village Shat-Kullu, H.P. August 28, 2002 (Convener: H.K. Badola).

Organized meeting of school teachers and villagers at Patli. September 3, 2002 (Convener: A. K. Mishra)

Training Programme on Science Motivation and Curiosity Interest in High School Standard (Science) Students of Garhwal Region at GBPIHED, Garhwal Unit, Srinagar Garhwal. September 2-6 and 22-27, 2002 (Convener: R.K. Maikhuri).

Delivered lecture to the of farmers and NGOs of North Cachar Hills Community resource management society (NCHCRMS). September 18, 2002 (Convener: S.C. Rai and D. Saha).

"Field training on "Application of SWEET" at Udyari, Almora. November 25, 2002 (Convener: Kireet Kumar).

Training Workshop IX on "Himalay Ki Jaiv Vividhata Sanrakshan Mei Janta Ki Bhagidari", GIC, Kanda, February 18-19, 2003. (Convener: U. Dhar)

Orientation Workshop I on "Himalay Ki Jaiv Vividhata Sanrakshan Mei Janta Ki Bhagidari", G.I.C. Majkhali, March 10-12, 2003 (Convener: U. Dhar)

Project Evaluation Committee (PEC) meeting under Integrated Ecodevelopment Research Programme of the Institute, Kosi-Katarmal, Almora, Uttaranchal, March 12-13, 2003 (Convener : P.P. Dhyani).

4.5.1. Participation in Symposia/ Conferences/training courses/ workshops

International workshop on "*Endangered Medicinal Plant Species in Himachal Pradesh*", organized by GBPIHED, HP Unit, Kullu H.P. March 18-19, 2002, (M.Pal, U. Dhar, S.C. Vishvakarma, J.C.

Kuniyal, N.A. Farooquee, S.Sharma and R.Joshi).

Meeting on National Strategy on Biodiversity Conservation and Action Plan (NBSAP) for Uttaranchal organized by Forest Deptt. Uttaranchal at Dehradun. April 14-15, 2002 (R.K. Maikhuri).

National Workshop on "*Evolving Sustainable Livestock Grazing Policy Guidelines & Practices in the Indian Himalaya*", held at Wildlife Institute of India, Dehradun. April 15-17, 2002 (M. Pal, N. A. Farooquee and G.C.S. Negi)

Short course on *'Air Quality: Monitoring, Modelling and Management'* at Nagpur, 17–19 April, 2002 (J.C. Kuniyal).

Meeting on Action Plan and Strategy for Medicinal Plants: Conservation, Cultivation and Utilization organized by Jaributi Sodh Evam Vikas Sansthan, Gopeshwar and WII, Dehradun. April 19-20, 2002 (R.K. Maikhuri).

Workshop on "*Farmers' Innovations in Different Shifting Cultivation Systems of the Eastern Himalayas*", organized by ICIMOD at North-Eastern Hill University, Shillong. April 23-25, 2002 (R.C. Sundriyal and S.C. Rai).

National Seminar on Education and Human Values organized by Dept. of Education, Dehradun at Haridwar, April 25, 2002 (R.K. Maikhuri).

National seminar on "*Women Environment & Sustainable Development: Strategy for Environmentally Sound and Participatory Rural Development in India*" at Nainital, April 28-30, 2002. (S. S. Bisht, B.S. Bisht, S.K. Bhuchar and A.K. Mishra).

Meeting on strategic plan of ICIMOD 2002–07 organized by Watershed Directorate, Govt. of Uttaranchal at Dehradun. April 30, 2002 (R.K. Maikhuri).

Training on apiculture and farm based livelihood at Defence Agricultural Research Laboratory, Pithoragarh. May 3 - 6, 2002 (G. S. Malwal).

Meeting on Sacred Mountain and Landscape organized by The Mountain Institute, USA at New Delhi, May 8, 2002 (R.K. Maikhuri).

Meeting on Documentation of Success Story on Nanda Devi Biosphere Reserve organized by UNESCO at New Delhi, May 10, 2002 (R.K. Maikhuri).

Bombay Natural History Society Bird Census Training Workshop, Gangtok. May 13-14, 2002 (S. Chhetri).

Training Course on Management of Forest Herbarium and Arboreta, Dehradun. May 13-17, 2002 (L.K. Rai).

Workshop on Natural Disaster and Mitigation organized by Dasholi Gram Swaraj Mandal (Gopeshwar), Space Applications Centre (Ahemdabad) and GBPIHED (Garhwal Unit) at Birhi, Chamoli, May 17-18, 2002 (R.K. Maikhuri).

International Geotechnical Conference on Instability-Planning and Management organized by Coastal Environment at Isle of Wight, Ventnor, United Kingdom. May 20-23, 2002 (V. Joshi).

IIIrd "Uttaranchal Medicinal Plants Grower's Workshop" held at INHERE Masi (Almora). May 25-26, 2002 (S.S. Samant).

Participated and presented paper in the National Workshop on "*Watershed Management Planning: Challenges and Options,*" organized by GBPIHED at Kausani, Almora. June 12-14, 2002 (P.P. Dhyani, K. Kumar, D.K. Agrawal, S.S. Samant, N.A. Farooquee, G.C.S. Negi).

Delivered lecture in the "Second University Grant Commission (UGC) Sponsored Refresher Course for College and University Teachers of North-East India in Geography", at Arunachal University, Doimukh. June 5-14, 2002 (S.C. Rai).

Delivered lecture in the training programme on "Planning and Management of Wasteland Development under Rural Development Programme", at Naharlagun, Itanagar. June 24-27, 2002 (S.C. Rai).

Training on ERDAS Imagine Image Processing, ESRI-India, Kolkata. June 24-28, 2002 (S. Kundu and S. Chhetri).

Training Programme on Medicinal Plant Cultivation and Conservation organized by Jaributi Sodh Sansthan, Gopeshwar. July 8-9, 2002 (R.K. Maikhuri).

Meeting on "*Issues and Options of Marginal Mountain Farms in Hindu-*

Kush Himalaya, held at ICIMOD, Kathmandu. July 8-10, 2002 (R.C. Sundriyal).

Consultation Workshop on Medicinal Plant of Arunachal Pradesh organized by State Medicinal Plant Board, Naharlagun, Itanagar. July 9, 2002 (T.C. Upreti, D. Saha, P. Deb, M. Dollo and K.I. Singh).

Workshop on Our Common Future: LEAD India in 2010 and How Sustainable is Our Development? organized by LEAD-India at New Delhi. August 4-6, 2002 (R.K. Maikhuri).

Inter Cohort meeting of LEAD at Delhi on "Rio +10 Sustainable development summit ". August 4–8, 2002 (Kireet Kumar).

Training programme on silvi-pastoral development for wasteland restoration in Western Himalaya organized by GBPIHED, Garhwal Unit at Dobh–Sirkot, Pauri-Garhwal. August 8, 2002 (S. C. Joshi).

Workshop on "*Equitable Natural Resource Management through Participatory Monitoring*", organised by Indian Network on Participatory Irrigation Management, New Delhi. August 21, 2002 (D.K. Agrawal and N. A. Farooquee).

Presented a paper on Impact of Air Pollution on Human Health During Kullu Dussehra, Northwestern Himalaya, India in "*National Conference on Impact of Environmental Pollution on Health: Problems and Solutions*" organised at New Delhi. August 29-30, 2002 (J.C. Kuniyal).

Training Programme on Science Motivation and Curiosity Interest in High School Standard (Science) Students of Garhwal Region organized by Garhwal Unit of GBPIHED, Srinagar. September 2-6 and 27-28, 2002 (R.K. Maikhuri, S.C. Joshi, V. Joshi, P. Prasad, Kusum Chauhan, L.S. Kandari).

Workshop on Bird Census organized by State Forest Research Institute, Arunachal Pradesh, Itanagar. September 2-3, 2002 (R.C. Sundriyal, M. Dollo, D. Saha, K.I. Singh, P. Deb and S. Chaudhry).

Resource Person in the WII-USFWS Collaborative project Terminal Workshop "*Identify potential areas of biodiversity conservation in the Indian Himalaya*", WII Dehradun. September 5-6, 2002 (R.S. Rawal).

PARDYP-III inception workshop at ICIMOD, Kathmandu. September 9-13, 2002 (B. P. Kothyari and S. K. Bhuchar).

Resource Person during meeting of Hon'ble Ministers, Ministry of Environment & Forest of Himalayan States, Darjeeling. September 19, 2002 (R.S. Rawal).

Training for Block Coordinators and Research Facilitators for Rudraprayag, Chamoli, Almora and Pauri Districts organized by National Institute of Administrative Research, Lal Bahadur Shashtri National Academy of Administration, Mussoorie. September 20-24, 2002 (V. Joshi).

Delivered invited lecture "Biodiversity problems in India" during training programme on ecological economics organized by Population Research Centre, HP University, Shimla. September 24, 2002 (U. Dhar).

Workshop on 'Exploration of Microbial Diversity: A Polyphasic approach' at MTCC, Institute of Microbial Technology, Chandigarh, September 30- October 12, 2002 (Anita Pandey).

Presented papers entitled 'Public Involvement in Environmental Assessment of Hydropower projects in the Beas valley' and 'Impact of Changing climate on Apple crop in Kullu valley' in "*International Seminar on Challenges and Options for the Sustainable Development of the Himalayas—Beyond 2002*", at Palampur. October 1-4, 2002 (J.C. Kuniyal).

Presented Paper in the Seminar on "Traditional Knowledge Systems" organized by Lok Vigyan Kendra, Almora and INHERE, Masi at Binsar, Almora. October 4-7, 2002 (S.S. Samant, N.A. Farooquee and G.C.S. Negi).

Delivered lecture in the Workshop "*Herbal Wealth of Uttaranchal - Potential and Prospects*" organized by the HESCO, Dehradun. October 9-10, 2002 (U. Dhar and R.K. Maikhuri).

Workshop on Role of Computer Technology in GIS Tools in Archeology organized by HNB Garhwal University, Srinagar, October 18, 2002 (R.K. Maikhuri).

Presented a paper entitled 'Solid Waste Management in the Himalayan towns and treks' in a National Seminar on "*Central*

Himalaya: Environment & Development", Srinagar-Garhwal. 21-30 October, 2002 (J.C. Kuniyal).

Attended orientation course on "GIS Application in Landslide Hazard Mitigation with Special Reference to North-East Region, at Wadia Institute of Himalayan Geology, Itanagar. October 21-31, 2002 (S.C. Rai and T.C. Upreti).

National Seminar on Central Himalayan Environment and Development: Problems and Prospects organized by HNB Garhwal University, Srinagar. October 23-24, 2002 (R.K. Maikhuri).

Training Programme on Medicinal Plant Cultivation and Conservation (IYM-2002) organized by GBPIHED and its Garhwal Unit, Srinagar at Durmi (Virhi Valley), Chamoli. October 22, 2002 (R.K. Maikhuri).

Workshop on Disaster Vulnerability Reduction in Uttaranchal organized by Disaster Mitigation and Management Centre, Dehra Dun. October 24, 2002 (V. Joshi).

Workshop on Landslide Hazard Zonation organized by NRSA and Disaster Mitigation and Management Centre, Dehra Dun. October 25, 2002 (V. Joshi).

International session of LEAD on "*Our future with or without Water - Sustainable management of common pool resources*" at Mexico. October 24- November 5, 2002 (Kireet Kumar).

Seminar on Destination Uttaranchal Tea at Academy of Administration, Nainital. October 29, 2002 (S. K. Nandi).

Delivered lecture to Trainees on "Paryavaran Evam Pradushan" at Regional Rural Development Institute Hawalbag, Almora. October 30, 2002 (S.S. Samant).

Presented a paper on 'Kullu-Manali Case Studies on Solid Waste Management' in a Workshop at Manali '*Solid Waste Management*' organised by State Council for Science, Technology & Environment, Shimla. October 31, 2002 (J.C. Kuniyal).

Participated as Resource Person in the Management for the " Professionalizing Protected Area Management for the 21 " century- A United Nations Foundations - UNESCO World Heritage Biodiversity Programme for India, organized by WII, Dehradun. November 1-2, 2002 (S.S. Samant).

Regional Workshop on "*Evolving Policies for Sustainable Livestock Grazing & Conservation Practices for Ladakh*" held at Leh, organised by Ladakh Autonomous Hill Development Council, IUCN, ICIMOD and WII, November 11-15, 2002 (N. A. Farooquee).

Regional workshop in "*University Education on Integrated Approaches to Mountain Natural Resource Management*", organized by UNESCO at North-Eastern Hill University, Shillong, November 11-16, 2002 (R.C. Sundriyal, S.C. Rai, R.S. Rawal and G.C.S. Negi).

Workshop-cum-training on medicinal and Aromatic plant cultivation and management for sustainable development in Arunachal Pradesh, Itanagar. November 18-19, 2002 (R. C. Sundriyal, T. C. Upreti, M. Sundriyal, P. Deb, and D. B. Shaha).

Judge in the State Level Science Exhibition Year 2002-2003 Uttaranchal, organized by D.I.O.S., Almora. November 13-15, 2002 (S.S. Samant).

Seminar on The Happy Children Movement organized by Shri Bhuvaneshwari Mahila Ashram, at Srinagar. November 14, 2002 (R.K. Maikhuri).

Workshop on "*Geodynamics of North-East Region With Special Reference to Arunachal Pradesh*" , organized by Government of Arunachal Pradesh and Wadia Institute of Himalayan Geology, Arunachal Unit, Itanagar. November 14-15, 2002 (S.C. Rai).

International Symposium on Mountain Farming organized by CECI, Canada at Mussoorie. November 19-21, 2002 (R.K. Maikhuri).

National Seminar on Natural Hazards: Its Geological Implications in Hilly Regions, Ranchi, Jharkhand. November 21-23, 2002 (A.P. Krishna).

Workshop for the formulation of project proposal on Nanda Devi Biosphere Reserve, organized by WII, Dehradun at Joshimath. November 23-24, 2002 (S.S. Samant).

Training Programme on Medicinal Plant Cultivation organized by

Jaributi Sodh Evam Vikas Sansthan, Gopeshwar. December 2, 2002 (R.K. Maikhuri).

Workshop on "*Developing Road Map on Natural Disaster Preparedness and Mitigation in N-E Region in India*", organized by Government of India and UNDP at Guwahati. December 6-7, 2002 (S.C. Rai).

Presented a paper on 'Environmental assessment of hydropower projects in the Beas valley of Himachal Pradesh: A local community perspective' *in* a National Workshop on "*Mountain Environment and Development: Potentials and Prospects*", organized by GBPIHED, Kosi-Katarmal, Almora. December 9-10, 2002 (J.C. Kuniyal).

Presented a paper entitled, "Use of Lantana mulch for soil and water conservation and soil fertility restoration in the mountain rainfed farming", in a National Workshop on "*Mountain Environment & Development: Potential & Prospects*", organized by GBPIHED, Kosi-Almora. December 9-10, 2002 (G. C. S. Negi).

Conference of the Association of Microbiologists of India at CCS Haryana Agricultural University, Haryana, December 11-13, 2002 (Bhasker Chaurasia).

Non-residential Technical Workshop on Roll Back of Seniority on promotion to SC/ST Government Servant as a Result of reservation/ Roster; CEMTASS, New Delhi. December 11-13, 2002 (P.P. Dhyani, K.K. Pande).

Regional Workshop on Wise Practices and Experimental Learning in the Conservation and Management of Himalayan Medicinal Plants at Kathmandu. December 15-20, 2002 (R.K. Maikhuri).

Planning workshop (PARDYP-III) at ICIMOD, Kathmandu. December 16-20, 2002 (B. P. Kothyari and S. K. Bhuchar).

As an expert in *State Level Inception workshop on Medicinal Plants Conservation and Sustainable Utilization Project*, Shimla, H.P. December 20, 2002 (H.K. Badola).

Presented Thematic Working Group- Wild Plant Diversity during Final Presentation Workshop of NBSAP, INSA, New Delhi. December 20-22, 2002 (U. Dhar).

Presented a paper entitled, "Vegetation and livestock grazing studies in an alpine meadow in the Central Himalaya" in "*International Symposium on Livestock Production System for Sustainable Food Security and Livelihood in Mountain Areas at* Pantnagar University. December 30-31, 2002 (G. C. S. Negi and H.C. Rikhari).

Presented paper in the Plant sciences symposium at the 90th Session of Indian Science Congress 2003 at Bangalore University. January 3-7, 2003 (P. Ghosh).

Sacred Values and Conservation: An Action Planning Workshop, TMI, USA; New Delhi, 8 January 2003. (P.P. Dhyani, N.A. Farooquee, R.K. Maikhuri, V. Joshi, M. Pal).

Delivered a guest lecture during Management & Development Programme on "*Management strategies for conservation, cultivation and utilizations of medicinal plants*", IIFM Bhopal. January 13-17, 2003 (R.S. Rawal).

Delivered lectures on "Status and indigenous uses of medicinal plants and prioritization for cultivation", and "Trade/marketing of Medicinal Plants" at Forest Training Institute, Haldwani. January 23-24, 2003 (S.S. Samant).

Participated as Resource Person in the meeting "Assessment of threat status of medicinal plants in the NW Himalaya" organized by MoE&F at WII Dehradun. January 31, 2003 (U. Dhar).

Foundation Course/Technical Workshop on Financial Management in Central Autonomous Bodies, Government Departments and PSUs; CTSR, New Delhi. January 9-11, 2003 (P.P. Dhyani and Surya Kant).

Residential Programme on Developing Leadership Skills, NPC-New Delhi, Goa. January 13-17, 2003 (P.P. Dhyani).

Training on Vermicomposting organized by Arunachal Pradesh Sewa Sangh at Doimukh (Midhpu). January 27-30, 2003 (T.C. Upreti, M. Sundriyal and M. Tiwari).

Paper presented in "Global change impact assessment for Himalayan mountain regions- a case study from India (Alaknanda valley)" in Seminar on "*Global Change Impact Assessment for Himalayan Mountain Regions*" organized by Institute for Development & Innovation, Kathmandu. January 9-12, 2003 (V. Joshi).

Training on Sloping Land Agricultural Technology for NGOs and Farmers of Meghalaya, Assam and Manipur organized by G. B. Pant Institute, North East Unit, Itanagar. February 18, 2003 (R. C. Sundriyal, T. C. Upreti and M. Sundriyal).

Seminar on Biodiversity and Sustainable Livelihoods in the Uplands of Asia, Chiang Mai, Thailand. February 11-15, 2003 (R.K. Maikhuri).

Training on Seismic Microzonation of Hilly Areas organized at Central Building Research Institute, Roorkee. February 11-15, 2003 (V. Joshi).

Presented a paper at the world *O-Cha* (Tea) Forum 2003, Shizuoka Japan. February 14-16, 2003 (Niladri Bag).

Training-cum-awareness programme on Wood Energy: Production and Utilization organized by High Altitude Plant Physiology Research Centre at Srinagar-Garhwal. February 17-18, 2003 (S.C. Joshi).

Workshop on "Policy consultations with experts and stakeholders on trade of threatened wild medicinal plants" organized by FRLHT, and GBPIHED in collaboration with Forest Department, Andhra Pradesh at Tirupati and sponsored by MOE&F. February 17-18, 2003 (M.Pal, K.S. Rao, S.K. Nandi and S.S. Samant).

Training Workshop IX on "Himalay Ki Jaiv Vividhata Sanrakshan Mei Janta Ki Bhagidari", GIC, Kanda. February 18-19, 2003 (U. Dhar, R.S. Rawal, G.C. S. Negi, S. Airi, B. Pandey, S. Manjkhola, M. Joshi, A.K. Bisht, M. Joshi, A. Bhatt, G. Mahar, S. Gairola, S. Joshi, S. and H. Andola).

Workshop on sustainable development of Village Barwa and its adjoining areas organized by Garhwal Unit of GBPIHED at Barwa Village, Dehradun. February 22, 2003 (M. Pal, R.K. Maikhuri, S.C. Joshi and V. Joshi).

Natural Resource Systems Programmes (NRSP) DFID workshop, Kathmandu & Pokhara, Nepal. February 24 – March 1, 2003 (S. K. Bhuchar).

Conservation Assessment and Management Prioritization workshop for medicinal plants of Arunachal Pradesh, Meghalaya and Sikkim organized at Guwahati. February 27 to March 1, 2003 (R.C. Sundriyal and Manju Sundriyal).

Participated in WOCAT training programme at ICIMOD, Kathmandu, Nepal. March 2-4, 2003 (S. K. Bhuchar).

Presented paper in XVIth Annual Conference of National Environmental Science Academy (NESA) W. B. Chapter, on 'Emerging Pollutants: Impact on Health, Agriculture and Environment, Kolkata. March 7-8, 2003 (P. Ghosh).

Participated as Resource Person in the GEF Project consultation meeting for Medicinal Plants, organized by Government of Uttarancahl, Dehradun. March 21, 2003 (U. Dhar).

Orientation Camp I on "Himalay Ki Jaiv Vividhata Sanrakshan Mei Janta Ki Bhagidari", G.I.C. Majkhali. March 10-12, 2003. (U. Dhar, S.S. Samant, R.S. Rawal, S. Airi, S. Manjkhola, A.K. Bisht, A. Bhatt, S. Gairola, S. Joshi, S. & H. Andola).

Attended "Indo-US Workshop on Molecular Biology and Biotechnological Applications of Mycorrhizal Fungi & National Congress on Molecular Symbiosis" held at JNU, New Delhi. March 23-28, 2003 (Bhasker Chaurasia).

Paper presented on "Hydrology and suspended sediment of Gangotri Glacier, Garhwal Himalaya" in Workshop organised by Geological Society of India, Lucknow. March 26-28, 2003 (V. Joshi).

DST Sponsored Workshop on GPS, C-MMACS, Bangalore. March 24 – April 4, 2003 (S. Kundu and S. Chhetri).

4.5. 2. Meetings

XII meeting of the Project Evaluation Committee (PEC) under Integrated Ecodevelopment Research programme, Kosi-Katarmal, Almora 12-13, 2003 (P.P. Dhyani, D.K. Agrawal and P.K. Samal).

Development of Agri Export Zones (AEZ) of Ginger and Large Cardamom in Sikkim organized by SIDICO, Govt. of Sikkim, Gangtok. April 9, 2002 (A.P. Krishna).

Meeting with Japan Ecology Foundation organized by Planning and Development Department, Govt. of Sikkim, Gangtok. April 10, 2002 (A.P. Krishna).

Interactive Session on Development and Environment organized by Home Department, Govt. of Sikkim, Gangtok. April 12, 2002 (A.P. Krishna).

Meeting on National Strategy on Biodiversity and Conservation and Action Plan (NBSAP– Uttaranchal) organized by Forest Deptt. at Dehradun. April 14-15, 2002 (R.K. Maikhuri).

Meeting on Action Plan and Strategy for Medicinal Plants Conservation, Cultivation and Utilization organized by Jaributi Sodh Evam Vikas Sansthan, Gopeshwar at WII, Dehradun. April 19-20, 2002 (R.K. Maikhuri).

Meeting on Strategic Plan of ICIMOD 2002–07 organized by Watershed Directorate, Govt. of Uttaranchal at Dehradun. April 30, 2002 (R.K. Maikhuri).

Meeting on Sacred Mountain and Landscape organized by The Mountain Institute, USA at New Delhi. May 8, 2002 (M. Pal, P.P. Dhyani, R.K. Maikhuri, N.A. Farooquee and V.Joshi).

Meeting on documentation of Success Story on Nanda Devi Biosphere Reserve organized by UNESCO at New Delhi. May 10, 2002 (R.K. Maikhuri).

Meeting with the Forest Department officials at Joshimath. May 23, 2002 (S.S. Samant, K. Kumar and S. Pant).

Meeting on "*Biotechnology Policy of H.P*", organized by Department of Biotechnology, Govt. of H.P., Mandi-Kullu. June 10-11, 2002 (H.K. Badola).

Meeting of Advisory Committee on Bio-Medical Waste Management, Deptt. of Health and Family Welfare, Govt. of Sikkim, Gangtok. July 4, 2002 (A.P. Krishna).

Consultation Meeting/Workshop on "*Involvement of local communities in the conservation of forest and wildlife*", Vigyan Bhawan, New Delhi. July 22-23, 2002 (U. Dhar).

Meeting of Eco-Groups of Binsar Wildlife Sanctuary at Almora, organized by Binsar Wildlife Sanctuary, Almora. July 27, 2002 (S.S. Samant).

Meeting on Environment and Development organized by HELP (NGO) at Dehradun. July 27-28, 2002 (R.K. Maikhuri).

Attended Executive Committee Meeting of Indian Society of Ecological Economics, IEG, New Delhi. August 5, 2002 (U. Dhar).

Second Advisory Board Meeting of Small Scale Service Institute, Gangtok. August 12, 2002 (A.P. Krishna).

Participated in "*Second State Biodiversity Steering Committee Meeting*" of the State Biodiversity Strategy and Action Plant, organized by State Council for Science & Technology, H.P., Shimla. September 9, 2002 (H.K. Badola).

Xth Staff Research Council Meeting of Indian Cardamom Research Institute, Regional Research Station, Spices Board, Gangtok. September 17, 2002 (K.K. Singh).

Meeting of C.F.D. Board organized by Director, F.T.I., Haldwani. September 21, 2002 (S.S. Samant).

Attended IUCN-Himal (Phase II) consultation meeting, New Delhi. September 31, 2002 (R.S. Rawal).

Presentation on Science Centre with State Council of Science and Technology for Sikkim and National Council of Science Museums, Kolkata. Government of Sikkim. October 1, 2002 (A.P. Krishna).

State Level Watershed Management Committee Meeting on NWDPRA Scheme, Govt. of Sikkim, Gangtok. October 3, 2002 (A.P. Krishna).

Meeting on "Livelihood Development and Enhancement in Uttaranchal" at Almora. October 22, 2002 (S.S. Samant).

Discussion Meeting regarding SWAJAL-CAP work with World Bank members at Dehra Dun. October 24-26, 2002 (B.P. Kothyari & V. Joshi).

DST Project Evaluating Meeting at Agarkar Research Institute, Pune. October 28-29, 2002 (R.K. Maikhuri).

Review Meeting of Technology Development Extension and Training Scheme for Wastelands Development in Non-Forested Areas organized by Ministry of Rural Development, Govt of India, New Delhi. November 11, 2002 (V. Joshi).

Executive Committee Meeting of Indian Society of Ecological

Economics, IEG, New Delhi. November 15, 2002 (U. Dhar).

Programme Monitoring Committee Meeting on Tea Network Project at the Department of Biotechnology, New Delhi. November 15, 2002 (S. K. Nandi).

Meeting of Barwa village and its adjoining areas organized by GBPIHED, Garhwal Unit at Barwa Village, Dehradun. November 16, 2002 (S.C. Joshi and V. Joshi).

XXV meeting of Governing Body of GBPIHED, Kosi-Katarmal, Almora, at MoE&F, New Delhi, December 4, 2002 (P.P. Dhyani).

IX meeting of G.B. Pant Society of Himalayan Environment and Development, MoE&F, New Delhi. December 16, 2002 (P.P. Dhyani and D.K. Agrawal).

Meeting of PMU Swajal at Dehradun. December 17-18, 2002 (Kireet Kumar).

Consultation Meeting on Threat Status of Medicinal Plants of the Western Himalaya organized by Wildlife Institute of India, Dehradun. January 31, 2003 (R.K. Maikhuri).

Programme Steering Committee meeting on Bioprospecting and Molecular Taxonomy at the Department of Biotechnology, New Delhi. February 3-4, 2003 (S. K. Nandi).

Training Programme on "IPR & WTO Issue-relevance for Uttaranchal", GBPUAT, Pantnagar. February 27-28, 2003 (R.S. Rawal).

Brain Storming Meeting on Biotechnology Development Plan for Mountain (Uttaranchal) at Dehara Dun. March 4, 2003 (S.K.Nandi).

PARDYP country coordinators annual meeting at ICIMOD, Kathmandu. March 5-7, 2003 (B. P. Kothyari, K. Kumar, S. K. Bhuchar and S. S. Bisht).

Access Meeting (common resources) at ICIMOD, Kathmandu. March 9-11, 2003 (B. P. Kothyari, S. K. Bhuchar and B. S. Bisht).

Brain Storming Session on the "*Mountain Environment and Climate Change Over Himalayan Region with Special Reference to Himachal Himalaya*" organized by the DST, Govt. of India and H.P. State Council of Science and Technology, Shimla. March 14-15, 2003 (S.C.R. Vishvakarma).

Project Advisory Committee (Plant Sciences) meeting and presented the progress of DST project at Banaras Hindu University, Varanasi. March 17-18, 2002 (G. C. S. Negi).

Presentations were made at PMC Glaciology meeting, Lucknow. March 20-21, 2003 (Kireet Kumar).

Executive Committee meeting of Indian Society of Ecological Economics, IEG, Delhi. March 26, 2003 (U. Dhar).

Meeting with Asian Development Bank Mission Team organized by Govt. of Sikkim, Gangtok. March 27, 2003 (A.P. Krishna).

Presentation was made in Expert meeting of DST on GPS project at C-MMACS, Banglore. March 29, 2003 (Kireet Kumar).

4.5.3. Delivered Lectures as Resource Persons

Presented invited talk in the National Workshop on "Evolving Sustainable Livestock Grazing Policy Guidelines & Practices in the Indian Himalaya" at Wildlife Institute of India, Dehradun. April 15-17, 2002 (G. C. S. Negi).

Delivered a lecture on '*Solid Waste Management awakening among the Public*' in a programme by the Naggar Panchayat, Manali. April 23, 2002 (J.C. Kuniyal).

Delivered a talk on *Crop Farming in Cold Desert of Lahual Valley: problems and Management Options* in a Workshop on *"Appropriate Development of Cold Deserts"*, organised by Ministry of Rural Development, Govt. of India and Pragya at New Delhi. May 9-10, 2002 (S.C.R. Vishvakarma).

Delivered a lecture on *'Motivation and Education: Solid Waste Management'* to the NSS Programme Officers at Kullu organized by the Institute for Development and Communication, Chandigarh. May 13, 2002 (J.C. Kuniyal).

Delivered a Lecture on Natural Resource Management in Himalaya for a Team of Researchers of ABC, Sweden organized by Daliyo Ka Dagdira (NGO) at Kritinagar, Tehri, 23 May 2002 (R.K. Maikhuri).

As resource person delivered a talk on "*Biodiversity Conservation and Human Approach*" in the Workshop, "*Biodiversity and Disaster Management*", organized by DUF,

Manali (CASA project, New Delhi), Manali, H.P. 3 June 2002 (H.K. Badola)

Delivered a lecture on Himalayan Environment and Development to Volunteers Working on Environmental Issues organized by DIET, Pauri at Kanda. August 12, 2002 (R.K. Maikhuri).

Delivered a lecture on Himalayan Agrobiodiversity Conservation and Management organized by Mountain Forum Himalayan and CASA, New Delhi at Dehradun. August 28, 2002 (R.K. Maikhuri).

Delivered lecture on "Conservation of some selected plants of Himalaya" in the Symposium on Moving Towards Sustainable Agricultural Development in Uttaranchal at G. B. Pant University of Agriculture & Technology, Pantnagar. November 12, 2002 (S. K. Nandi).

Delivered a lecture on *'Solid Waste Management Campaign among School Children'* at senior secondary school and Naggar Panchayat, Manali, 13 November, 2002 (J.C. Kuniyal).

Delivered lectures (i) Environmental Impact Analysis; and (ii) Monitoring and Evaluation to forest officials at Forest Panchayat Training Institute, Haldwani. November 19, 2002 (P.K. Samal).

Delivered Keynote Lecture on 'Landslide management in the Himalayan region' in the National Seminar on Natural Hazards: Its Geological Implications in Hilly Regions, Ranchi, Jharkhand. November 21-23, 2002 (A.P. Krishna).

Delivered two lecture on (i) Environmental Impact Analysis and (ii) Monitoring and Evaluation to forest officials on November 26, 2002 at Forest and Forest Panchayat Training Institute, Haldwani (P.K. Samal).

Delivered a Keynote lecture on Integrated Rural Development in the Central Himalaya for the Swedish Volunteers/University Students and DKD Volunteers organized by ABC active aid Sweden and Daliyon Ka Dagriya at Kritinagar. February 5, 2003 (R.K. Maikhuri).

Delivered a Lecture on Mountain Environment and Strategies for Development to Farmers/NGOs participating in energy plantation training programme organized by High Altitude Plant Physiology Research Centre at Srinagar-Garhwal. March 26, 2003 (R.K. Maikhuri).

M/s SHARAD PODDAR ASSOCIATES.,
CHARTERED ACCOUNTANTS,
"ASHARWAD" 7, RAJ VIHAR, P.O. F.R.I.
DEHRADUN - 248006
PHONE : 0135-2760402
Email : spoddar@vsnl.com

THE DIRECTOR,
G.B.PANT INSTITUTE OF HIMALAYAN
ENVIRONMENT & DEVELOPMENT,
KATARMAL, KOSI,
ALMORA - 263643, (UTTARANCHAL)

Dear sir,

We have audited the Balance Sheet of G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT, KOSI, KATARMAL, ALMORA (UTTARANCHAL), as on 31st MARCH, 2003 which are in agreement with the books of accounts,maintained by the Institute.

We have obtained all the information & explanations, which to the best of our knowledge and belief were necessary for the purpose of audit. In our opinion, proper books of accounts, as requied by the law have been kept by the Head Office and the Units of the above named Institute, so far as appears from our examination of the books. Proper returns adequate for the purpose of audit have been received from Units not visited by us, subject to the Notes on Accounts and comments given below:-

In our opinion, and to the best of our information and according to the explanations given to us and subject to the notes forming part of accounts the said accounts give the true and fair view :-

I) In the case of Balance Sheet of the State of Affairs of the above named Institute as on 31st MARCH, 2003 and

ii) In the case of Income & Expenditure accounts of the INCOME of its accounting year ending 31st MARCH, 2003.

FOR SHARAD PODDAR ASSOCIATES.,
CHARTERED ACCOUNTANTS

sd/- SEAL
(VINOD GUPTA)
F.C.A. PARTNER
DATED : 19-08-2003
PLACE : DEHRADUN

M/s SHARAD PODDAR ASSOCIATES.,
CHARTERED ACCOUNTANTS,
"ASHARWAD" 7, RAJ VIHAR, P.O. F.R.I.
DEHRADUN - 248006.
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Email : spoddar@vsnl.com

G.B.PANT INSTITUTE OF HIMALIYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA) UTTARANCHAL
BALANCE SHEET AS ON 31ST MARCH 2003

PARTICULARS	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
CORPUS / CAPITAL FUND	1	11095876.97	7940827.55
RESERVE AND SURPLUS	2	355045298.84	333257833.84
EARMARKED / ENDOWMENT FUNDS	3	24612698.36	20678471.30
SECURED LOANS & BORROWINGS	4	0.00	0.00
UNSECURED LOANS & BORROWINGS	5	0.00	0.00
DEFERRED CREDIT LIABILITIES	6	0.00	0.00
CURRENT LIABILITIES AND PROVISIONS	7	21539283.39	21051934.61
TOTAL		412293157.56	382929067.30
ASSETS			
FIXED ASSETS	8	355045298.84	333257833.84
INVEST. FROM EARMARKED/ENDOWMENT FUND	9	4570315.00	4570315.00
INVEST. OTHERS	10	0.00	0.00
CURRENT ASSETS , LOANS, ADVANCES ETC.	11	52677543.72	45100918.46
MISCELLANEOUS EXPENDITURE			
TOTAL		412293157.56	382929067.30

SIGNIFICANT ACCOUNTING POLICIES	24
CONTINGENT LIABILITIES & NOTES ON ACCOUNTS	25

AUDITOR'S REPORT
As per our separate report of even date annexed.
FOR SHARAD PODDAR ASSOCIATES .,
CHARTERED ACCOUNTANTS

sd/-
(VINOD GUPTA)
F.C.A PARTNER
DATED : 19.08.2003
PLACE : DEHRA DUN

SEAL

sd/-
(DR.UPPEANDRA DHAR)
(DIRECTOR I/C)

sd/-
(DR. S.K. NANDI)
(D.D.O)

sd/-
(SURYA KANT)
(FINANCE OFFICER I/C)

M/s SHARAD PODDAR ASSOCIATES.,
CHARTERED ACCOUNTANTS,
"ASHARWAD" 7, RAJ VIHAR, P.O. F.R.I.
DEHRADUN - 248006 PHONE : 0135-2760402
Email : spoddar@vsnl.com

G.B.PANT INSTITUTE OF HIMALIYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA) UTTARANCHAL
INCOME & EXPENDITURE A/C FOR THE YEAR ENDED 31ST MARCH 2003.

PARTICULARS	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
INCOME			
Income from Sales/Services	12	27000.00	44066.00
Grants/Subsidies	13	76991941.10	72308048.50
Fees/Subscriptions	14	100257.00	162505.00
Income from Investments (Income on Invest. from earmarked/endow Fund transferred to Funds)	15	0.00	0.00
Income from Royalty, Publication etc.	16	475.00	1100.00
Interest Earned	17	1130250.42	123964.41
Other Income	18	1897067.00	2054648.00
Increase (decrease) in stock of Finished goods and work in progress)	19	0.00	0.00
TOTAL (A)		80146990.52	74694331.91
EXPENDITURE			
Establishment Expenses: a) Institute	20	12943415.00	12010568.00
b) Projects (As per Annexure)		5759294.00	4623022.00
c) E.C (Projects)		1826358.00	1714313.00
Administrative Expenses : a) Institute	21	37479669.50	32404552.50
b) Projects (As per Annexure)		11314290.00	13292537.00
c) E.C (Projects)		1645822.00	2014352.00
Expenditure on Grants, Subsidies etc.	22	6023092.60	6248437.00
Interest	23	0.00	0.00
Depreciation (Net Total at the year-end-as per Schedule 8)		0.00	0.00
TOTAL (B)		76991941.10	72307781.50
Balance being excess of Income over Expenditure (A - B)		3155049.42	2386550.41
Transfer to special Reserve			
Transfer to/ from General Reserve			
BAL.BEING SURPLUS TRETO CORPUS/CAPITAL FUND		3155049.42	2386550.41

SIGNIFICANT ACCOUNTING POLICIES	24
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25

AUDITOR'S REPORT
As per our separate report of even date annexed.
FOR SHARAD PODDAR ASSOCIATES .,
CHARTERED ACCOUNTANTS

sd/-
(VINOD GUPTA)
F.C.A PARTNER
DATED : 19.08.2003
PLACE : DEHRA DUN

SEAL

sd/-
(DR.UPPEANDRA DHAR)
(DIRECTOR I/C)

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(DR. S.K. NANDI)
(D.D.O)

sd/-
(SURYA KANT)
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M/s SHARAD PODDAR ASSOCIATES.,
CHARTERED ACCOUNTANTS,
"ASHARWAD" 7, RAJ VIHAR, P.O. F.R.I.
DEHRADUN - 248006 PHONE : 0135-2760402

G.B.PANT INSTITUTE OF HIMALIYAN ENVIRONMENT & DEVELOPMENT, KATARMAL, KOSI (ALMORA) UTTARANCHAL
RECEIPTS & PAYMENTS A/C FOR THE YEAR ENDED 31ST MARCH 2003

RECEIPTS	CURRENT YEAR	PREVIOUS YEAR	PAYMENTS	CURRENT YEAR	PREVIOUS YEAR
I. OPENING BALANCES			I. EXPENSES		
a) Cash in hand	9342.05	5763.05	a) Establishment Expenses (Corresponding to Schedule 20)	12093070.00	12010568.00
b) Bank Balances			b) Administrative Expenses (Exclusive Of Capital Exp.) (Corresponding to Schedule 21)	25342645.50	19075721.50
i) In current accounts	1776108.50	798977.74			
ii) In deposit accounts			II. Payments made against funds for various proj.	23096676.60	24163996.00
iii) Savings accounts	12986112.34	2568076.03	III. Investments and deposits made		
c) Advances & Others (As per annexure Attached)	28267702.53	25258876.80	a) Out of Earmarked/ Endowment funds		0.00
			b) Out of Own Funds (Investments Others)		0.00
II. Grants Received			c) General Fund	2400000.00	5500000.00
a) From Government of India			IV. Expenditure on Fixed Assets & Capital W.I.P.		
i) Institute	58367000.00	53600000.00	a) Purchase of Fixed Assets	12066786.00	13328831.00
ii) Projects	22303522.00	22151274.00	b) Expenditure on Capital Work-in-progress	7500000.00	0.00
b) From State Government		0.00	V. Refund of Surplus money / Loans		
c) From other sources [from FC]	232297.86	0.00	a) To the Government of India	211099.00	17087.00
III. Income on Investments from			b) To the State Government	0.00	0.00
a) Earmarked/ Endow.Funds	638616.39	582514.18	c) To other provident of funds	0.00	0.00
b) Loans, Advances etc.		0.00	d) To others [security/caution money]	7750.00	0.00
			VI. Finance Charges (Interest)		
IV. Interest Received			VII. Other Payments (PF TRf./Withdrawals etc.)	371521.00	628848.00
a) On Bank deposits	1035541.42	83947.55	VIII. Closing Balance		
b) Loans, Advances etc.	94709.00	714.00	a) Cash in hand	339.05	9342.05
V. Other Income (As per annexure Attached)	2024799.00	2069324.00	b) Bank Balance		
			i) In current accounts	3964241.53	1776108.50
VI. Amount Borrowed	0.00	0.00	ii) In deposit accounts	0.00	0.00
VII. Any other receipts.			iii) Savings accounts	11871981.74	12986112.34
a) (As per annexure Attached)	3803877.67	3454053.57	c) Advances & Others (As per annexure attached)	32634818.42	28267702.53
b) Transferred to Advances 21300.08	0.00				
TOTAL	131560928.84	117764316.92	TOTAL	131560928.84	117764316.92

AUDITOR'S REPORT
As per our separate report of even date annexed.
FOR SHARAD PODDAR ASSOCIATES ., CHARTERED ACCOUNTANTS

sd/-
(VINOD GUPTA)
F.C.A PARTNER

SEAL

sd/-
(DR.UPPEANDRA DHAR)
(DIRECTOR I/C)

sd/-
(DR. S.K. NANDI)
(D.D.O)

sd/-
(SURYA KANT)
(FINANCE OFFICER I/C)

DATED : 19.08.2003
PLACE : DEHRA DUN

M/s SHARAD PODDAR ASSOCIATES.,
CHARTERED ACCOUNTANTS,
"ASHARWAD" 7, RAJ VIHAR, P.O. F.R.I.
DEHRADUN - 248006 PHONE : 0135-2760402
Email : spoddar@vsnl.com

STATEMENT OF OPENING & CLOSING BALANCES

PARTICULARS	OPENING AMOUNT	CLOSING AMOUNT
Cash & Bank Balances		
Cash In Hand :		
Srinagar	12.78	39295.07
Sikkim	378.60	666.00
Kullu	3487.17	5357.17
Itanagar	68827.61	53824.27
Cash at Bank Balances		
SBI Almora A/c No.01170003256 (Endo)	32466.33	34014.72
SBI Tadong A/c No 01000050044	352335.42	484041.92
SBI Kullu A/c NO.01100076038	380425.01	1252955.01
SBI Itanagar A/c No 01100050337	826844.34	573682.39
SBI Srinagar A/c No 01100030433	808953.49	121906.97
SBI Almora PF A/c 01100003255 (P.F.)	1100650.97	234861.64
Advances		
House Building Advance	2555555.00	2956737.00
Motor cycle/Car Advance	468512.00	214386.00
Festival Advance	24000.00	20100.00
PF Advance	389903.00	444733.00
G.I.S.I	(12958.06)	799.14
C.P.F	36.00	36.00
Revenue Stamp Recovery	(2.00)	(2.00)
Units of Institute:		
Sikkim Unit	36136.00	37294.10
HP Unit	(78335.00)	(29173.00)
Garhwal Unit	4983.21	258009.02
NE Unit	6424.66	(5427.00)
Fixed Deposit		
With SBI Endowment Fund	4570315.00	4570315.00

contd...

PARTICULARS	OPENING AMOUNT	CLOSING AMOUNT
Interest Accrued on FDR(General Fund)	1172570.00	1809638.00
SBI PF	8035518.00	10264281.00
CBI PF	2911416.00	5196185.00
Interest Accrued on FDR(PF)	2465632.00	2058670.00
FDR (Margin Money/LC A/C)		
DST (HCR)	95000.00	0.00
DST (KK)	176000.00	0.00
ISRO (APK)	39000.00	0.00
BIOTECH -IX	163000.00	0.00
Institute	1064995.00	1519256.00
BIOTECH -XI	213000.00	67732.00
BIOTECH -XII	79777.00	758.00
Due Staff/ other IC A/c		
Allen Press Inc (SDRE)	7711.00	7711.00
Hardley Brothers	1877.00	0.00
A.S.Parihar	389.00	389.00
Post Master G.P.O Almora	139.00	13846.00
NRSA Hyderabad (SK)	0.00	0.00
Employment News	13287.00	18287.00
Sigma Aldrich Chemicals	10590.00	10590.00
Siltap Chemicals Ltd (Biotech -III)	408.00	408.00
NRSA Hyderabad	8400.00	8400.00
R.K.Nanda & Sons	28517.00	28517.00
Elsvier Science (CSIR-AP)	5000.00	9500.00
S.K.Gurani (IERP)	(75.00)	(75.00)
NRSA Hyderabad (MOE & F-KSR)	138000.00	138000.00
Combat Mathew (ICCR)	2000.00	0.00
IUCN Switzerland	86000.00	0.00
Journal of Horticulture	2500.00	0.00
Allen Press Inc (KANSAS)	5600.00	5813.00
M/s Backman Coultr. Intl. Switezerland	0.00	206000.00
F.C.Inter A/C	2500.00	2500.00
TOTAL	**28267702.53**	**32634818.42**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT KATARMAL,
KOSI (ALMORA) UTTARANCHAL
SCHEDULE OF FIXED ASSETS AS ON 31st MARCH 2003

PARTICULARS	COST AS ON 1/4/02	ADDITION DURING THE YEAR	COST OF SALES/ TFD. DURING THE YEAR	TOTAL
Land :	75639.23	0.00	0.00	75639.23
Building	2749848.00	149359000.00	0.00	152108848.00
Furniture & Fixture:				
(Details)	12335418.40	1300548.00	0.00	13635966.40
Institute	12317811.40	1300548.00	0.00	13618359.40
ICIMOD SALT	11000.00	0.00	0.00	11000.00
ICIMOD ISSMA	6607.00	0.00	0.00	6607.00
Scientific Equipments :	73157407.11	10915135.00	0.00	84072542.11
(Details)				
Institute	54491014.19	8856668.00	0.00	63347682.19
DST (RSR)	7415.00	0.00	0.00	7415.00
BIOTECH-I	1840346.00	0.00	0.00	1840346.00
BIOTECH-II	4029751.00	0.00	0.00	4029751.00
BIOTECH-III	2129381.00	0.00	0.00	2129381.00
UNDP (HAIGAD)	70960.00	0.00	0.00	70960.00
CSIR (RCS)	137948.00	0.00	0.00	137948.00
DST (SKB)	808564.00	0.00	0.00	808564.00
FAO-BIO-DIVERSITY	132792.00	0.00	0.00	132792.00
ICAR (ES)	174507.00	0.00	0.00	174507.00
ENVIS	242380.00	0.00	0.00	242380.00
NWDPRA	64858.00	0.00	0.00	64858.00
IEG PROJECT	52465.00	0.00	0.00	52465.00
DST (SKN)	323172.00	0.00	0.00	323172.00
BIOTECH (V)	112159.00	0.00	0.00	112159.00
WWF (CBD)	7700.00	0.00	0.00	7700.00
HAIGAD II	115438.00	0.00	0.00	115438.00
NORAD	1921158.00	0.00	0.00	1921158.00
ICIMOD (SALT)	216447.92	0.00	0.00	216447.92
INDO CANADIAN	180076.00	0.00	0.00	180076.00
ICIMOD ISSMA	67161.00	0.00	0.00	67161.00
ECO-TOURISM	75738.00	0.00	0.00	75738.00
MACARTHER UNESCO	63450.00	0.00	0.00	63450.00
ICIMOD (PARDYP)	333130.00	16460.00	0.00	349590.00
ICIMOD (CBD)	52801.00	0.00	0.00	52801.00
ICIMOD (FIBRE)	216882.00	0.00	0.00	216882.00
MRE	2450.00	0.00	0.00	2450.00
ICIMOD-GIS EQUIPMENT	148800.00	0.00	0.00	148800.00
BIOTECH (IV)	244811.00	0.00	0.00	244811.00
BIOTECH (VI)	325965.00	375172.00	0.00	701137.00

PARTICULARS	COST AS ON 1/4/02 YEAR	ADDITION DURING THE THE YEAR	COST OF SALES/ TFD. DURING	TOTAL
BIOTECH (IX)	718299.00	404516.00	0.00	1122815.00
BIOTECH (XI)	303010.00	192029.00	0.00	495039.00
BIOTECH (XII)	1084900.00	202108.00	0.00	1287008.00
CSIR (AP)	105004.00	0.00	0.00	105004.00
DST (HCR)	11144.00	95000.00	0.00	106144.00
DST (KK)	508702.00	0.00	0.00	508702.00
CSIR(SCR)	507339.00	0.00	0.00	507339.00
MOE&F (RSR)	13541.00	0.00	0.00	13541.00
MED.ARO. PLANT	76320.00	0.00	0.00	76320.00
ISRO (APK)	98200.00	37467.00	0.00	135667.00
MOE&F (NDMD)	148900.00	0.00	0.00	148900.00
DST (GCSN)	51531.00	750.00	0.00	52281.00
BIOTECH VIII	46904.00	98946.00	0.00	145850.00
MOE&F (US)	11076.00	0.00	0.00	11076.00
DST(MANJU SUND.)	29877.00	0.00	0.00	29877.00
ICAR (RCS)	646298.00	314769.00	0.00	961067.00
CSIR(RKM)	149400.00	0.00	0.00	149400.00
DST (SCR)	57242.00	0.00	0.00	57242.00
DST KK II	0.00	33000.00		33000.00
ICAR [NATP] KSR	0.00	100776.00		100776.00
ENVIS II	0.00	119200.00		119200.00
MED PLANT B. [UD]	0.00	52000.00		52000.00
DST [KKS]	0.00	16274.00		16274.00
Office Equipments :	5303398.35	608160.00	0.00	5911558.35
Institute	5187054.35	459160.00		5646214.35
I.E.R.P	116344.00	149000.00		265344.00
Fire Fighting Equipments :	60962.00	0.00	0.00	60962.00
Library :	35803227.50	1001654.00	0.00	36804881.50
Vehicles :	4739888.25	461968.00	0.00	5201856.25
(Details)				
Institute	2931435.30	461968.00	0.00	3393403.30
ICIMOD SALT	279224.00	0.00	0.00	279224.00
TSBF	280475.00	0.00	0.00	280475.00
MACARTHER UNESCO	290375.00	0.00	0.00	290375.00
ICIMOD	233589.95	0.00	0.00	233589.95
Biotech XII	724789.00	0.00	0.00	724789.00
Glass/Net House :	3568581.00	0.00	0.00	3568581.00
(Details)				
Institute	1517793.00	0.00	0.00	1517793.00
BIOTECH (III)	2050788.00	0.00	0.00	2050788.00
TOTAL RS..	137794369.84	163646465.00	0.00	301440834.84

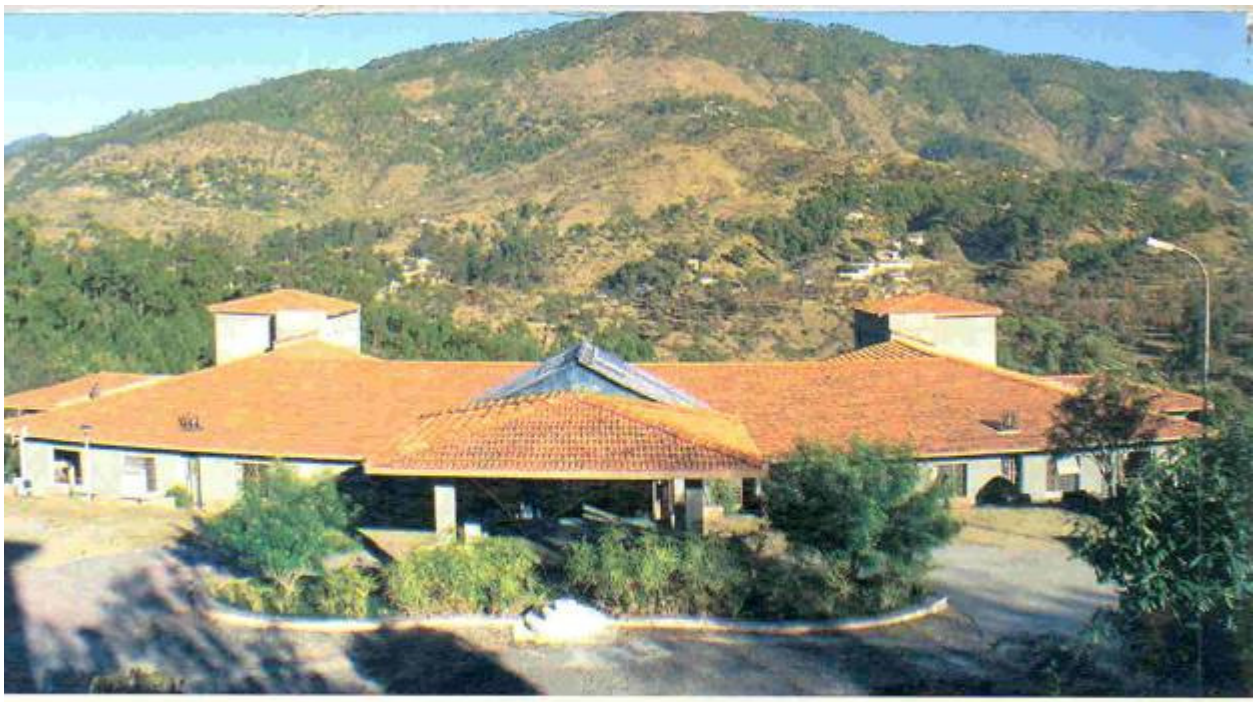
Detailed staff vacancy position of G.B. Pant Institute of Himalayan Environment & Development

Details of Vacant Position as on 31.03.2003

Name of the Individual Post	No. of Sanctioned Post	No. Vacant Post	Remarks
GROUP 'A'			
1. Director	01	01	
2. Scientist-E	01	01*	Vacant on deputation
3. Scientist 'D'	04	02	
4. Scientist 'C'	10	06	
5. Scientist 'B'	14	02+02*	Vacant on lien (1), on deputation (1)
6. Scientist 'A'	10	01	
7. Finance Officer	01	01*	Vacant on lien
8. Administrative Officer	01**	-	
Total 'A'	**41**	**16**	
GROUP'B'			
1. Technician-B	07	-	
2. Accounts Officer	01	-	
Total 'B'	**08**	-	
GROUP 'C'			
1. Office Supdt./SPA	02	-	
2. Estate Manager/ Library Assistant	02	01	
3. UDC/Steno	06	-	
4. LDC/Driver	12	01	
Total 'C'	**22**	**02**	
GROUP'D'			
1. Peon/Chowkidar	13	-	
Total 'D'	**13**	-	
Grand Total (A+B+C+D)	**84**	**18**	

* Vacant on deputation/lien basis.

** The post of Administrative Officer was initially sanctioned on tenure basis. The services of the then Administrative Officer was terminated vide decision in the GB meeting held on 19.4.1996.



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MOHAL, KULLU

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SIKKIM UNIT
TADONG, SIKKIM

PH : 03592-231675/231675
FAX : 03592-231090

GARHWAL UNIT
UPPER BHAKTIYANA,
SRINAGAR, GARHWAL

PH: 01388-252905
FAX : 01388-251159

NORTH EAST UNIT
VIVEK VIHAR, ITANAGAR

PH : 0360-2211773
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