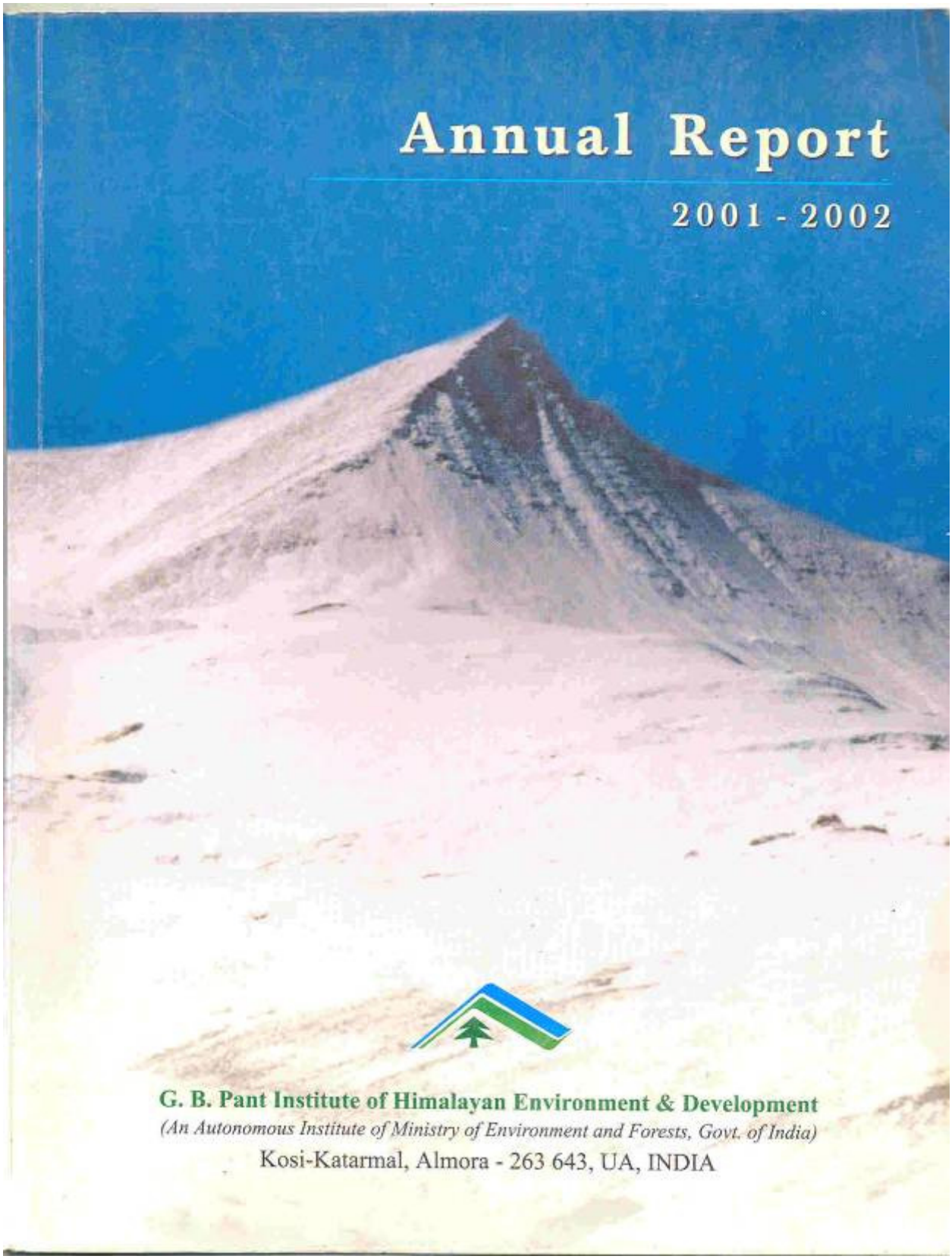
Annual Report

2001 - 2002



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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New Delhi

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(Nominee of Director, GBPIHED).

ANNUAL REPORT

2001-2002

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, Uttaranchal, India

CONTENTS

Director's Foreword

The Institute, in the reporting year 2001-2002, made considerable advancement in its academic activity, infrastructure expansion, and creation of new facilities. A number of training and capacity building programmes for farmers, NGOs, scholars and school children were held at different locations with emphasis on medicinal plant cultivation, protected cultivation, and conservation of biodiversity and importance of indigenous knowledge systems. In all these programmes, a conscious effort is made to supplement traditional knowledge and indigenous practices, rather than introduction of alien concepts and technologies. Our Networking with NGOs and educational Institutions has steadily strengthened. The creation of Uttaranchal as another important Himalayan state has increased our responsibility, and we have accordingly streamlined and focused the Institute's activities to address the regional and other issues important for Uttaranchal. However, difficult as it may be, the Institute has an obligation to explain its progress to the public. We have placed priorities for logical understanding of 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 new regime of world trade organizations, glamorous concepts of 'global village' and the new vistas and horizon of growing seed industry. 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 towards the capacity building of the faculty.

One of the significant developments during the year was formulation of strategy and action plan for the conservation of Wild Plant Diversity in response to the initiative to prepare National Biodiversity Strategy and Action Plan (NBSAP) taken up by the Ministry of Environment and Forests, Govt. of India. The completion and acceptance of Comprehensive Siwalik Watershed Development Strategy by the Ministry of Agriculture, Govt. of India, makes it mandatory for the Watershed Development Projects in the Siwalik Region to follow the guidelines is yet another significant achievement of the Institute. The milestone events, mentioned in subsequent pages in this report, indicate that a number of noteworthy achievements were made. The Institute has increased its R & D activities, in close association with the villagers and grass root workers to understand the real requirements and problems of the villagers before coming up with any suitable options for economic development of the region.

(Dr. Mohinder Pal)

MAJOR ACHIEEVEMENTS

- Formulation of Strategy & Action Plan (SAP) on Wild Plant Diversity (India). The document reviews Wild Plant Diversity of Indian Himalaya Region under special area and identifies issues and suggests SAP for this region. Also a state level biodiversity strategy and action plan for Uttar Pradesh was developed. It will help the policy planners and managers in implementing the biodiversity related activities in the state.

- Successful demonstration of SWEET package on 26 ha community land with active support of villagers in Uttaranchal.

- Establishment of functional tissue culture laboratory facility at Sikkim Unit for multiplication of high value and threatened Himalayan tree species including endemic Rhododendron.

- Regular dissemination of knowledge through training and demonstration of various technologies to farmers, villagers, NGOs and officials for economic upliftment of the rural populace.

- Successful completion of Badrivan restoration programme at Badrinath in Chamoli Garhwal and revival of Badrivan by maintaining a number of saplings of many high altitude trees/ shrubs in Badrinath valley.

- The preparation of data base on Nanda Devi Biosphere Reserve in the nomination form for UNESCO-MAB network has been accepted by UNESCO.

- Initiation of a multi institutional, multi site project on biodiversity relations with soil fertility management has been initiated with GEF support under TSBF-SARNET Programme of the Institute.

- Standardization of improved vegetative propagation techniques of highly valuable medicinal plants on farmer's fields to increase the acreage and yield.

- Capacity building on concepts and fundamentals of ecological economics for practicing scientists and ecologists of Himalayan region in particular and country in general.

Executive Summary
Research and Development Activities

The Institute follows a multi-disciplinary and holistic approach in research and development programmes to address the issues of sustainable development of the Indian Himalaya. The emphasis on interlinking of natural and social sciences is the major thrust of all the R&D programmes. In this effort special attention has been placed on 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 around following seven core programmes.

Land and Water Resource Management

The activities of this core programme during the current year were focused on both research and extension works related to study of government and community managed canal irrigation systems, application of Sloping watershed environment engineering technology (SWEET) model for rehabilitation of wasteland, soil and water conservation through (SWC) slope stabilization, survey of traditional SWC methods, GPS data collection, suspended sediment study and hydrometry of Gangotri glacier and *in-situ* moisture conservation through reduced tillage and mulching, etc. Use of watershed approach in community canal system was identified, which is an example of efficient water management built and operated by the farmers of several villages. A technical publication in the form of a folder was released based on the successful experiment of spring sanctuary development for recharging they drying springs in the mountains to popularize the technology. An important finding of glaciology project was strong influence of winter snowfall on meltwater discharge of Gangotri glacier. Reduced tillage and mulching with Lantana (a weed) leaves was found beneficial in first two years over traditional practices of crop cultivation with regard to crop yield and soil and water conservation.

Sustainable Development of Rural Ecosystems

During the reporting period studies on the natural resource management strategies of various indigenous societies of Himalaya continued. The focus of the study was on Monpas, Akas, Sherdukpens, Khowa and Majis of West Kameng District of Arunachal Pradesh. Customary laws pertaining to their village institutions, impact on local governance have been documented in detail. Contour hedgerow technology in north eastern region and agroforestry practices in Western and Central Himalayan region were studied and given wider popularity in the region. Experiments with the agroforestry established that about 60% of branch lopping is sufficient for achieving optimum crop productivity with selected species. Out of 175 Nitrogen fixing species screened, four could be considered as most promising potential hedgerow species for the conditions of Northeastern region. The Farmers Field School-Cum-Training Programme increased our out reach to several areas and the extension of contour hedgerow technology and medicinal plant cultivation on agricultural fields is encouraging.

Conservation of Biological Diversity

During the year biodiversity studies on the protected areas (Nanda Devi and Kanchendzonga Biosphere Reserves and Kanawar Wildlife Sanctuary), subtropical and temperate forests, studies along disturbance gradient and timberline zone were carried out to strengthen the biodiversity database. Inventory of Orchids of the Trans, North west and west Himalaya was prepared and analyzed for species richness, distribution pattern, nativity, endemism and rarity. Agrotechniques and post harvest processing of medicinal plants were brought out and documented. Farmers, NGOs and Government Organizations cultivating/working on medicinal plants were listed. Arboretum was strengthened through extension of the nursery and arboretum sites, development of demonstration plot of *in vitro* propagated plants, development of propagation packages for *Myrica esculenta* and medicinal plants. Responses of the participants were analyzed for impact assessment. Studies on the population biology and *in vitro* propagation methods of high value endemic medicinal plants were carried out. Establishment and strengthening of herbal gardens were continued. Development of database for the Himalayan Biosphere Reserves, interactions with the Experts and Biosphere Reserves Managers were continued. National Biodiversity Strategies and Action Plans for the Wild Plant Diversity (India) and Uttar

Pradesh State were developed. The participatory biodiversity conservation programme was further strengthened through VIII Training Workshop

Ecological Economics and Environmental Impact Analysis

During the reporting period, air quality monitoring and solid waste characterization in and around tourist destinations of Kullu valley were studied. The level of tourist inflow and the solid waste generated at Rohtang Pass draws attention to the growing menace of solid waste in the Himalayan region. Background levels of air pollutants were monitored in the Kullu valley during the tourist season to develop database. The study on impact of economic condition and education on the fertility behaviour of women in the Central Himalayan region highlights the relationship between these factors among various communities of this region. Study on resource use pattern and conservation strategies of native communities of Central Himalaya reveals that women are the repositories of indigenous knowledge. Study on vegetable cultivation both season and off-season in Khairna Valley, Nainital district reveals that due to vegetable cultivation and though, the settlements have diverse natural setting, most of the villagers have adopted similar cropping pattern as their economic base. A comprehensive strategy document for eco-restoration and socio-economic development of the Siwalik region was prepared for the Ministry of Agriculture.The assignment was undertaken to put together an analytical compilation of the data sets, and synthesize various issues to integrate the individual working plans in a uniform manner so as to provide the broad guidelines. The study on evaluation of landslide hazards in Sikkim Himalaya has provided RS/GIS framework for geo-environmental assessment and mitigation.

Environmental Physiology and Biotechnology

The Core activities have in general focussed on understanding the factors which govern the productivity, functioning and regeneration of plants, in the light of harsh climatic conditions of the Himalayan region. In keeping with the need, use of conventional methods alongwith the blend of biotechnological techniques has been applied to meet the different R & D objectives of the core. Investigations on plant responses to environment, development of propagation protocols, analysis of active ingredients of medicinal importance and plant microbe interaction are underway. *In vitro* multiplication packages for several plant species have been developed. Isolation, screening and characterization of soil microbes of colder regions are in progress. Microbial inoculants are being developed for biocontrol and improving plant productivity. Furthermore, demonstration of on-site simple technology packages and imparting trainings has contributed to improving the living standard of some village communities.

Institutional Networking and Human Investment

Under the Integrated Ecodevelopment Research Programme (IERP) of the Institute seventeen R&D projects were sanctioned and funded to the various organization/institutions/universities (for the execution of location-specific action-oriented R&D activities in different parts of the North East and North West region of the country) Sixteen IERP projects were completed successfully during the year and 46 projects were on-going in different parts of the Indian Himalayan region (IHR). Two IERP workshops one at Jammu University, Jammu, J&K, and another one at Arunachal University, Doimukhn (Itanagar), Arunachal Pradesh for the creation of awareness among the prospective PIs/Groups/ NGOs etc. for execution of location-specific action-oriented R&D activities in the (IHR) region were also organized during the year 2001-2002. In all, follow-up action on almost one hundred and eighty six (186) project was initiated/ completed during the year. In addition to the above, central plant nursery at Kosi Campus of the Institute served for demonstration purpose for various hill technologies for the upliftment of rural populace of Central Himalaya. A three day on-site training programme on nursery development, tree plantation techniques, and natural resource conservation and management was also organized at Anandpuri village in Almora district of Uttaranchal in which sixty four (64) local participants were trained by the staff of the Institute. The Central library of the Institute was also maintained and strengthened properly during the year at the headquarters of the Institute. An addition of 776 new books was done and subscription of 132 periodicals (80 international and 52 national) was continued in the library during the year. Two volumes of Hima-Paryavaran and two Institute Annual Reports were also distributed during the year to a number of organizations/ individuals/subject experts and others. Besides above, Badrivan restoration programme was completed successfully during the year 2001-2002. Almost 50,060 plants of various high altitude trees/shrubs survived at various Badrivan project sites and out of these, 21670 saplings of various trees/shrubs revived Badrivan (the ancient sacred forest of Badrinath shrine) in Badrinath valley.

Indigenous Knowledge System

During the year the core activities have been focused on few 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 of some of the traditional practices which are on the verge of being phased out, and as a result the knowledge can be lost. Indigenous method 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 is also being analysed scientifically. The documentation of various landraces of traditional crops and their role in the agricultural systems is also being analysed before they are lost.

1. INTRODUCTION

The reporting year 2001-2002 is thirteenth financial year of research and development activities being carried out by the Institute at various locations in the Himalaya, in tune with regional issues, and is endeavoring to seek practical and workable solutions to 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 new programmes.

At present, the activities of the Institute are centered on seven designated core programmes. Several projects were successfully concluded during the year. Summaries of these are placed 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 2001-2002 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

Shri. B.S. Rawat, Hon'ble Union Minister for State, Science and Technology, Government of India, inaugurated a three day workshop (4-6 September, 2001) at the Institute HQs, Katarmal, Almora. It was organized by the NRDMS Division of Department of Science & Technology (DST) and was attended by over 60 representatives from various organizations, institutions, universities and NGOs. The workshop focused on the issues pertaining to development of a focused programme for the generation of sustainable development plan for the state of Uttaranchal. The Garhwal Unit organized a meeting cum workshop on Conservation of Crop Genetic Resources with inhabitants of Urgam village (22 September, 2001) and with academic experts representing the field of biology, agroforestry, marketing, socio-economics and policy issues, who expressed their views on the modeling of implementation of on-farm conservation at Srinagar on September 25, 2001.

A five-day Training Programme on Environmental Economics for Practicing Scientists and Ecologists was organized in the Institute (October 16-20, 2001) under the auspices of "Indian Environmental Management Capacity Building Technical Assistance Project" with the World Bank assistance. Professor J.S. Singh, Banaras Hindu University, Varanasi inaugurated the workshop, and was attended by the eminent ecologists and economists. The programme dwelt on ecology and economics keeping in view the varied biodiversity, bio-climates and natural resources of this country on one hand and interests of participants on the other.

The Parliamentary Standing Committee on Science and Technology, Environment & Forests visited the Sikkim Unit of the Institute at its upcoming Panthang complex (October 20, 2001). The Chairman of the Committee Shri. B.P. Singhal, Member of Parliament (RS) and other Hon'ble Members took keen interest in the research and development activities of the Institute and sought clarifications and offered constructive suggestions. Under the National Agriculture Technology Programme of ICAR, a one day workshop was organized (November 30, 2001) at Beragaon, Chamoli district (Uttaranchal). The training focused on discussions about issues of traditional crop germplasm conservation with local villagers, and nearly 350 participants attended the programme.

A two day workshop (December 28-29, 2001) entitled "Creation of awareness among the prospective PIs/ Groups/NGOs etc. of the J & K region

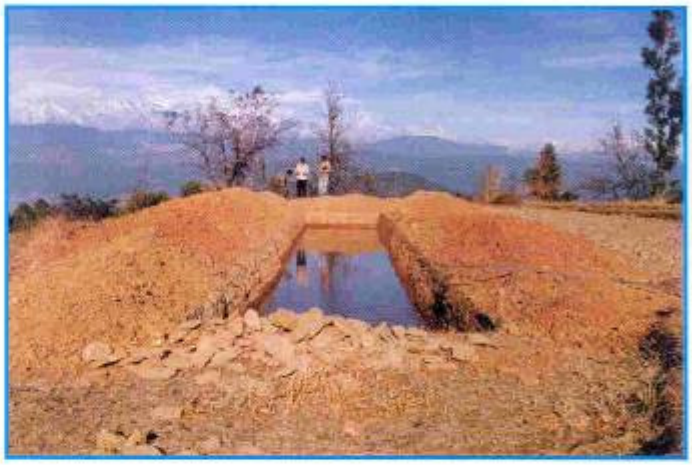
was organized for execution of location-specific action oriented R & D activities under the Integrated Eco-development Research Programme (IERP) of the Institute: Project presentation cum evaluation" was held at the Department of Botany, Jammu University, Jammu. The workshop was convened by Dr. I.A. Hamal of Jammu University in collaboration with the Scientist Incharge IERP, of the Institute. The workshop was inaugurated by Prof. B.B. Chattoo, Vice-Chancellor, Mata Vaishno Devi University, Katra and was presided over by Dr. K.K. Dwivedi, Vice-Chancellor, Arunachal University, Itanagar. About 124 delegates from different parts of Jammu and Kashmir participated in the workshop.

A two-day International Workshop on "Endangered Medicinal Plant Species in Himachal Pradesh" was organized by the Institute at its Himachal Unit, Mohal-Kullu (March 18-19, 2002). The workshop was jointly organized by the G.B. Pant Institute of Himalayan Environment and Development, Katarmal-Almora, Rothamsted International, Institute of Arable Crops Research, UK, and Centre for Advancement of Sustainable Agriculture, New Delhi. It presented a forum to scientists and various stakeholders including industrialists, farmers, NGOs and policy makers to address core issues on medicinal plants conservation by cultivation. Around 40 identified experts from diverse disciplines attended the workshop.

3. RESEARCH AND DEVELOPMENT PROGRAMMES

In order to achieve the sustainable development of the Indian Himalaya, research and development programmes of the Institute are based on a multidisciplinary and holistic approach with particular emphasis on interlinking of natural and social science. 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 centered on seven core programmes, viz., Land and Water Resource Management, Sustainable Development of Rural Ecosystem, Conservation of Biological Diversity, Ecological Economics and Environmental Impact Analysis, Environmental Physiology and Biotechnology, Institutional Networking 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



Land and water are the important natural resources for providing socio-economic and ecological security to the mankind. With increasing pressure of human and animal population, the natural balance between these resources has been distorted. As a consequence, serious problems of soil and water conservation have arisen. Sparse population, undulating terrain, tiny and scattered land holdings and inclement weather conditions are the typical characteristics of Himalayan region, which have made the problem more complex. In this context integrated resource management using watershed as the unit for development is being attempted widely in the region. This particularly attempts 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 resources. 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

Agriculture in most parts of the Central Himalayan region depends on rainfall, mainly due to poor development of irrigation facilities. Irrigation is practiced on very small scale, particularly in the valleys along the streams and natural water sources. Irrigation systems in the region 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). Community managed irrigation systems are working for ages. They are easy to build and maintain because of its low cost. Under this project selected community systems are studied in detail for assessment of their performance. This study also proposes to analyze both successful and unsuccessful experiences in traditional as well as modern Government managed hill irrigation systems.

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

Results and Achievements

1. The performance of community-managed systems is found better than govt. managed schemes in terms of irrigation intensity (irrigation intensity up to 186.92±8.37 %) and conveyance efficiency (mean = 52.62 ± 10.65%) mainly because of appropriate alignment and size of community schemes. Performance of these systems was consistent in both cropping seasons.
2. Community managed systems are developed based on availability of land for making canal and suitability of sources for diverting water with least consideration to design parameters such as canal ratio and channel slope.
3. Weak co-relation among different parameters indicated limited influence of water availability at sources (Table 1).
4. In the Central Himalayan region springs are the main source of drinking and irrigation water. Studies were conducted on six springs emanating from differing recharge zones. Geologically these springs were identified as fracture/joint related (FR/JT-type) and fracture/joint/colluviums type (FR/JT/COLL – type). Rainfall and spring discharge are better co-related in FR/JT/COLL –type springs (r = 0.596) than FR/JT type springs.

Table 1: Co-relation between different canal parameters

Parameters	r values	
	Govt. system	Community system
Duty Rabi ~ Discharge	0.822	0.664
Duty Rabi ~ CR-rabi	0.574	0.436
CR-CCA~Discharge	0.604	0.061
Duty (av.) ~ CR-CCA	0.693	0.424
CR-Rabi ~ Discharge	0.264	0.116
CR-Kharif~ Discharge	0.248	0.066
Duty Kharif ~Discharge	0.855	0.670
Duty Kharif ~ CR-Kharif	0.548	0.447
Irrigation intensity ~ discharge	0.653	0.354
Conveyance effi. ~ Discharge	0.010	0.198

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

Background

In the Himalayan region many researches have been done in the field of modern techniques of soil and water conservation. Most of these techniques have recently emerged in the face of water shortage for irrigation and inadequate soil moisture to support germination and growth of food crops. But, the farming community applies many traditional strategies in order to conserve soil and water. 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 soil and water conservation in the Himalayan mountains.

Objectives

1. To identify and document traditional soil and water conservation (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 interviews with the local people and ground survey in selected localities in the region a number of indigenous SWC methods were documented (Table 2).
2. The study (3 year) conducted in erosion plots revealed that Bioengineering measures in first year are more effective in erosion control year for all intensity levels. Checking the human and animal erosional activities and allowing natural growth of vegetation was found effective in erosion control on steep slopes over three year period.
3. In west and north district of Sikkim Himalaya, more than 50% farmers practiced terraced agriculture. Most of the terraces were found with gentle outward slope of 2 to 5 degree. Use of agroforestry is the predominant SWC practice in these sloping lands.

Table 2. Some indigenous methods of SWC in the Garhwal Himalaya

Activities	SWC advantages
Ploughing and leveling crop fields soon after kharif crop harvest in post-monsoon season	Soil moisture and weeds are buried in soil and the decomposition of weeds and moisture retention in soil provide better growth conditions for the following rabi crop
Irrigating fields soon after kharif crop harvest	Low competition for irrigation immediately after post-monsoon period makes easy availability of water and soil moisture is conserved for the following rabi crop
Mulching vegetable nursery/cropfields with crop residue fodder leftover by the cattle	To escape from frost injury, provide warmth to soil for seed germination, moisture conservation and to increase soil fertility after decomposition
Soaking seeds overnight before sowing	To supplement moisture for quick seed germination
Rooftop water/household waste water is guided to flow in channels to backyard	Supplements moisture to kitchen garden crops

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

Background

People and Resource Dynamics Project (PARDYP) a regionally collaborated programme which involve local, national and international (Univ. of Berne, Univ. of British Columbia, Chinese Academy of Sciences, Pakistan Forest Institute, HMG of Nepal and GBPIHED) partners is presently in its second phase of operation. In this phase, emphasis has been laid on people's priorities and perception 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 & evaluation are being exercised. Efforts are being 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 a 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 and thereby to increase household and community benefits.

Results and Achievements

1. Hydro-meteorological studies conducted in the Bhetagad

watershed for the year 2001 showed that the total precipitation was 108.5 cm (with 71.1% of the total rainfall occurring during the monsoon season), which was about 40% less than that observed during 2000. Maximum annual precipitation (116.7 cm) for 2001 was calculated for M3 station located at 1840 m amsl in Kausani. Water discharge from the watershed during the calendar year 2001 was 0.2399 m^3/sec as compared to 2.0619 m^3/sec during 2000. Studies once again confirmed that the major proportion of the total discharge (about 90%) is in the monsoon season. Soil and water studies indicated /reconfirmed that the highest runoff and soil loss (19.3% of total annual effective precipitation and 0.933 t/ha/year, respectively) took place from the open pine forest.

2. On-farm biofertilizer experiments conducted on two varieties of wheat (local and VL-738) sown at different altitudes showed positive response of application of Ac W_5 strain bio-fertilizer. In general, the total biomass of local and VL – 738 variety increased by 12.9 – 13.7% and 14.2 – 14.6 %, respectively, as compared to their controls. Similar trends were recorded for rice varieties (local and VL-81), treated with Nutrilink (VAM fungi) during their nursery stages. The use of bio-fertilizer had a significant effect on the productivity of a few vegetable plants, and there was an increase of about 12.5% - 18.7% in fruit production in various species of pumpkin, brinjal, tomato, capsicum, cucumber and beans.

3. Although the demand for polyhouses by the farmers of the study watersheds has increased multifold, evaluation of a few cases (studied earlier as well) showed that by adoption of off-season vegetable cultivation practices, farmers earned a net gain of upto Rs. 19,585.00 in a year (2001).

4. A few important livelihood potentials for improving the income generation capacities of the individual families have been identified as nursery, off season vegetables, cash crop cultivation, pisciculture, apiculture and poultry farming. In the field of pisciculture and apiculture adequate training was provided to key farmers and during 2001, more than 30 farmers adopted one or more of these practices. On account of the facilitation and support provided by PARDYP, the area now has more than 40 water harvesting tanks for multiple purposes. Furthermore case studies conducted indicated that poultry farming could be one of the possible lucrative businesses for the inhabitants. This is evident from the fact that the persons carrying out this business earned a net profit of Rs. 13,250.00 – Rs. 47,500.00 during the year 2001, depending upon the carrying capacity of an individual.

5. In the common resources sector, villagers continued to reap the benefits from the rehabilitation sites. There was further expansion of plantation activities by villagers, and the idea of social fencing and adopting natural resource management strategies gained more popularity as the number of farmers involved increased during the year 2001. At Doba more than 20 families are now being benefited from the community based water harvesting and rehabilitation programmes that were carried out under the PARDYP umbrella.

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

Background

The Gangotri glacier is the largest glacier in the Bhagirathi basin. It is 30.20 km long and its width varies from 0.5 to 2.5 km. numerous small sized glaciers join the main Gangotri glacier. The total spread of the ice volume is about 39.18 km^3 and total glacerized area is about 258.86 sq.km. The main Gangotri glacier drains in north-westerly direction from Bhagirathi group of peaks. This project envisages study of discharge and suspended sediment transport in the proglacial stream draining the Gngotri glacier with a view to identify relationship between hydrological characteristics and the sediment delivery. Study of sediment yield rates and its correlation with melt water discharge is of immense importance for the life of river valley projects down stream. This study was initiated in year 1999 with financial support from Department of Science and Technology. Continuous monitoring is being done for last three 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 are, production mechanism and transport pathways of the

suspended and dissolved load of the glacier.

Results and Achievements

1. Total melt water yield from the Gangotri glacier catchment was estimated as 696.64×10^6 cum during the 2001 ablation season. The discharge in year 2000 was lower than the discharge in 2001 for the same period. In the year 2001, mean air temperature was slightly higher in comparison to last two years, which may have some influence on discharge.

2. During the 2001 ablation season, total suspended sediments load was high in July and August as 147.19×10^4t and 86.04×10^4t, respectively, and lowest in the month of October (0.36×10^4t). Total suspended sediment yield from the glacier during the observation period was estimated as 287.86×10^4t, which is higher than the sediment yield of year 1999 and 2000. High discharge and higher thermal component are responsible for increase in suspended sediments load in this year.

3.1.5. Hydro-Ecological Linkages of Carbon Dynamics in Relation to Land-use/Cover Change in a Himalayan Watershed

Background

There has been a large scale conversion of forests to other land-uses in the past few decades from the Himalayan region. This has disrupted the hydrological cycle and a great loss of carbon is envisaged. This study will cover change of land-use from forest to agriculture and wastelands and in the process study carbon dynamics and hydrological process change in various land-uses. The hydrological parameters such as stream discharge, sediment concentration, overland flow, sediment loss, partitioning of precipitation pathways and nutrient loss from different land-uses will be estimated. The soil organic carbon, carbon in litter and humus layer and in various plant components will be estimated. Carbon is a good indicator of systems stability and change in land-use and its carbon dynamics will reflect its sustenance. Watershed is regarded as a unit for development in hills. The resource mobilization and settlement pattern in hills is governed by watershed functioning. Therefore, this study on hydrology and carbon dynamics in a series of transformed land-uses will be studied in a watershed in Sikkim Himalaya.

Objectives

1. Estimation of land-use/cover change detection over period of time using satellite imagery in a selected watershed of Sikkim.

2. Budgeting of carbon in various ecological compartments in different land-uses. Carbon flux between these compartments along with carbon fixation, losses through respiration, harvest flux, land cover change combustion emission and agricultural change emissions will be estimated.

3. Hydrological studies such as overland flow, soil erosion, carbon loss through soil erosion, sediment concentration in stream water, and discharge will be carried out on land-use basis. Hydrological processes will be correlated with ecological dimensions.

4. Land-use sustenance will be studied taking soil carbon levels as an indicator.

Results and Achievements

1. The total biomass for different types of forests and agroforestry systems were measured. The total biomass varied from 18 Mg ha^{-1} in mandarin based agroforestry systems to 472 Mg ha^{-1} in temperate natural dense mixed forest. The total biomass of large cardamom based agroforestry was 47 Mg ha^{-1}. The total biomass was 28% higher in the *Alnus*-cardamom stand and tree biomass slightly higher for *Alnus* despite its lower stand density. The contribution of cardamom biomass to stand total biomass was 34% in *Alnus*-cardamom and 18% in the forest-cardamom stand.

2. The floor litters in different land-use/covers were also measured to quantify the total carbon pool. The floor litter was highest (13 Mg ha^{-1}) in temperate dense mixed forest followed by cardamom based agroforestry systems with 11.6 Mg ha^{-1}. Temperate natural open mixed and subtropical degraded forest had almost equal quantity of floor litter and the mandarin based agroforestry system had the lowest (0.4 Mg ha^{-1}). The total carbon content was 52 Mg ha^{-1} in cardamom based agroforestry systems, followed by 42 Mg ha^{-1} in temperate natural dense mixed forest, 30 Mg ha^{-1} in subtropical degraded forest, 26 Mg ha^{-1} in temperate natural open mixed forest and 0.8 Mg ha^{-1} in mandarin based agroforestry systems.

3. The soluble carbon in the different stream water of the watershed was analysed. The soluble carbon in different streams varied from 0.96 Mg yr^{-1} in Rangrangkhola to 814 Mg yr^{-1} in Pockcheykhola. Rinzikhola being the outlet of the watershed had highest (2025 Mg yr^{-1}) soluble carbon content.

4. In order to see the total carbon pool on land-use/cover basis; soil samples were collected and analyzed through CHN analyzer upto 1m depth. The total carbon values for the soils ranged from 2.95 to 8.01% in the surface layer (0-15 cm), slightly decreased to 1.10 to 6.42% in 15-60 cm and then drastically decreased to 0.83 to 2.63% at 1 m depth. On the land-use/cover basis the highest value was recorded in temperate natural dense mixed forest and lowest in wasteland area subtropical.

3.1.6. A continuous Reference GPS Station at GBPIHED, Kosi-Katarmal, Almora

Background

Global Positioning System (GPS) allows one to determine the location of any point on the globe with an accuracy of a few millimeters. Repeat measurements of the coordinates of some fixed points in a deforming region, thus yield changes in their position with time and thereby knowledge of their velocities with respect to some fixed reference points. These illuminating knowledge bases about the rates and style of ground deforming processes can help in designing effective measures to enhance our resilience to inevitable natural hazards and thereby mitigate their disastrous impacts. A high precision Global Positioning System (GPS) installed in the campus of the GBPIHED, at Katarmal, has recorded data continuously since October 1997.

Objectives

1. Quantifying the space gradients of strain rates right through and across the great Himalaya from a denser data set from closely spaced points and to define the space time strain accumulation and release mechanism in the Central Himalaya identified as a seismic gap, preparatory to, during, and after a moderate or large earthquake, based on real time observation of baseline changes between the Indian Shield (Bangalore/Kodaikanal/Delhi) and Almora, in the event of a moderate or great earthquake.

2. Studying the land slope evolution of some critical landslide areas in Kumaun with a view to modeling the processes preparatory to and culminating into landslides, and attempting to develop an Advance Warming System using real time or near real time GPS monitors.

Results and Achievements

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

2. A status report on the role of GPS surveys in landslide studies was prepared for DST. The study revealed significant co-relation between landslide activities and distance from the active fault zones. In tectonically active zones, geology and land use played less significant role in controlling landslide activities.

3.1.7. Ecology of Reduced Tillage and Mulching in Central Himalayan Crop fields

Background

Soil fertility improvement and *in-situ* moisture conservation in rainfed farming of the Himalayan Mountains is an important step towards increasing crop yield in the hill agro ecosystems. Therefore, attempts are required to investigate the traditional methods of crop cultivation vis-à-vis reduced tillage and mulching to bring out better management practices. The SWC impact of improved practices has also to be experimentally worked out for sustainable hill farming.

Objectives

1. Quantification of runoff, soil loss, crop yield and nutrient loss through runoff and soil loss under different treatments of tillage and mulching in comparison with traditional farming practices.

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

Results and Achievements

1. A two-year study indicate that Lantana mulch turns out to be better with regard to agronomic yield, conservation of water and rapid improvement of soil fertility as compared to Oak and Pine leaf litter mulch and traditional cultivation practices.

2. While no-tillage practice loose more water through runoff but conserve soil compared to other tillage and mulching treatments.

3. Reduced tillage (once tillage) and mulching with Lantana (a weed) combination was found beneficial over traditional practices of crop cultivation with regard to crop yield and SWC.

3.1.8. Environmental Hazards and Optimal Resource Use in the Alaknanda Valley, Garhwal Himalaya Using Remote Sensing and GIS Techniques

Background

In the tectonically active Himalayan Mountains landscape is

fragile and sensitive to land use and land cover changes (LUCC). This sensitivity is often seen as recurring landslides and activation of old landslides in response to LUCC. Attempts are therefore required to understand these linkages to recommend LUCC for the stability of the landscape without compromising the dependence of local inhabitants on forests for fodder and fuel wood requirement and other land uses maintained by them.

Objectives

1. Survey of representative villages for suitability of fodder and fuel wood tree plantation in the surrounding wastelands.

2. Prepration of geological map for landslide hazard zonation study.

Results and Achievements

1. In some representative village (those short of fodder and fuel wood) in the Alaknanda valley survey work was conducted to look into the land resource availability and suitability/ desirability of fuel wood and fodder trees that could be grown in such villages. People mainly prefer broadleaf fodder species to other fact growing inferior species.

2. Integration of structural and landslide maps of the study area in collaboration with Space Applications Centre, Ahmedabad was completed.

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

Background

All the watersheds in the Central Himalaya both small and large are being subjected to variety of changes ranging from rapid extraction of all available natural resources to environmental impacts of different types of development intervention. The Takoli Gad watershed in the Garhwal Himalayan is one such watershed where the loss of natural resources has affected the entire population inhabited there. The poor who were supplementing their meager agricultural incomes from various natural resources activities are finding it increasingly difficult to find these natural resources. What is needed is a multi-dimensional approaches to devising means to restore there commons and build new socio cultural processes and institutional mechanisms that can effectively manage these natural resources in a sustainable manner.

Objectives

1. To collect primary and secondary information related to socio-economic conditions, agriculture, livestock, water resources, natural resource utilization pattern, employment, irrigation, 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. In-depth agro-ecosystem studies including cropping pattern, crop rotations, crop yield assessment has been carried out. Besides, the traditional ecological knowledge related to agro-ecosystem management has also been documented.

2. The ginger is cultivated as a cash crop during the kharif season in both irrigated as well as rainfed terraced lands in the form of mixed or mono crop in the watershed. The detail agricultural practices related to ginger cultivation i.e. agronomy uses, marketing and its impact on forest resources have been worked out.

3.1.10. Performance and Adaptability Analysis of "SWEET" in the hills of Kumaun Himalaya

Background

Community wasteland of hill villages is heavily grazed by the livestock and is severely degraded. The soil is generally poor in quality and had low water holding capacity. Due to sloppy land and sparse vegetation cover under continued grazing pressure acute soil erosion is apparent in all part of Kaman Himalaya. In this project such village community land was proposed to be rehabilitated through SWEET technology for direct benefits such as fodder and fuel wood and soil and water conservation, etc. as well as the other associated benefits. The project is funded by Dept. of Land Resources, New Delhi.

Objectives

1. To identify potential sites for wasteland development that can successfully be applied for soil and water conservation in Kumaun Himalaya.

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

3. To modify and suggest appropriate technology package

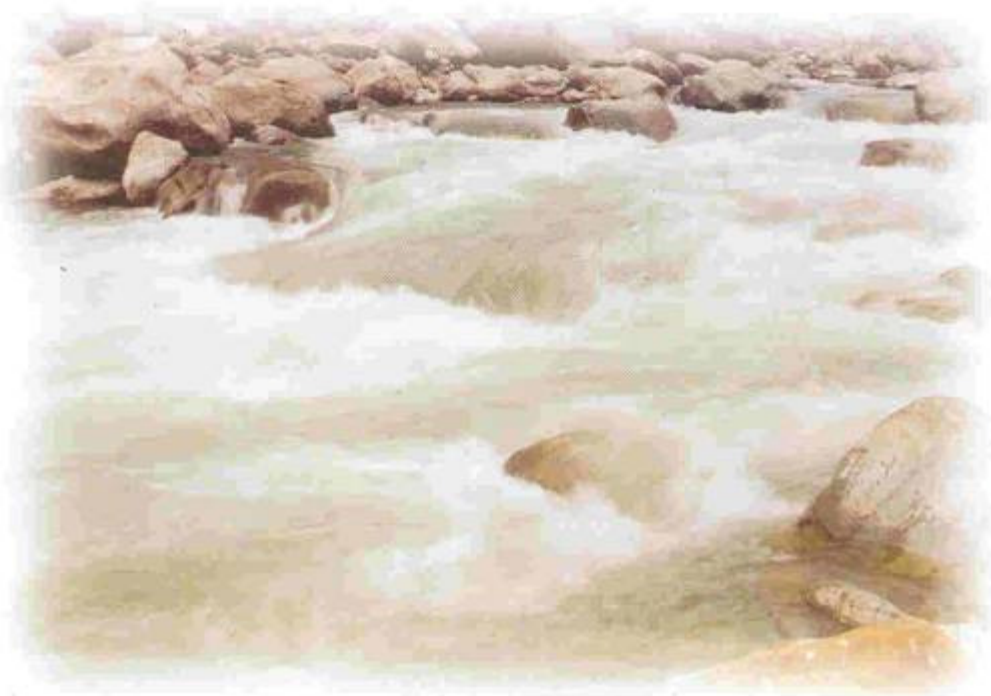
based on performance report and cost-benefit ratio for future application in wasteland development and soil and water conservation programme in the Himalayan region.

Results and Achievements

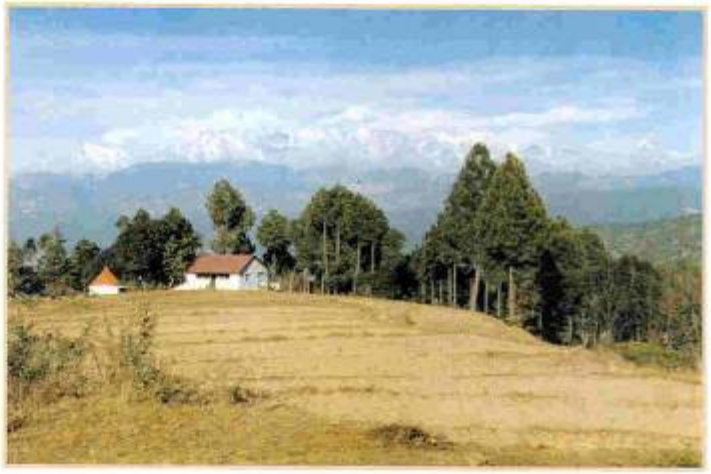
1. In five selected villages of Kumaun, where the farmers depend upon adjoining community lands for their fodder and fuel wood requirements, which caused degradation and making the land prone to soil erosion, about 44 ha of such land were taken for extension of SWEET model.
2. The soil of the selected site was tested before plantation (Table 3). Improve-ment in soil quality will be monitored every year.

Table 3: Soil physico-chemical characteristics of the community wasteland in Munao village

Soil parameter	Mean value (± SE)	Range	
		Minimum	Maximum
pH	6.53±0.17	6.15	8.03
Electric conductivity (us cm^{-1})	26.0±3.69	15.0	45.0
Organic carbon (%)	0.47±0.13	0.015	1.23
PO_4 (mg/L)	0.43±0.11	0.04	1.12
Water holding capacity (%)	46.5±4.09	19.0	61.0



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. 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) 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 community in North East India. So far Adi community from East Siang district, Niyshis from Papumpare district and Apatanis from Lower Subansiri district have been covered. For last two years, the work has been concentrated in West Kameng district. In the reporting year an attempt has been made to study the demographic profile, occupational structure, land use pattern and dependence (with particular reference to agriculture), and socio-economic profile of the Monpas, Sherdukpens, Akas, Khowas and Mijis based on the data collected from two villages of each of the community. Further more Sherdukpen community was studied in more detail with reference to their customary laws and village institutions, its continuity and changes over the years. Impact of customary laws in local governments and decision-making was also assessed.

Objectives

1. To assess natural resources and community structure and sustainable management practices among selected tribal communities.
2. To quantify the status of resources and traditional utilization patterns.
3. To assess village institutions and effectiveness of Customary Laws in system functioning of ecosystems at local level.
4. To quantify and assess the ecological efficiency of traditional natural resource management practices.

Results and Achievements

1. Studies in West Kameng district (HQs. Bomdila) were initiated. The district has three sub-divisions, viz., Kalaktang Community Development (CD) block, Nafra-Buragon CD block and Dirang CD block.

2. The district inhibits five major tribal groups, namely, Monpas (in Dirang circle), Akas (Jamiri circle), Sherdukpen (Rupa curcle), Bugun/ Khowas (Singchung circle) and Mijis (Nafra circle) and two minor groups, viz. Lishpa, Chugpa (they are found around Dirang). The total population of district is 74,595 persons (2001 census), with a population density of 10 persons per sq km. The estimated growth rate during 1991-01 was 32.21, literacy rate was 62% and the sex ratio is 749 female per 1000 males. The proportion of rural-urban population of the district is 90:10 persons. Dirang circle showed highest population with 17,827 persons whereas the Balemu circle had the lowest with 1,224 persons. Monpa is the most dominant tribe while Khowa (Bugun) had lowest population (Fig. 1).

3. Monpas and Sherdukpens are mainly agriculturist communities and generally do permanent cultivation. They, however, also raise yaks, which mainly fed on alpine pastures. The Akas, Khowas and Mijis live in the east of Sherdukpens in bamboo houses built on wooden posts, practice shifting agriculture and rear Mithuns. All the communities are highly depended on natural resources (collection of fuel, timber, wild edibles, medicinal plants, wild animal poaching and fishing). Demographic profile varies from village to village (Table 4).

4. Of the total land area of 7422 km^2 in West Kameng district, a major share of land is under forest cover. However due to extensive use of forest resources, the considerable area has degraded. Most of the high altitude areas are either under pasture or barren. Broadly, the Evergreen forest comprised 72.87% of total area in the district and 11.51% is under degraded forest. The Settled agriculture is just 2.77% while the total shifting cultivation area is 3.21% (Fig. 2).

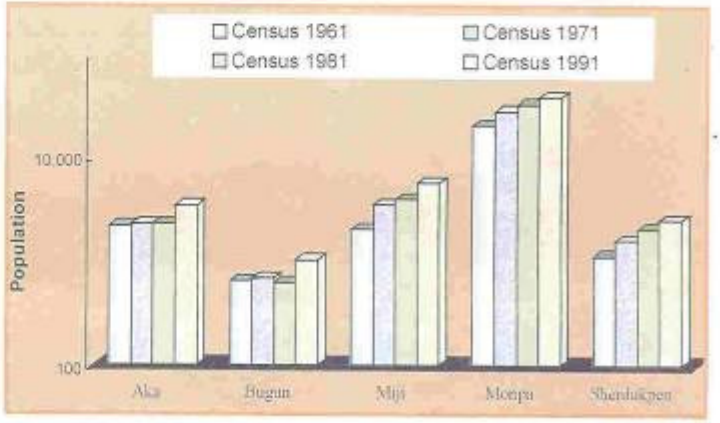


Fig. 1. Growth in the tribal population of West Kameng district

Table 4. Demographic profile of the study villages

Tribes	Study Villages	No. of House holds	Total persons	Males	Females	Literates	
						Males	Females
Miji	L/ Dzang	40	271	147	125	40	32
	U/Dzong	32	167	85	82	24	13
Khowa	Kaspi	44	193	106	87	62	36
Akas	Old Jamari	12	77	41	36	8	-
	New Jamiri	93	481	262	156	159	42
	Muna	11	46	27	19	12	5
Sherdukpen	Shergaon	302	1303	729	574	355	355
	Jigaon	82	458	254	204	129	129
Monpa	Dirang	297	1311	713	598	323	96
	Lish	147	738	381	357	93	9

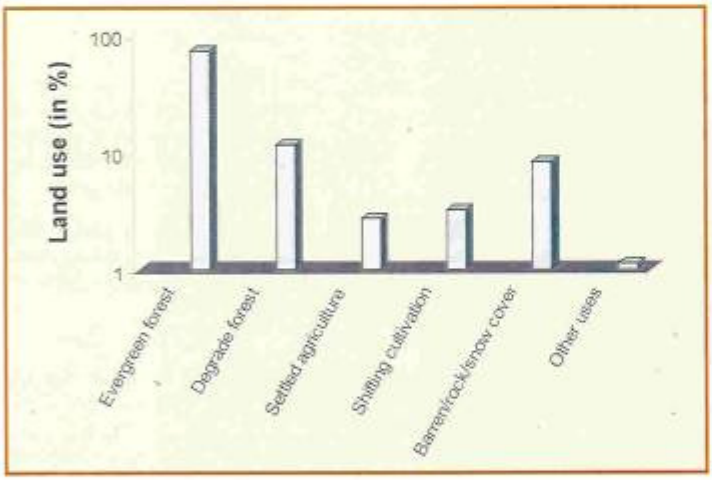


Fig. 2. Land use pattern of the West Kameng District

5. The shifting cultivation (jhum) is locally known as *Plumghing* by Miji tribe, *sibe* by Buguns and *sibey* by Akas. The area under shifting cultivation varies in different circles (Fig. 3). For shifting cultivation, the activities started in the month of January or February when the vegetation of a selected area is cut or slashed and thereafter burned in March- April. The crops are sown in a mixed way, which includes maize and millets as main crops with many minor crops, i.e. chilly, pumpkin, cucumber and other vegetables & spices. The crop harvesting is done from September onwards till November.

(b) Land use models for Himalaya

Background

In traditional agroforestry systems, farmers manage a number of multipurpose tree species (MPTs) on the raised margins of rainfed terraces which provide a variety of much needed non-timber products to the farmers. In agroforestry, the particular interfaces that need to be investigated are those between trees and crops. Light and temperature appear to be the most limiting factors beneath the tree canopies for crop productivity and any benefits from improved soil fertility and moisture in the proximity of the trees are outweighted by the reduced light. In this situation some management techniques are required to optimize the crop productivity with MPTs. Appropriate thinning (manipulation of the canopy) of the MPTs could be one such way by which the optimum sunlight could be made available for the growth of understorey crops. No study has so far been reported from this region on this aspect of canopy manipulation of agroforestry trees for the management of shade to optimize crop yield in the traditional as well as developed agroforestry systems.

(a) Central Himalayan Case Study

Objectives

1. To identify agricultural land use practices suited to the ecological and socio-economic attributes of

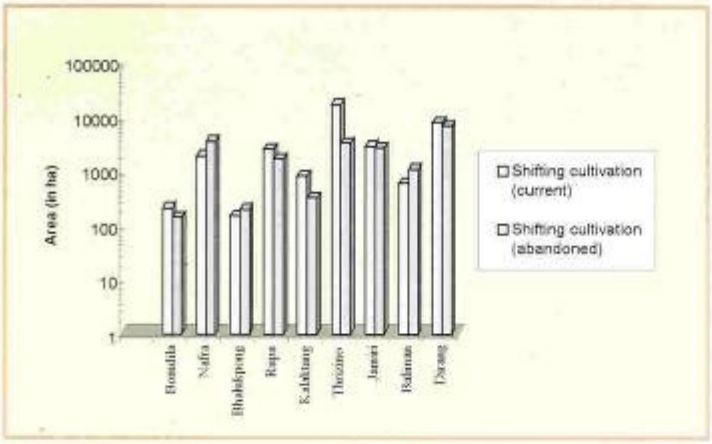


Fig. 3. Area under shifting cultivation in different circles in West Kameng district

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. Nine plots were randomly selected for creating each of five lopping regimes: intact canopy, i.e., no lopping, and removal of 25%, 50%, 75% branches starting from the canopy base and lopping of all branches (100% or full lopping). All these plots of a given lopping regime were randomly allocated to three major traditional winter crops, wheat, mustard and lentil, sown in November 2000 and harvested in March/April 2001. Similarly, three major rainy season crops, rice, barnyard millet and foxtail millet, were sown in May 2000 and harvested in September/October 2001. All agronomic operations (ploughing, manuring, sowing, weeding, harvesting and threshing) followed traditional practices (Table 5).

2. Total fodder and fuelwood availability from the tree component increased from 4015 and 5285 kg ha^{-1}, respectively, in the 25% lopping treatment to 17492 and 17950 kg ha^{-1}, respectively, in the full lopping treatment. *Alnus nepalensis* provided the highest amount of both fodder and fuelwood from lopped branches. *Pyrus pashia* yielded the lowest amount of fodder. The lowest amount of fuelwood was available from *P. pashia* and *Celtis australis* with insignificant difference ($P>0.05$) between them (Table 6).

(b) Northeast Himalaya 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 local 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

Table 5. Important features of cultivation of traditional crops in experimental site at Banswara in Central Himalayan Region, India

Crops	Features			
	Seed input (kg ha^{-1})	Manure input (t ha^{-1})	Ploughing (No. of times)	Weeding (No. of times)
Winter season crops				
Wheat	100	20	2	Once in January
Mustard	45	20	2	Once in January
Lentil	100	20	2	Once in January
Rainy season crops				
Paddy	90	20	3	Once in June and once in August
Barnyard millet	48	20	3	Once in June and once in August
Foxtail millet	45	20	3	Once in June and once in August

Table 6. Tree fodder and fuelwood available from mixed plantation over a period of one year due to different intensities of lopping (mean, n = 9) at Banswara, Central Himalayan Region.

Species	Fodder (kg ha^{-1})				Fuelwood (kg ha^{-1})			
	25%	50%	75%	100%	25%	50%	75%	100%
Albizzia lebbek	261	471	803	1012	472	777	1071	1235
Alnus nepalensis	1121	2202	3150	3964	1654	3486	4782	5732
Boehmeria rugulosa	503	1125	2002	2422	523	978	1378	1623
Celtis australis	251	602	1061	1303	233	457	685	882
Dalbergia sissoo	501	900	1502	1801	711	1411	2007	2502
Ficus glomerata	602	1351	2444	3021	652	1216	1752	2207
Grewia optiva	350	883	1581	1979	305	638	959	1219
Prunus cerasoides	232	481	952	1138	511	916	1328	1657
Pyrus pashia	194	408	633	852	224	447	673	853
Least significant difference between species (P = 0.05)	11	81	110	150	66	105	122	152
Total	4015	8423	14128	17492	5285	10326	14635	17910

4. To study the impact of contour-hedgerow species on insect infestation and crops damage, if any, and also on soil micro-fauna and flora

Results and Achievements

1. Over 175 local N_2-fixing species have been screened so far and a few important ones are being tested for their germination and growth performance. Germination and growth performance of few important N_2-fixing species is being monitored in the nursery. Hedgerows are being planted in contours along the slopes.

2. So far more than 5000 m length of hedgerows have been established. Hedgerows have attained good growth and biomass. The impact of hedgerow mulch on the selected crops is being monitored.

3. Four nitrogen fixing hedgerow species (viz. *Tephrosia candida, Flemingia macrophylla, Desmodium rensonii* and *Indigofera anil*), which are already recommended for NE region, are also being monitored for their performance in nine-different soil types. One set of experiment on *Flamingia, Tephrosia* and *Desmodium* species has already been initiated and for *Indigofera* is in process.

4. To observe the impact of pruning intervals on the performance of hedgerow species, an experiment has been initiated in pot culture under field conditions with four pruning intervals (i.e. 1, 2, 3, 4-months interval between two successive prunings).

5. Impact of hedgerow species as insect-pest repellent/attractant is being monitored by using 20 leaves of each of the four hedgerow species on quarterly basis to estimate the amount of leaf damage by insect feeding. Insect specimens of different species are being collected at different locations, each observation is in the process of identification for further studies.

3.2.2. People-centered Landuse Development in the shifting agriculture affected areas in Arunachal Pradesh

Background

Over the last hundred years there has been a variety of attempts to find a solution to the vexed problem of jhum cultivation (Shifting agriculture) in the north eastern region. The project focuses to contribute towards designing strategies for sustainable livelihood and development of traditional hill societies in the region, linking environmental concerns with sustainable development in selected locations in Arunachal Pradesh. It also aims to contribute for capacity building of the community through research, training and ecosystem management and conservation, and awareness programmes, and also to design and develop site-specific *in situ* strategies, explore *ex situ* conservation possibilities and bring together

scientists, managers, planners and local communities together with a view to design strategies for buffer zone management particularly in Namdapha national park, and community areas in Western part of Arunachal Pradesh. It is a multi-institutional project, cleared by MOEFs, Govt. of India, and major collaborators area the Arunachal University, the State Forest Research Institute (SFRI), North East Regional Institute of Science and Technology (NERIST), and the G.B. Pant Institute of Himalayan Environment & Development (GBPIHED), with academic co-ordination from School of Environmental Sciences, JNU, New Delhi. The GBPIHED is working in the West Kamang district while all other organisations have taken their sites in Namdapha area.

Objectives

1. To study landuse pattern and change, natural resource management, role of shifting cultivation in socio-economics of local communities, and assess village institutions, socio-cultural dimensions and traditional ecological knowledge.

2. To understand forest ecosystem dynamics, particularly of Reserve Forest (RF), Anchal Forests (AF) and Unclassified State Forest (USF), and identify its linkages with the community

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. All forest types of Eastern Himalaya, except for *Dipterocarpus* type, are present in West Kameng, and are rich in species diversity. Among different canopy layers the major timber species are found at canopy level, fuel and minor forest produce in the middle layer, whereas the ground flora consisted of economically important and medicinal herbs.

2. There are many rare and endangered plants species found in the area. The area also comprises large variety of unexplored plants which needs to be studied.

3. The Forest Department maintains different categories of forest considering the interest of the government as well as the local communities (Table 7). The major categories are- the Reserve Forest (RF)- An area notified by the state government through gazette notification; the Anchal Forest (AF)- Notified area including for one to many villages, revenue share on 50% basis between Forest Deptt. and communities; the Village Community Forest (VCF)- Notified area for a village on map, and the community has certain rights; and the Unclassified State Forest (USF)- all forest area other than above category having traditional rights of communities, and state govt. does not have rights on that.

4. The species composition vary in all these forests due to different level of pressures on them. Besides shifting cultivation, fire, grazing, medicinal plant collection, poaching, NTFPs harvesting are major threats to the flora and fauna.

5. Forest structure and anthropogenic pressure is being measured at Reserve Forests (RF), Anchal Forest (AF) and Unclassified State Forests (USF) stands. The biotic

Table 7. Protected Area (PA) Network in the study area

PA Network and location	Forest Division	Total area (km^2)	Major animals/plants of interest
Wildlife Sanctuaries:			
Pakhui WLS	Sejusa WL Div.	861.95	Elephant, Tiger, Gaur, Saqmbhar, Barking Deer, Binturong, Leopord, Pheasants etc.
Eagle nest WLS	Sejusa WL Div.	217.00	Vegetation and wildlife
Sessa Orchid Sanct.	Sejusa WL Div.	100.00	Orchids and wildlife
Reserve Forests:			
Doimara	Khellong FD	534.59	Timbers and wild animals
Papum	-do-	1063.86	-do-
Amatula	-do-	294.23	-do-
Tenga	Bomdia FD	96.60	Temperate species

pressure was high at USF areas than AF and RFs, however the tree density was recorded maximum at USF (360 tree ha^{-1}), followed by AF (429 tree ha^{-1}) and RF (180 trees ha^{-1}).

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

Background

The Himalaya constitutes a unique geographical and geological entity comprising 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 about forty villages of the block are being studied. During this year various information on fuel (availability, sources, type, uses, etc.) were collected and analyzed.

Objectives

1. To study the sources of fuel energy for household functioning.
2. To quantify the total production and consumption of fuel in the different geo-environment condition.
3. To study the population dependency on different fuel energy in different geo-environment condition.

Result and Achievements

1. In all the three zones it was found that the rural inhabitants are using fuel energy for cooking and lighting through out the year. In addition during the winter season they are using fuel for warming the cattle shed, rooms and water.
2. Fuel wood is an important form of energy in all three zones which is collected from different forest areas and from their own farm land but the percent of consumption decreased with decreasing altitudinal zones. It was about 98% in zone III and about 78% in the zone I. The remaining fuel energy is fossil fuel based kerosene oil and/or cooking gas purchased from the market.
3. The percent contribution of kitchen fuel supported by the farm itself increased with increasing altitude/ zones as it was about 5% in zone I to about 36% in zone III.
4. Women of the I zone covers maximum distance for fuel wood collection whereas the women of III zone covers minimum distance for the same.
5. Electricity is mainly used for lighting purpose for all the three zones but in case of kerosene oil it is used for lighting, cooking and water heating.

3.2.4. Farmers Field School-Cum-Training programme

Background

Providing sustainable livelihood technology training through participatory technology transfer method is a major activity of the programme. To be able to reach the rural inhabitants the communication mechanisms has to be down to earth. The core under this programme attempted training trainers from the local inhabitants who have potentials of training others and understanding of the intricate details of scientific interventions.

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

(a) Central Himalaya

1. Three field manuals were prepared and published for the benefit of trainers in the field on various aspects of sustainable livelihood technologies.
2. A total of 150 local farmers were trained at Phapharsali village of Hawalbagh Development block. These farmers were provided with opportunity to interact and discuss with prgressive farmers and trainers on the methods of improving the soil fertility, package of practices for improved cultivation.
3. Demonstration models on bio-composting, polyhouse technology and water harvesting technology for management of growing period and planting stock and soil fertility status along with life saving irrigation management were shown to the farmers.

(b) North-eastern region

1. Training programmes were organized at Doimukh and Midphu in Arunachal Pradesh on contour hedgerow technology and various aspects of sustainable livelihood technologies.

2. A total of 85 local farmers were invited for the training programmes and these farmers were provided with opportunity to interact and discuss with progressive farmers and trainers on the methods of improving the soil fertility, package of practices for improved cultivation.

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.

Background

Himalaya is distinguished as a global biodiversity hotspot where ecological and evolutionary factors favoured huge species diversity with over 1740 species of medicinal and aromatic plant species (MAPs) with various traditional and modern medicinal uses. Almost all medicinal plants collected, either legally or illegally all over the Himalaya or even other parts of the country for different purposes, are from the wild and very small number of species are cultivated. Large scale over exploitation has resulted in the reduction of population of many of these species in their natural habitat, leaving little scope for their natural regeneration. However, a considerable knowledge base exists with the indigenous communities, which traditionally cultivate a few medicinal and aromatic plant species (MAPs) in smaller scale for their domestic use, local market and bartering purposes. All these MAPs are cultivated under the low input system through indigenous techniques which provide low yield. In the wake of growing concern in relation to monetization and commercialization of the medicinal plant economy, across the globe, there is a need to promote cultivation of MAPs and develop appropriate agro-techniques of some potential species using simple and cost-effective techniques. This will not only provide the employment opportunities to the locals of the region but will also help in conservation and management of natural resources including MAPs of the region.

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 already brought under cultivation.

3. To work out cost-benefit analysis of cultivation and their role in local economy.

4. To create awareness among the villagers/farmers towards cultivation of medicinal plants and their role in economic opportunity generation and conservation of natural resources.

Results and Achievements

1. Seed germination and improvement studies were carried out for following medicinal and aromatic plants species : *Aconitum heterophyllum*, *Arnebia benthamii*, *Saussurea costus*, *Selinum vaginatum*, *Rheum emodi* and *Carum carvi*. Among the species, seed germination without any treatments ranged between 46% to 76%. Hot water treatments significantly improved the germination in case of *R. emodi* (100%), *A. heterophyllum* (91%) and *S. costus* (85%). However, the application of GA_3 (200 ppm) exhibited 93% germination in *A. benthamii*, the seeds of *C. carvi* showed 100% germination in cold-water treatments.

2. Vegetative propagation studies were carried out in few selected MAPs i.e. *Selinum vaginatum*, *Rheum emodi*, *Dactylorrhiza hatagirea*, *Arnebia benthamii*, *Allium* species, *Angelica glauca* and *Pleurospermum angelicoides* for their large-scale multiplication / cultivation, while using simple and cost effective techniques. It was observed that when rhizome of each species cut into single or two equal pieces exhibited 100% sprouting/emergence as well as survival. But, when rhizome of these species cut into three or four equal pieces, sprouting/emergence and survival decline upto 10 to 20%.

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

Background

Arunachal Pradesh is inhabited by over 26 major and 110 sub-tribes. These communities intimately dependent on their natural resources for their survival and basic needs, and possess huge knowledge about the utilization and management of various resources. Diversity of food resources and traditional knowledge regarding their use play a vital role in fulfilling the demands of proper nourishment of all including the nursing and expectant mothers of the indigenous communities.

which is being practiced since time immemorial. Unfortunately during recent years due to large-scale deforestation and decline in soil fertility, many such important food sources along their knowledge base are eroding fast. There is an urgent need to screen out the available information on such plants, explore them in their natural habitats, document indigenous knowledge about their utilization and management, and taking necessary step for their *in-situ* conservation with identifying new species of potential use becomes imperative to conserve such resources. Some of the species must be conserved through large scale multiplication (*ex-situ*), should be distributed to the local farmers to avoid their over exploitation, using some low cost technologies that are easily accessible to the local people.

Objectives

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

2. To augment agricultural productivity by introduction of simple soil fertility enhancement measures such as by the introduction of biocomposting.

Result and Achievements

1. A total 157 households from two villages of Nishi and two from Adi areas were surveyed. Analysis showed that most of the sampled population of mothers is predominantly illiterate, and only 22% women were found to be educated. The education level had a definite impact on the family size and generally educated mothers (families) had less number of children. As the education level increases, the reproductive health status of village women has also improved. Level of education of the village women has been found to have a clear positive impact on all other aspects as well. General spacing trend, which includes 9 months of gestation period, showed that most of the women have an average spacing of 2-2.5 years in between two children.

2. Nearly 3% of the total surveyed women have been found to have conceived their first child in less than 15 years of age, and almost 75% of total women gave birth to their first child at an age below 18 years. This teen-age motherhood had a direct relation to mean child mortality and complicacies during birth. About 55% of total surveyed women had 1-3 number of children, while 22% were found to have mean number of children above 5.

3. Early marriage, poor reproductive health status and teen-age motherhood are very common in the community, which ultimately leads to many complexities in women during birth time, at times is dangerous to both the baby and the mother.

4. The Nishi community of Papum Pare district does not have any specific food items for the expecting and nursing mothers. So a detail survey of all types of edible plants has been done. In total information regarding 159 wild edible plants has been collected. From the listed plants it has been found that leaves of *Clerodendron viscosum*, pith of *Angiopteris evecta* and *Cythea gigentia* and leaves of *Piper pedicellosum* are very common in their diet. Besides five *Dioscorea* species were also reported as very common edible items of the villagers.

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 9 No. 1 and 2 were published.

2. 160 queries were handled during the year 2001 to provide response services.

3. Attempts were made to update the demographic data base with 2001 census information.

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 centre 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
4. To offer advice and assist scientists in the preparation of research proposals and obtaining funds

Results and Achievements

1. Compilation of abstracts and bibliography was continued.
2. Collaborative project submitted for possible funding from GEF was pursued and the sanction was obtained for starting the activity from 2002.

3.2.9. Impact of multipurpose contour hedgerows inter-cropping on productivity and soil fertility in shifting agricultural (jhum) fields in the North East India

Background

The slash and burn agriculture shifting cultivation (jhum) is the predominant form of land use in NE region and nearly 43 thousand families practice jhum agricultural system that has a very close linkage between food production systems and natural forest ecosystem. The jhum practice involves slashing of the vegetation of a desiegnated plot that is dried and burnt before rains for immediate release of nutrients. Unfortunately the rapid depletion of the natural resources during recent years, particularly the deforestation has adversely affected the productivity of the lands. This has decreased food production and also enhanced soil erosion. The contour hedgerow inter-cropping system based on the planting of N_2-fixing hedgerow species along the contours and allowing crop production in alleys holds promise as hedgerow species provide biomass availability for mulching and also reducing soil erosion to a greater extent. It can easily be duplicated by upland farmers with the use of local resources, require minimal labour, thus is economically feasible and easy to be acceptable culturally. The present study focuses on the impact of hedgerow incorporation and biomass mulching on crop productivity and soil fertility in shifting agricultural fields in Arunachal Pradesh. The project has been sponsored by DST under its Fast Track Young Scientist Scheme.

Objectives

1. To study hedgerow species biomass accumulation, pruning, and frequency and assess impact of mulching on soil moisture and weed proliferation.
2. To assess nutrient release from leaf litter and mulch biomass.
3. To study root nodulation in hedgerow species and impact of pruning on its frequency.
4. To study nitrogen age activity of different hedgerow species, and to assess the impact of soil on root nodulation.

Results and Achievements

1. Growth performance of the selected hedgerow species (i.e. *Flemingia macrophylla, Desmodium rensonii, Indigofera anil* and *Tephroshia candida*) is being monitored. Data collection on cutting frequency and biomass production at 40-50 cm height above ground for all hedgerow species at monthly, bimonthly, trimonthly and quarterly intervals is under progress.
2. Soil moisture content and temperature as affected by hedgerow incorporation is being studied for steep and gentle slopes at two depths (0-15 cm and 15-30 cm). The soil moisture content was higher at upper soil layers (0-15 cm depth) than the lower soil depths (15-30 cm). Soil between double hedgerows had highest moisture content than the soil of alleys and control site. Contrarily, the control site showed maximum soil temperature, followed by alleys and minimum in between the double-hedgerows.
3. Impact of mulching of hedgerow biomass on crop yield and total production was assessed using a randomized block design for cabbage crop (45x 60cm plant to plant and row to row distance). The best plant growth was recorded in plots applied with heavy mulch followed by light mulch. The per plant production was more than double in treated plots than the control plot. Mere hedgerow incorporation increased the crop production by 20% than the control plots. Application of green mulch @5 t ha^{-1} increased crop production up to 35.49-44.84 t ha^{-1}, while mulching @10 t ha^{-1}, the crop increased to 38.00-57.47 t ha^{-1}. For no mulch with hedgerows the total crop yield was recorded was 24.014-26.889 t ha^{-1}.

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; programme to identify and monitor 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
2. Identifying degree of biotic and anthropogenic pressures causing fragmentation
3. Identifying habitats that support important taxa
4. 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. Compilation of the vascular plants and analysis of the data for various ecological parameters including delineation of forest communities recorded from a number of forest sites has been initiated.
2. Soil samples were analysed for physical and chemical parameters. The soil moisture content of the forest sites ranged between 2.00-38%; pH between 3.90-6.80; organic matter between 0.92-17.17%, organic carbon 0.53-9.96%; nitrogen between 0.03-0.98% and C/N ratio between 5.30-35.00.
3. Resource utilization pattern of the Dhyoli and Bhargaon villages indicated that over 50 species of vascular plants are utilized by the inhabitants of the villages for medicine, food (wild edible), fuel, fodder, house building, fiber, religious and various other purposes.
4. Over 15 species of crops, 20 species of vegetables and 15 species of fruits have been cultivated in the villages. Among these species *Citrus sinensis, C. reticulata, C. limon, C. aurantifolia, Pyrus communis, Solanum tuberosum, Raphanus sativus, Allium cepa, A. sativum* and *Colocasia esculenta* are traded.

(b) Biodiversity studies along disturbance gradient

1. In three selected forest types i.e., Pine, Mixed and Oak forest in each site (i.e., Syaidevi, Kukucheena and Aincholi) structural/ compositional details of vegetation during winter and rainy season have been completed.
2. Data were analysed for structural/ compositional patterns across different disturbance gradients. Preliminary results suggest that in Syaidevi forest the index of diversity (H') ranged from 0.00 (Pine forest semi degraded site) to 1.81 (Mixed forest-pristine site). In Kukucheena forest it ranged from 0.26 (Pine forest-Semi degraded forest) to 1.98 (Mixed forest-pristine site), and for Aincholi forest the total diversity (H') ranged from 0.20 (Pine forest-pristine site) to 1.52 (Mixed forest-pristine site).
3. In Pine forest maximum richness of tree species was found in Degraded site (3-9 species) and minimum in pristine site (1-4 species), in Mixed and Oak forest maximum richness of tree species was found in pristine site (4-8 species), and in Mixed and Oak forest maximum richness of tree species was found in Pristine site (4-8 species-Oak forest; 7-12 species-Mixed forest) and minimum in degraded site (3-6 species-Oak forest; 4-7 species-Mixed forest).
4. The total herb and shrub density in all the forests were maximum in Degraded site and minimum in Pristine site.
5. The soil was acidic in nature in all the study sites, pH ranged from 3.93-6.10 in Aincholi Oak forest and Syaidevi Pine forest, respectively. Organic carbon ranged from 0.502-7.056% and moisture content (5-25%).

(c) Studies in sensitive habitats - timberline

1. Compositional features of timberline vegetation were analysed for three different sites (i.e. Lata and Tungnath in Garhwal and Pindari in Kumaun) at three altitudes (i.e., 2800, 3200 and 3600 m amsl). The total forest stand tree density (843 ind/ha) was highest at

2800 m in Lata site. Across all sites it was noticed that both tree density and total forest basal area decreased considerably with increasing altitude.

2. Seedling and sapling density was relatively high in mid elevation (3200 m) plots of all the sites (Lata site seedlings & saplings density: 2800 m – 4400 & 7000, 3200 m – 4400 & 8300, 3600 m - 2000 & 2000; Tungnath site seedlings & saplings density: 2800 m – 2300 & 4050, 3200 m – 2800 & 4300, 3600 m - 8000 & 2200; Pindari site seedlings & saplings density: 2800 m – 8400 & 4750, 3200 m – 9300 & 5350, 3600 m - 8300 & 7300 ind/ha).

3. Density-distribution curves were prepared for different altitudes and sites (Fig. 4).

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

1. Using quadrate methods, population studies in *Hedychium spicatum* were made in KWLS. Initially, six sites (3 sub-sites each) located along 1600 - 2100 m altitudes were targeted for different topography and canopy coverage.

2. Density and frequency of the individuals was obtained for each sub-sites. Sample harvesting of individuals was made to assess potential sites for targeted taxa. Qualitative and quantitative observations were made for plant morphology and biomass.

3. A total of ten microhabitats were identified for *H. spicatum*, of which Moist Moss Laden Boulder (canopy) showed maximum density (8.8 plants/m^2) and Rotten Moss Laden Log (canopy) showed the minimum (4 plants/m^2). Other micro-habitats with high density were Forest Spring, Moist Moss Laden Rocky Slope (canopy), Moist Moss Laden Rocky Slope (Open) and Dripping Moss Laden Rock, etc.

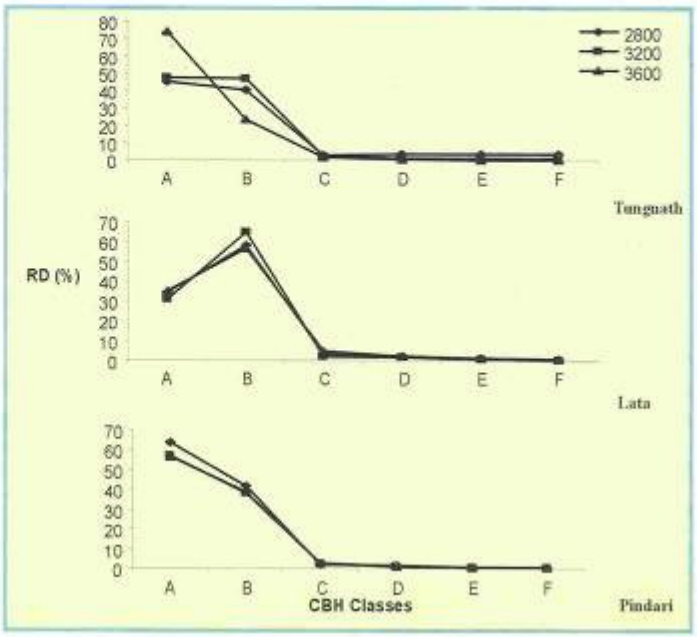


Fig. 4. Population Structure at different altitude and sites.

4. Highest frequency (33.89) of individuals was obtained for Moist Moss Laden Rocky Slope (Canopy) and minimum (1.67) for Rotten Moss Laden Log (Canopy).

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, endemic, key stone species, orchids, etc.) has been initiated.

Objectives

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

Results and Achievements

1. Inventory of orchids of Trans, Northwest and west Himalaya has been prepared. 244 species of orchids belonging to 5 sub-families and 72 genera have been listed.

2. Among the subfamilies, Epidendroideae (19 genera and 91 species) showed the richness in species, followed by Orchidioideae (58 spp.), Vandoideae (50 spp.), Neottioideae (42 spp.) and Cypripedioideae (3 spp.).

3. Among the genera *Habenaria* (17 spp.), *Dendrobium* (15 spp.), *Bulbophyllum* (11 spp.), *Oberonia*, *Liparis* and *Peristylus* (10 spp., each), *Eria* and *Eulophia* (9 spp., each), *Cymbidium*, *Herminium* and *Calanthe* (8 spp., each), and *Malaxis* and *Nervilia* (7 spp., each) are species rich.

4. Maximum species (i.e., 211) are distributed in the sub-tropical zone (<1800m), followed by the temperate zone, 1801-2800 m (103 spp.), sub-alpine zone, 2801-3800 m (63 spp.), and alpine zone, > 3800 m (21spp.).

5. 155 species are native to Himalayan region and 13 species are native to Himalayan region and neighboring countries together. 19 species are endemic and 63 species are near endemic.

6. 15 species have been recorded in the Red Data Book of Indian Plants (Table 8).

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-Almora (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 at Kosi-Almora.

1. Extension of the nursery and arboretum area for the introduction and establishment of germplasm including orchids, ferns, medicinal and wild edible plants, and rare-endangered species was carried out.

2. Propagules of over 50 species including rare-endangered species, orchids, ferns, medicinal and wild edible plants were collected and accessioned. Germination and growth performance of the species were monitored.

3. In the nursery beds seeds of *Fraxinus micrantha* showed

Table 8: Rare-endangered orchids listed in the Red Data Book of Indian Plants

Taxa	Altitudinal range (m)	RDB status
Calanthe alpina Hk. f. ex Lindl.	2400-3600	Rare
C. mannii Hk. f.	1200-2400	Rare
Cymbidium hookerianum Reichb. f.	1500-2500	Vulnerable
Cypripedium cordigerum D. Don	2500-3000	Rare
C. elegans Reichb. f.	2500-4000	Rare
C. himalaicum Rolfe	3000-4300	Rare
Diplomeris hirsuta (Lindl.) Lindl.	Upto 1000	Vulnerable
Eria occidentalis Seidenf.	1200-1500	Rare
Flickingeria hesperis Seidenf.	1500-2000	Endangered
Neottia microglottis (Duthie) Schltr.	1800-2600	Rare (Kumaun, Garhwal)
Eulophia mackinnonii Duthie	Upto 800	Rare
Neottia inayatii (Duthie) Beauv.	2500m	Rare
Aphyllorchis gollani Duthie	2400-3000	Endangered/Possibly extinct
A. parviflora King & Pantl.	3600	Rare
Calanthe pachystalyx Reichb. f. & Hk. f.	2000	Endangered

56.38% germination whereas in polythene bags seeds showed poor germination (i.e., 16%), and seeds of *Dalbergia sissoo* showed 33.50% germination in nursery beds. Seeds of *Holboellia latifolia* and *Hippophae salicifolia* showed no germination.

4. Developmental responses in relation to diameter, height and number of branches of the saplings of 19 species established in the arboretum sites were monitored.

5. Over 5,000 seedlings were planted in the arboretum sites and Institute premises. Seedlings of multipurpose species were also distributed to local inhabitants through various projects of the Institute.

(b) Propagation protocols for MPTs

1. *Myrica esculenta*, a high value multipurpose tree species in west Himalaya, was investigated for source dependent variation in seed germination. Seed set, obtained from three different altitudes, forest types and tree size classes, were compared and potential effects of pre-sowing treatments on seeds of different sources assessed.

2. *Myrica esculenta* exhibits significant adaptive germination variation across seed sources of different altitudes. In controlled condition high altitude seed source (2200 m amsl) responds (40.3%) markedly better than the seeds from lowest (1400 m amsl) altitude source (20.9%).

3. Prechilling (20 d, 4°C) improved germination significantly ($p < 0.05$) over control for seeds from all the altitudes. However, mean germination (78.3%) obtained for high altitude population under this treatment was significantly better than the responses under other treatments. Prechilling also reduced the mean germination time (MGT) compared to control in all the cases.

4. Seed germination responses varied markedly among habitats. Prechilling and mechanical scarification plus GA_3 improved the germination of seeds from all the habitats. However, significantly higher germination (70.3%) was observed for seeds from pine forest (under prechilling).

5. Variations in seed germination responses for untreated seeds across habitat and CBH classes are presented in Fig. 5. Compared to seeds of lower girth class (A) seed from higher girth classes (B & C) exhibited better germination.

6. Germination of three month stored seeds, under prechilling (68.3%) was better than fresh seeds (50.8%).

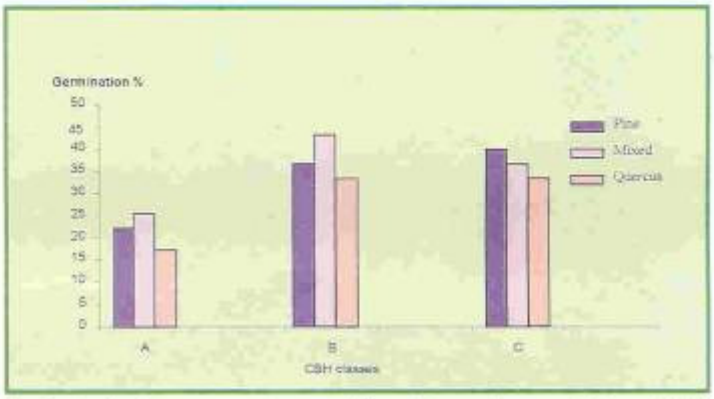


Fig. 5: Germination responses of untreated *M. esculenta* seeds across habitats and CBH A: <60; B: 61-90; C: >90cm CBH)

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 (VIII in this series) was organized at GIC Syalde, District Almora, on February 2-3, 2002 (Fig. 6). Over 111 participants (79 students, and 32 teachers) representing 31 educational institutions of Syalde, Bhikyasain and Salt Blocks in District Almora, participated in the Workshop.

2. Following aspects of biodiversity conservation were introduced to the participants through deliberations and demonstrations: definition and dimensions of biodiversity, traditional and contemporary approaches of assessment/monitoring; linkages of biodiversity with soil and other environmental factors; importance of traditional knowledge system; techniques of *in situ* and *ex situ* conservation; value of biodiversity and value addition; and relevance of genetic diversity studies.

3. Group discussions were organized with students and teachers separately to identify the area specific biodiversity related issues. Possible approaches of addressing these issues were also discussed. A structured questionnaire was circulated among the participants to assess the impact of training and their response was obtained.

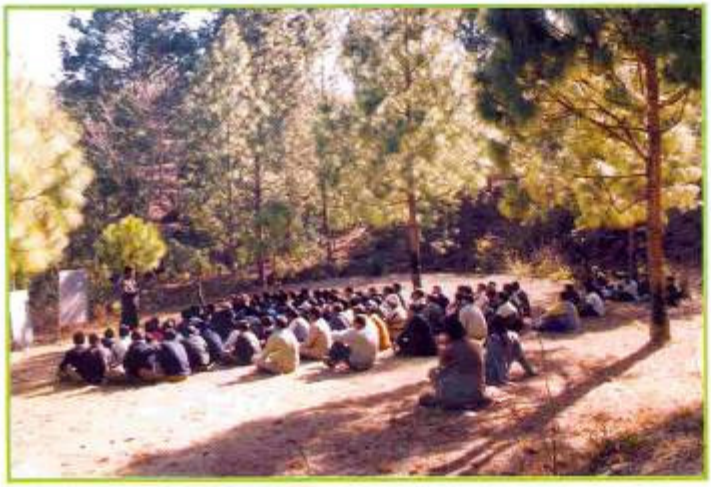


Fig. 6: Participation of school children in the training workshop on Biodiversity conservation

3.3.5. Studies on the Structure, Composition and Changes of the Vegetation in Nanda Devi Biosphere Reserve of West Himalaya

(Summary of the completed project)

Background

The protected areas of the Himalaya represent unique species, habitats, communities and ecosystems. In most of the protected areas comprehensive studies have not been carried out so far. Therefore, focused studies on the structure and composition of vegetation, delineation of forest communities, human dependence on the biological resources including the extent of extraction, species preference, changes in the structural and compositional patterns of vegetation and identification of rare endangered species and their habitats are required. The project was initiated to undertake studies in these directions in Pindari, Milam and Lata-Tolma- Phagti areas of Nanda Devi Biosphere Reserve in Uttaranchal.

Objectives

1. To delineate plant communities along an elevational gradients and assessing their compositional and structural patterns

2. To assess human dependence on different plant communities

3. To analyze changes of the vegetation

4. To identify conservation priorities and mapping

Results and Achievements

1. Twenty three forest communities representing five habitats and 62 alpine communities representing nine habitats have been identified from Pindari, Milam and Lata Tolma Phagti areas of the Reserve.

2. In the forest zone, in general, the total tree density ranged from 400-1220 ind/ha; total basal area ranged from 16.60-164.81 m^2/ha; total shrub density ranged from 1490-6695 ind/ha, and total herb density ranged from 24.2-391.2 ind/m^2.

3. From the forests communities 509 species (trees: 51 spp; shrubs: 79 spp.; and herbs: 379 spp.), and alpine communities 421 species (herbs: 387 spp.; and shrubs: 34 spp.) were recorded.

4. In general, among the communities the richness of trees ranged from 5-27, shrubs from 10-31 and herbs from 30-79. Species diversity (H^1) for trees ranged from 0.45-2.50, shrubs from 0.76-3.14 and herbs from 1.81-3.49.

5. Alpine vegetation has been analyzed for density, distribution pattern, species diversity (H^1), species richness, and concentration of dominance.

6. 62.67% species of the forest zone were native, 2.50% species of the natives were endemic, and 44.51% species were near endemic; whereas 65.56% species of the alpine zone were natives, 3.26% species of the natives were endemic and 52.90% species were near endemic.

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

Background

Recent conversion of the Khangchendzonga Biosphere Reserve 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 represents one of the biodiversity hot-spots from the eastern Himalayan region. Khangchendzonga is a unique mountain ecosystem falling in three different national boundaries of India, Nepal and Tibetan Autonomous Region (GIS generated Fig. 7). This mountain ecosystem encompasses subtropical to alpine zones housing a large number of flora and fauna and makes it a hot-spot of biodiversity. In this mountain ecosystem we find great variations in elevation, climate, landscape, habitat and vegetation types. It has a rich ethno-cultural diversity and the socio-economic attributes of the people living in and around this mountain ecosystem are location specifically variable and unique.

Objectives

1. Assessment of landscape change and specialized habitat monitoring for identification of keystone species with respect to habitat change

2. Man-animal-biosphere interaction on specific places

3. Functional understanding of vegetation types based on altitudinal distribution

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

Results and Achievements

1. In the buffer zone/fringe areas, a comparison of tree densities, regeneration and biomass across the degraded and undegraded sites was undertaken. In January

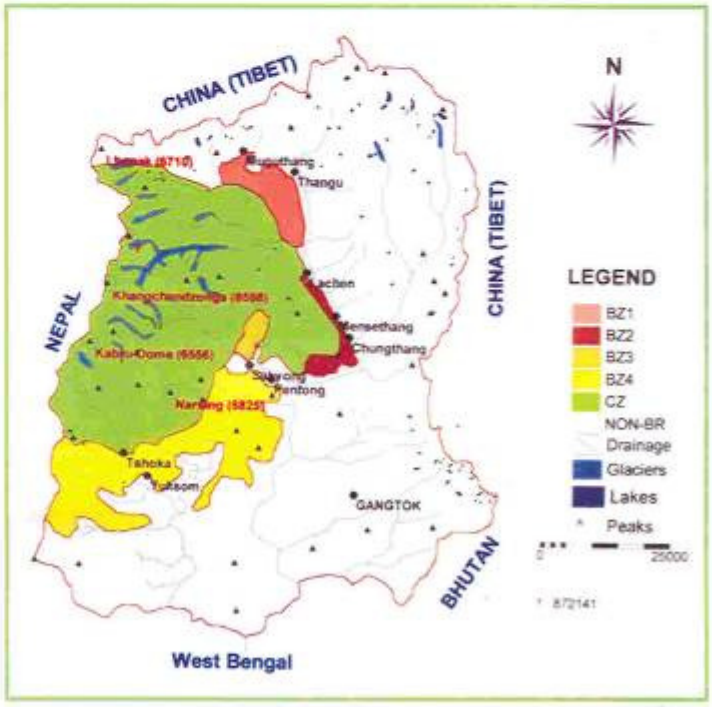


Fig. 7. Geographical information system (GIS) generated map of Khangchendzonga Biosphere Reserve in Sikkim showing its components as well as important glaciers, lakes and peaks

2001 woody tree biomass for degraded forest was 4123 ton ha^{-1}, whereas undegraded forest had 1619 ton ha^{-1} biomass. This difference is attributed to the larger DBH class sizes of the trees of degraded forest stand although the tree density was less while in undegraded site, the tree density was more with lower DBH class size of trees.

2. The mean tree density of degraded forest stand was 350 trees ha^{-1} while it was 700 trees ha^{-1} in undegraded forest stand. Low tree density in the degraded forest stand was due to more anthropogenic pressure. This was found to increase with an altitudinal gradient and could be a pointer of pressure on resources in future.

3. The number of saplings in the degraded stand (2103 sapling ha^{-1}) was lower than the undegraded forest stand (5258 sapling ha^{-1}). Similarly, number of seedling in the degraded forest (4842 seedling ha^{-1}) was also lower than the undegraded forest stand (6788 seedling ha^{-1}). The low natural regeneration of sapling was primarily due to the impact of grazing animals and heavy trampling by animals.

4. Survey in the selected settlements close to buffer/fringe areas was done on the preferred fuelwood, fodder and timber species. It was found that there are nearly 23 fuelwood and 20 fodder species of diverse nature used by the inhabitants. Such estimates should serve the purpose of baseline information for assessment of changes and pressures due to fringe area human-animal activities.

5. The preferences and usage of fuelwood, fodder and other non-timber forest produces (NTFP) including medicinal plants in the 6 sample settlements close to buffer zone (Fig. 8) showed that the annual consumption of NTFP by different settlements was lower than fuelwood and fodder. Resources (fuelwood, fodder and other NTFP) used by settlements of Thangu, Mensethang and Sakyong was about 1.5 times (1.5 ton yr^{-1}) more than the other settlements of Lachen, Pentong and Chungthang (10 ton yr^{-1}).

3.3.7. Evaluation and propagation of selected endemic medicinal plants of the Himalaya

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

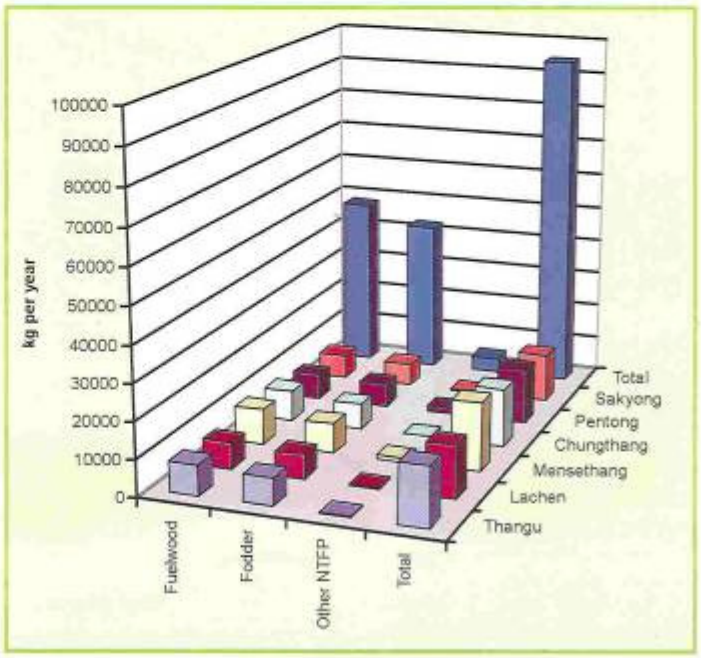


Fig. 8. Fuelwood, fodder and other NTFP usage pattern of sample settlements of KBR fringe area in North Sikkim

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

5. To develop germplasm bank of proposed taxa in selected sites

Results and Achievements

1. Distribution pattern and ecological status of different populations of *Arnebia benthamii*, (10), *Angelica glauca* (8), *Swertia angustifolia* (9) and *Saussurea obvallata* (5) in Uttaranchal and Himachal Pradesh, have been investigated (Fig. 9). *Arnebia benthamii* reveals high level of genetic variability among different populations.

2. Improvement in seed germination using various plant growth regulators have been achieved in *Arnebia benthamii*, *Angelica glauca*, *Swertia angustifolia* and *Saussurea obvallata*.

Fig. 9. *Arnebia benthamii* in naural habiat

3. Vegetative propagation through terminal growing point of root has been achieved in *Arnebia benthamii*.

4. *In-vitro* propagation protocol for *Swertia angustifolia* (using leaf, root and epicotyl segment), *Arnebia benthamii* (using terminal point of root) and *Saussurea obvallata* (using epicotyl segment) has been developed.

5. Live specimens and seedlings of *Arnebia benthamii*, *Angelica glauca*, *Swertia angustifolia* and *Saussurea obvallata* raised through conventional methods are maintained at the Institute arboretum.

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 including modeling system for integrating social, economic and ecological data. The Central Government has designated Lead/ Coordinating Institution for each existing Biosphere Reserve 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 Biosphere Reserves.

Objectives

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

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

3. Interaction with Biosphere Reserve managers to assess the research needs and crucial issues requiring research efforts

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

Results and achievements

1. Literature survey was carried out and research papers/articles published in journals, books, magazines, and also in technical reports, etc. were collected. Information was compiled, synthesized and documented.

2. Interaction/Coordination with the State and Central Government organizations and NGO's was carried out through correspondence, and project proposals on various gap areas of the Reserves were invited from these organizations.

3. The Himalayan Biosphere Reserves Biannual Bulletin, Vol. 3 (1&2) was published. The Bulletin includes comprehensive data base on the fauna of Nanda Devi Biosphere Reserve, floral diversity of Valley of Flowers National Park

and Manas Biosphere Reserve, management issues of Dehang-Debang Biosphere Reserve, abstracts, project and Ph.D. summaries, news items, bibliography, etc.

4. Comprehensive database was prepared for Nanda Devi Biosphere Reserve in the Nomination Form for UNESCO MAB network.

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. Compositional features under different disturbance levels at TLZ of UKBR were studied and analysed (Table 9).
2. Demographic patterns of three dominant communities viz., *Abies pindrow*, *Betula utilis* and *Acer*-mixed were obtained under different disturbance categories.
3. Secondary information from Forest Working Plans obtained and compiled.
4. Seasonal monitoring of recruitment patterns and diversity of herbaceous flora is continuing.
5. Experimental designs and data set for litter dynamics studies were developed.

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

Background

The use of medicinal and aromatic plants in Ayurvedic, Unani and other traditional systems has increased the demand of most of the high value species growing in the Indian Himalayan Region. The increasing demand of Medicinal and Aromatic Plants has increased pressure on most of the wild populations of high value species. This has caused decrease in

Table 9. Compositional features of trees, shrubs, herbs and recruitment pattern under different disturbance levels at timberline zone of UKBR

Parameters	*Betula utilis*			*Abies pindrow*			*Acer* mixed		
	A	B	C	A	B	C	A	B	C
Stand Density (**ind ha^{-1}**)	1206	746	820	720	533	726	1046	920	710
Total Basal Area (m^2 ha^{-1})	33.45	35.98	17.90	62.22	86.77	53.17	34.29	20.40	30.57
Diversity Index (H')	0.35	0.59	0.70	0.80	0.99	1.35	1.33	1.22	1.67
Concentration of Dominance	0.82	0.69	0.46	0.49	0.48	0.30	0.31	0.39	0.21
Shrub Density (**ind ha^{-1}**)	4810	3630	1360	2165	2180	627	1191	1973	700
Herb Density (ind ha^{-1})	206000	184800	82000	128400	194800	73300	162000	163000	83000
Sapling Density (ind ha^{-1})	27000	24500	7200	18900	16600	7000	22600	21500	4100
Seedling Density (ind ha^{-1})	20800	16800	8900	14600	20000	14500	17200	13900	10000

A – Pristine (Inside Valley of Flower PA)
B - Semi-degraded (Relatively less human impact / small grazing)
C - Degraded (High human impact / grazing)

the population of most of the species to a great extent. To maintain and conserve the germplasm of high value Medicinal and Aromatic Plants, 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 Medicinal and Aromatic Plants 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, Almora

Results and Achievements

1. A Nursery was developed approximately in 1 ha land. Nursery beds were prepared for the establishment and maintenance of medicinal and aromatic plants.

2. Propagules of over 20 Medicinal and aromatic plants have been collected from various locations for the establishment of herbal garden.

3. Among the cultivated species, *Acorus calamus* and *Valeriana wallichii* have been categorized as critically rare, and *Hedychium spicatum, Thalictrum foliolosum,* and *Bergenia ligulata* as vulnerable.

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. Female involvement in marginal work in Kullu district is about 11 times higher than that of male. Further, lean periods in horticulture production affects female wages in marginal works. To compensate the loss of wages in orchard activities, male labours usually get diverted towards medicinal plant extraction. However, uncertainty of marginal work exploration not only dissipate the female energy and time alone but remove her physically far from her vicinity, and hinder her to dispense with family responsibilities. *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 remain the source of economy of 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

Results and Achievements

1. Based on household survey, determination of Ethnomedicinal Use Index (EUI) indicated *Aconitum heterophyllum, Picrorhiza kurrooa, Thymus serpyllum, Dactylorhiza hatagirea Angelica glauca,* etc. as top used taxa in identified villages.

2. A workshops on 'Medicinal Plants Cultivation' was organised at village Shat (18 men and 24 women). A field exposure training (exchange) of villagers (13 men and 9 women) of village Shat to demonstration plot at village Silha was organised In addition numerous one to one basis interactions and several small group meeting for mobilising villagers.

3. In village Silha a Field Training on Cultivation Techniques was organised where villagers were demonstrated on planting technology by using practical harvest from demonstration plot.

4. In addition to half a dozen household level plots each in two villages, at village Shat a demonstration plot (on voluntary basis) was established for medicinal plant cultivation trials for sensitive and trade taxa. These are *Angelica glauca, Aconitum heterophyllum, Hedychium spicatum, Podophyllum hexandrum, Picrorhiza kurrooa, Saussurea costus, Valeriana jatamansi, etc.*

5. Even using a quarter (63% survival) and half (71% survival) part of nodal segment of rhizome,

of *H. spicatum* has shown encouraging results. *V. jatamansi* plants, using root stock nodes were better survived using compost as manure over use of FYM (63% and 40% survival, and 57% and 33% survival, respectively using full and halved root stock node). After 20 weeks of sowing about 63% seedlings of *S. costus* were survived using FYM. Using upper rhizome cuts, 100% plants of *A. glauca* were survived under humus mixed soil at demonstration beds at Silha. A significant increase in fresh root biomass was achieved in higher spacing over lower spacing and well using humus and compost over FYM in *A. glauca* and *S. costus* in first year.

3.3.12. National Biodiversity Strategy and Action Plan: Uttar Pradesh

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 and being executed through a Technical and Policy Core Group (TPCG) consisting of experts of different fields, Coordinated by the Environmental Action NGO Kalpvriksha. The Biotech Consortium India Ltd. (BCIL) is handling its administration.

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. Extensive literature survey has been carried out. Information on geographical, socio-economic, political, ecological and historical profiles, current range and status of biodiversity, proximate and root causes of the loss of biodiversity, major actors and their current roles relevant to biodiversity, on going biodiversity initiatives, etc. has been gathered. The information has been analyzed, synthesized and documented.
2. The State has been broadly categorized into three major eco-zones i.e., Terai region, Gangetic plain and Bundelkhand including Vindhyanchal. The forest ecosystems are mainly dominated by Sal, Sal-Teak mixed, miscellaneous, Khair-Sissoo, dry thorn and swamp forests, grass lands and aquatic vegetation. Agrosystems are mainly dominated by Wheat, Rice, Pulses, Ragi, Maize, Bajra, Barley, Jowar, Gram, etc.
3. The State supports 2508 wetlands of which 1193 are larger than 56.25 ha area. 25 wetlands have been identified as fragile ecosystems.
4. 2711 species of angiosperms belonging to 1088 genera and 185 families have been listed. *Ipomoea, Ficus, Cyperus, Fimbristylis, Euphorbia, Blumea, Crotalaria* and *Acacia*, respectively are the species rich genera. 689 species of Algae, over 500 species of Fungi, 471 species of Lichens (including Uttaranchal), 19 species of Bryophytes and 72 species of Pteridophytes are known from the State. Only 10 endemic species are known from the State.
5. Regarding floristic explorations, only three districts are thoroughly explored, 31 districts are fairly explored and 36 districts are under explored.
6. The State is inhabited by tribes such as Kols, Gonds, Lodhs, Gujjars, etc. They use plant resources as medicine, food, fodder, fuel, timber, agricultural tools, religious and other purposes. Over 300 species are of medicinal use and 100 species are being utilized in preparing Ayurvedic formulations.
7. Over 80 species of fishes, 50 species of reptiles, 65 species of mammals and 500 species of birds are known from the State.
8. Appropriate action plan and strategy has been developed for the conservation of biodiversity of the state.

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

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 will be considering the diversity at different levels/groups to prepare a comprehensive document for India's plant diversity. Also, an attempt will be 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. Information on the species richness has been collected and analysed from the various sources i.e., floras, research papers, reports, monographs, etc. Database of about 17672 species has been developed.
2. Various aspects of plant biodiversity have been analysed for states and UTs and correlated with total area, non- cultivated area and protected area network. The states and UTs have been ranked and prioritized accordingly.
3. Considering the richness per sq km of the species, Sikkim, Himachal Pradesh and Goa rank among the first three (1-3 respectively) and Gujarat, Rajasthan, Madhya Pradesh and Andhra Pradesh rank the least (18-20).
4. Considering the use value of species in various states West Bengal, Orissa and Rajasthan ranked 1st, 2nd and 4th, in spite of the low protected area cover (<6%). Uttaranchal ranks high (rank 3) on the basis of species use value.
5. Representation of rare species was high in Bihar (rank 1), Tamil Nadu (rank 2) and Maharastra (rank 3).
6. Cumulative score of all the attributes i.e., richness, use value, rarity and endemicity against non-cultivated, protected area and total land area ranked Uttaranchal on top priority, followed by Tamil Nadu and Kerala.
7. Considering the cumulative score (richness, use value, rarity and endemicity) following states need special attention: Tamil Nadu (2), Kerala (3) and Orissa (4) with high biological values but relatively less wild land cover (40-60%), protected area (<6%) against total land and <10% protected area against non cultivated land area (except Kerala under class 10-20%) deserve special attention. Uttaranchal (1) with high cumulative scores of biological values emerge as a unique state with relatively high use value (rank 3), rarity (rank 8), endemicity (rank 5) and richness (rank 11) of wild plants.

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 (MPs) with 1748 species having various traditional and modern therapeutic uses. The unique diversity of MPs in the region is manifested by the presence of a number of native, endemic and threatened elements. MPs comprise 14% of total Red Data Plant species of IHR. 118 species of MPs yield essential oil. Also, the MPs of the region are highly valued on account of their potential to deliver novel bimolecular and larger quantity of active compounds. The pharmaceutical industries rely more on exclusively wild forms compared to wild cultivated and cultivated. Moreover, to meet quality specifications of the raw material, the domesticated material is preferred in comparison to their wild counterparts. The available information on domestication is fragmentary and largely confined to research laboratories. However, a considerable knowledge base exists with the indigenous communities, which traditionally cultivate MPs for their domestic use and not necessarily for income generation. 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 MPs cultivation and post harvest processing

3. To identify who are in the commercial cultivation of MPs.

Results and Achievements

1. A total of 81 villages of 11 different districts were surveyed for gathering information on MPs.

2. Over 107 farmers are involved in cultivation of MPs in Uttaranchal (Kumaun & Garhwal) whereas 113 farmers in Himachal Pradesh.

3. Over 22 Government and 16 Non-Government Organizations are actively involved in agrotechniques and post harvest processing of MPs of trans, northwest and west Himalaya.

4. The detailed agrotechniques and harvesting processes of over 20 species of trans, northwest and west Himalayan MPs have been compiled. The notable species are *Aconitum balfourii*, *Aconitum heterophyllum*, *Saussurea costus*, *Mucuna pruriens*, *Aloe barbadensis*, *Rauvolfia serpentina*, *Allium stracheyi*, *Pleurospermum angelicoides*, *Carum carvi*, *Inula racemosa*, *Bunium persicum*, *Podophyllum hexandrum*, *Dactylorhiza hatagirea*, *Artemisia maritima*, *Crocus sativus*, *Dioscorea deltoidea*, *Heracleum candicans*, *Humulus lupulus*, *Nardostachys garndiflora*, etc.

3.4. ECOLOGICAL ECONOMICS AND ENVIRONMENTAL IMPACT ANALYSIS

The development in the Indian Himalayan region 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 the Himalayan region. 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 focussed on aspects of solid waste characterization and air pollution monitoring in and 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 vegetable cultivation 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 study of Tourism sector

Background

This study was initiated in 1993-94, keeping in view increasing pressure of tourists and related activities in the valley 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 realised that Kullu and Manali spots in Kullu valley are facing infrastructural constraints. As a result, solid waste is becoming a major environmental problem to be tackled. During 1994-95, recommendations regarding waste management and other amenities in local situations were finalised on the occasion of Kullu Dussehra and submitted to district administration for implementation. An impact of this study was again tested after a gap of 5 years during Kullu Dussehra 1998, which showed a positive progress in creating basic amenities to the festivities except toilets. 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 (1996) and Kullu (1997). After this study, it was felt that major point sources such as hotels (1999 and 2000) and hospitals (2000) are prime contributors in increasing load of waste generation.

Objectives

1. To assess tourist pressure in tiny spots surrounding to major tourist centre- Manali.
2. To find solid waste composition and apply waste management options in sub-alpine and alpine environment.

Results and Achievements

1. The vehicle congestion on the Rohtang top is a major environmental problem during tourist season. About 750 vehicles per day reach at the top out of which 655 vehicles belonged to tourists.
2. The estimated visitors to reach this place are around 480,000 per summer season mostly between the months of April to May (or within 91 days).
3. About 1,335 kg per day solid waste is generated at Rohtang Pass during summer season which in total has reached 122 metric tonnes from April to May. All the wastes are left behind by the tourists. From waste composition point of views, the largest share is of non-biodegradable waste (68%). However, if brought back up to major market centre, the waste can be reused and recycled (Fig.10).
4. Besides reusing and recycling, waste management requires co-ordinated efforts from the host communities, tourists, research institutions, non-governmental organisations and local government along with general awakening programmes that the waste is not a waste rather it is a resource.

3.2.2. Ambient Air Quality Monitoring in Kullu Valley

Background

The present study area—Kullu valley is an important tourist destination in western Himalaya where this study was started primarily with the measurement of total suspended particulate (TSP) matter during 1994-95 and 1995-96 at Mohal (1100 m), Manali (2058 m) and Kothi (2530 m) in the Kullu valley. In 1996-97, Mohal and Manali were the monitoring sites. In 1997-98, Palchan (2320 m) south to Kothi was the sampling site which was again

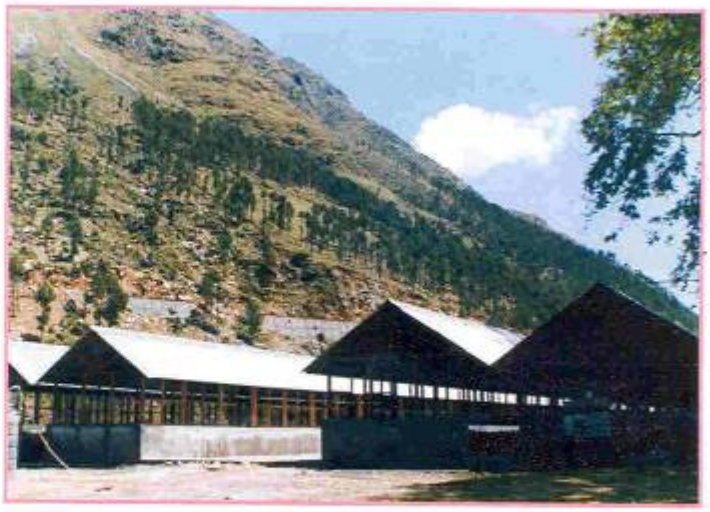


Fig.10. Bio-composting Practices from MSW of Kullu town at Pirdi. The Himachal Unit of the Institute is providing technical guidelines to the Municipal Council, Kullu for the management of solid wastes.

shifted to Jagatsukh (2040 m) in 1998-99 and onwards. The overall objective in shifting these sites around Manali and Kullu is to get true background concentration of particulate matter and other air pollutants. In 2000-01, TSP monitoring sites have been Mohal, Kullu and Jagatsukh whereas for rainwater collection, the monitoring sites were Mohal, Jagatsukh and Kothi.

Objectives

1. To assess background concentrations of air pollutants, and

2. To pinpoint some atmospheric chemical transformations in the Himalayan ecosystem.

Results and Achievements

1. TSP concentration in 2001 at Mohal and Jagatsukh (Manali) was monitored bi-monthly for eight hours using High Volume Sampler (HVS-APM 415). The TSP values showed variations (Fig. 11). On the occasion of Kullu Dussehra 2001, the TSP values ranged 126.4 to 1023.2 µg/m^3. These values are 10 times higher from its permissible level. Every selected location had TSP values above permissible level (100 µg/m^3) set for the sensitive areas.

2. The pH of rainwater at Kothi varied between 4.69 and 7.57 indicating from acid to alkaline rain. A majority of the samples were found to be acidic at Kothi as well as two other locations. The acidity of rainwater at Kothi may be due to low concentration of the neutralising components. Whereas, at Mohal the pH varied between 5.23 to 7.63. The seasonal variations in pH values throughout the year showed acidic rain in monsoon (July-October).

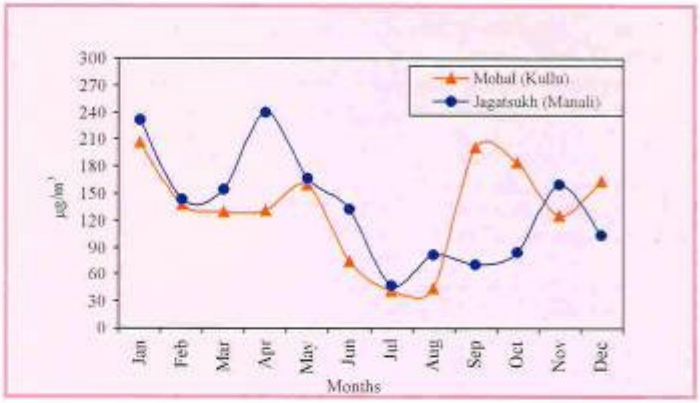


Fig. 11. Average TSP concentration in Mohal and Jagatsukh in Kullu valley

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

Background

Increasing the well being of women in terms of their health, education, economy & economic independence and personal autonomy, reportedly, has the effect on reducing the family size. This relationship has often 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. Level of literacy among 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, this study is undertaken to trace the impact of economy, education and altitude on fertility behaviour of women.

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. The survey through sampling, so far, covered 322 respondents (mothers), which included 181 respondents in five rural villages inhabited by caste Hindus, 38 respondents in two rural villages inhabited by the Bhotia tribal community and 103 respondents from the Muslim residents of Almora town. The number of conceptions and surviving children per mother is being worked out for analysis

2. Mean age at first marriage of the respondents varied in different communities being 16.43, 17.21 and 18.90 for caste Hindus, Tribals and Muslims, respectively. As much as 86.19% of the respondents among the Hindus were married in the age group of 15-19. Analysis of data carried out so far for Hindu

respondents only established a definite correlation between educational status and age at first marriage, viz., mean age at marriage increased with increase in educational status (Table 10) and decrease in fertility with increase in age at marriage (Table 11)

Table 10. Correlation between educational level and age at first marriage (Hindus only)

Edocational status	Total respondent	Mean age at marriage
Illiterate	92	15.69
Primary (1-5)	50	16.32
Middle (6-8)	20	16.95
High school	10	18.6
Intermediate	4	19.75
Graduation and above	5	22.0
Total	181	16.43

Table 11. Correlation between age at marriage and fertility behaviour (Hindus only)

Mean age at marriage of the respondents (mothers)	Total respondents		No. of conceptions per mother	No of surviving children per mother
Less than 15	17	(9.39)	3.88	3.53
16 – 19	152	(83.98)	3.55	3.12
20 – 24	11	(6.08)	2.00	1.45
25 – 29	1	(0.55)	1.00	1.00
Total	181	(100.0)	3.48	3.05

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

Background

Khairna valley, comprising of 190 settlements, spans over an area of 18,267 hectares and altitudinal range of 900-2000 m amsl. The area falls in the regimes of two development blocks of Nainital district and one of the Almora district. The vegetable cultivation, both season and off-season, is becoming an accepted norm in the valley and is replacing the cultivation of traditional food-crops. Besides, suitable agro-climatic conditions, the cash incentives (quick money), connectivity, water availability, landholding structure, technology, policy and extension are some of the scores of factors that would have enthused this change in the valley. This may also be impacting on the life style of the people and the prevailing landuses. Such changes in land use, cropping patterns, socio-economy and environment, that would have transpired are totally unknown. The implications involved are many and hence the analysis of the causal factors and impacts is a must. Therefore, the study was undertaken to investigate the following objectives.

Objectives

1. Assessment of the scale and extent of vegetable cultivation
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
4. Impact identification and study of land use changes
5. Scenario analyses and policy recommendations

Results and Achievements

1. Nineteen villages were surveyed, and responses of nearly 777 households were recorded and are being compiled. A general profile/ sketch of the valley drawn on the basis of compiled primary information for household size and landholdings is shown in Table 12. Nearly 64.5% of the households have the landholdings between 0.04 to1.02 ha and 5% of the households posses landholdings above1.51 ha.

Table 12. General Sketch, Khairna Valley.

Population Characteristics	Household Size N=777	Landholding per household (ha) N=776
Mean	7.13	0.53
SD	3.34	0.49
Max	28	4.70
Min	1	0.00

2. The comparative statistics of vegetable cultivation altitudinal zone-wise and in terms of distance of the village from the road-head, is given in Table 13. The percentage of 'average gross area under vegetables to average holding size' does not exhibit a clear linear trend with the altitude and with the road-head distance. This rules out altitude or the distance from road-head as a single exclusive force governing/influencing the vegetable cultivation in the valley.

Table 13. Comparative Statistics of Vegetable Cultivation.

Scenarios		Average Landholding size per Household (ha) N=776	Average Gross Area under Vegetable Cultivation per Household (ha) N=759	Percentage of Average Gross Area under Vegetable Cultivation to Average Landholding size
Altitude	<1200 m	0.63	0.19	30.16
	1200-1500 m	0.65	0.27	41.53
	>1500 m	0.44	0.17	38.64
Road-head Distance	0-2 km	0.50	0.25	50.00
	2-5 km	0.48	0.15	31.46
	>5 km	0.76	0.27	35.53
Overall		0.53	0.21	39.62

3. Amongst the altitudinal zones the ratio of 'gross area under vegetable to the holding size' is maximum (41.53%) for the mid altitude and minimum for the low altitude zone (<1200 m) suggesting the vegetable cultivation is more intensive in mid and upper zones than the valley area. However, the comparative statistics assorted in terms of road-head distance suggests an impact of road on vegetable cultivation up to 2 km, as the ratio for gross area under vegetables to landholding size is maximum 50% in that zone.

4. The overall statistics yields some revelation on the extent of vegetable cultivation where the ratio of 'gross area under vegetable to the holding size' is 39.62%.

3.4.5. Performance evaluation of bioengineering treatments for mitigating landslide hazards

(Summary of completed project)

Background

The complexities of development in conjunction with the difficulties presented by the geology, topography, climate and land use have necessitated adoption of eco-friendly mountain area developmental programmes. This has helped in the development of the concept of Bioengineering within the broader theme of Mountain Risk Engineering (MRE). However, it is noteworthy that in spite of significant advancement in the field application of bioengineering treatments for mitigation of landslide, comparatively little developments have taken place for their performance evaluation.

Objectives

1. To undertake field activities at field sites of MRE in the Kumaun region for performance evaluation of various bioengineering techniques,
2. To collect base line data on people's perception and adoption of bioengineering measures, and
3. To develop norms for field application of bioengineering practices.

Results and Achievements

1. The MRE sites at village Joshiyana and Khoont rehabilitated in 1998 were taken up as study sites. During the field visits it is noted that all of the physical structures excepting one (water collection chamber) are intact and performing their expected duties. It is further noted that the bioengineering works have performed relatively better at village Khoont sites as compared to village Joshiyana sites. This was evident from the survival rate, mortality of various species at different sites recorded for various plant species with average mortality of ~52 per cent at Khoont as against ~78 per cent at Joshiyana.
2. In order to assess the perception of local inhabitants about principles and practices of MRE, a questionnaire was developed and random survey of residents of Khoont and Joshiyana village together with their background pertaining to gender and literacy, the results indicated the likely reasons and causes for adoption of bioengineering practices.
3. In Kumaun region comprising of districts Almora, Pitthoragarh and Nainital districts of Uttaranchal, an extensive survey along the road network was carried out to document the roadside instabilities and their causative factors. Road

segments of 2 kilometres length were identified in various altitude zone along the roads network of the region for various kinds of alignment, viz. ridge, valley and along the slope.

4. Based on the findings of the field survey regarding the average number of unstable sites, non-functional culverts, subsidence sites, etc., it was found that ridge alignment has advantages over other alignments.

5. The nature of instabilities at majority of sites indicated that these instabilities could be best stabilized adopting bioengineering practices and consequently a detailed guideline for incorporation of these practices to have GREEN ROADS were developed.

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

Background

Sikkim state suffers from landslide problems very often due to heavy rainfall/cloud burst as the single most important triggering factor. But the host terrain condition in terms of geology, physiography and allied genetic factors greatly aid the process. Therefore, there is a need to assess *in-situ* conditions of landslide/mass-wasting. Parameters in line with the concepts of Mountain Risk Engineering (MRE) are envisaged to be evaluated for their possible application in this study. Remote Sensing (RS) data are useful to derive relevant terrain characteristics. For synthesis and analysis, Geographical Information System (GIS) based techniques are extensively used. This is perceived to build an approach, which is more dynamic and interactive.

Objectives

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

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

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

Results and Achievements

1. Two important road alignments of West district of Sikkim state with annual average daily traffic (AADT) of 200-500 were investigated in detail during the reporting year. Landslide prone areas were mostly found in the lesser Himalayan portion along the study area which is rugged and highly dissected. Lithology generally showed the presence of sedimentary rocks such as shale, dolomite, limestone and sandstone; and metamorphic rocks of low to high grade such as slate, phyllite, schist and gneiss etc.

2. Remote sensing techniques were used for extracting different thematic details from satellite data of Indian Remote Sensing Satellites (IRS) 1C/1D LISSIII of the year 1997 and PAN of the year 1999. IRS 1C/1D LISS III bands 2, 3 and 4 data were subjected to image processing techniques.

3. Field as well as laboratory investigations on different host geo-environmental characteristics of the area with respect to landslide occurrences selecting relevant

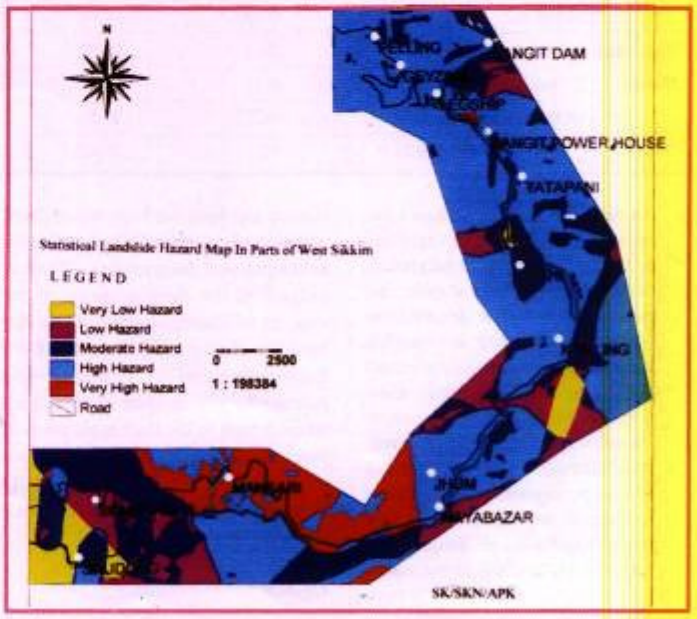


Fig. 12. Statistically generated landslide hazard map of study area, W. Sikkim

parameters such as active landslides of significant dimensions, lithology, drainage density, land use, digital elevation model (DEM) for slope information and rainfall condition in terms of elevation zones were carried out.

4. Statistical landslide hazard analysis under a Geographical Information System (GIS) platform was carried out based on the information generated for each landslide site leading to a statistical landslide hazard inventory of the study corridors (Figure 12).

5. An expert system based approach has been adopted in the study by incorporating the detailed knowledge of known landslides (Figure 13) along the road alignments in the region to statistically predict the susceptibility of contiguous portions. This showed that in an area of 187.39 km^2 along the road corridors under study, the percentage areas under very low, low, moderate, high and very high hazard classes were 4.31%, 10.89%, 21.23%, 52.87% and 10.70% respectively.

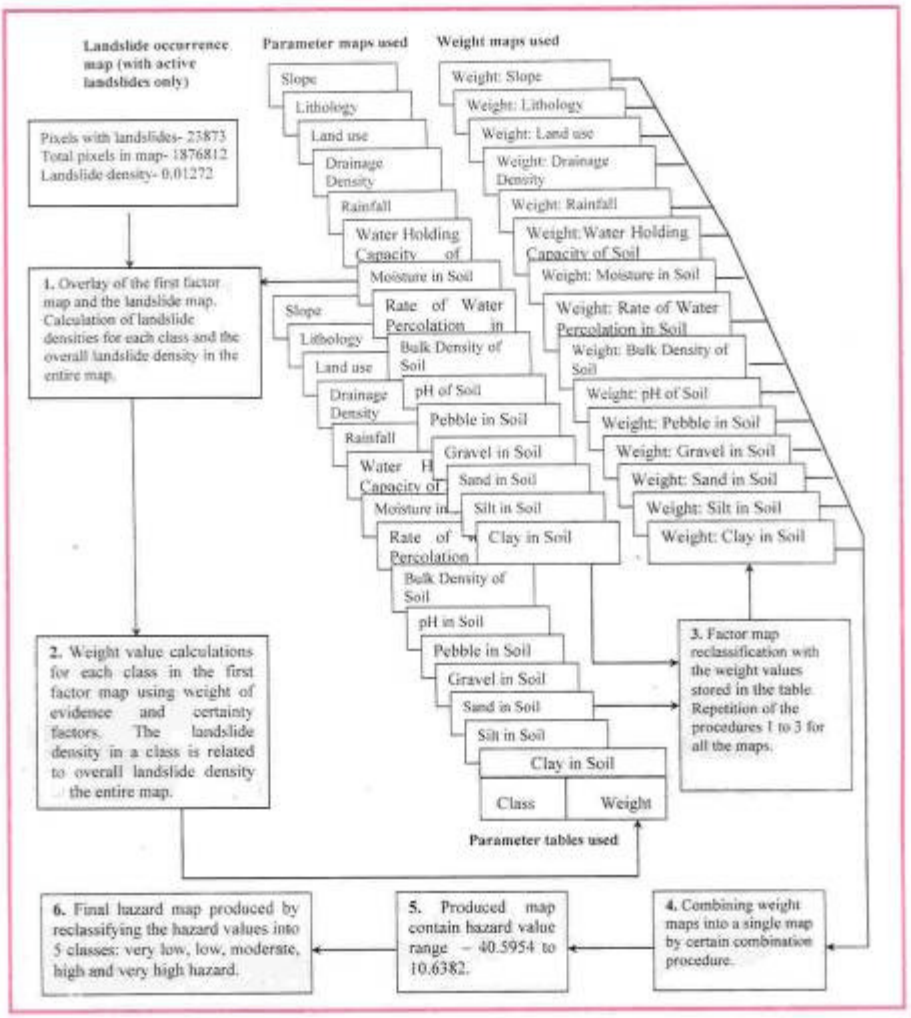


Fig. 13: Statistical (bivariate) landslide hazard analysis in the project (example of W. Sikkim roads).

3.4.7. Development of Comprehensive Siwalik Development Strategy

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 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 synthesize 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 Shivalik zone of Jammu & Kashmir, Haryana, Punjab, Himachal Pradesh and Uttaranchal, and

2. Development of a uniform strategy that is environmentally and socially sound, and to help arrest the degradation of the zone and to simultaneously enhance economic development.

Results and Achievements

1. A detailed compilation on the natural setting of the Siwalik region has been made after delineating the Siwalik region on the basis of geology. Social infrastructure data of the region has been also compiled for the Siwaliks based on the administrative units of the region. Table 14 presents a general profile of the Siwalik region.

2. Broad outline of the strategy-cum-action plan for the overall development of the region has been prepared.

Table 14. Statistical profile of the Siwaliks.

Geographical area, ha	24,94,000
Administrative area, ha	43,24,500
IWDP-Hills II area, ha	1,98,978
Land use pattern, in per cent of administrative area	
• Forest	16.7
• Cultivated land	45.4
o Irrigated (per cent of cultivated land)	47.3
• Culturable waste	18.9
• Not available for cultivation	19.0
Demographic profile (1981)	
• Human population, millions	12.5
o Rural population, per cent of total	76.9
o Urban population, per cent of total	23.1
• SC population, per cent of total	22.3
• ST population, per cent of total	1.3
• Population density, persons per sq.km.	241
• Sex ratio, female per 1000 male	923
• Literacy rate, per cent	66.3
o Male	76.7
o Female	55.2
Occupational pattern (1981)	
• Main workers, per cent of total population	29.8
o Cultivators, per cent of main workers	42.5
o Agricultural labour, per cent of main workers	12.3
o Household industry, per cent of main workers	1.7
o Livestock activities, per cent of main workers	1.8
o Mining and quarrying, per cent of main workers	0.2
o Other than household industries, per cent of main workers	7.2
o Construction, per cent of main workers	4.4
o Trade and commerce, per cent of main workers	7.3
o Transport and related activities, per cent of main workers	3.2
o Other services, per cent of main workers	19.4
• Marginal workers, per cent of total population	4.7
• Non workers, per cent of total population	65.5

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

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 in this ecosystem, 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 under technification and other factors.

Objectives

1. To understand population dynamics and socio-cultural milieu
2. Inventorying of resource bases to maximum possible extent 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
3. Review and analyses of the existing information/data on traditional knowledge & indigenous practices
4. Documentation of further indigenous/traditional knowledge on use, conservation and management of resources including rural bio-technological practices and role of women in change and preservation of traditional knowledge system, and

Results and Achievements

1. Documentation of indigenous knowledge on biodiversity management, land (rights, use and cover), weed control, pest control, crop varieties, cropping pattern, planting, harvesting, kitchen garden, soil and water conservation, livestock composition, livestock breeding, animal health (ethnoveterinary), ethnomedicine, housing, food and food habits, clothing, family planning measures, socio-cultural practices, institutions, measures, etc., is being carried along altitudinal gradients covering ethnic communities.
2. Considering that the region, largely governed by inaccessibility and fragility, suffers from inadequate medical infrastructure both physically and qualitatively, due efforts have been made to document indigenous medicinal practices and their relevance in resource conservation, physical well-being and economic development of the locals. Covering as many as 500 knowledgeable respondents drawn equally from both the sexes, more than fifty indigenous healthcare practices were documented. It was found that women possess more knowledge on indigenous practices than men (Fig. 14).
3. These practices mitigate the inadequacy in modern medicines substituting through ethno-medicine, ensure compelled resource conservation and save expenditure on physical health through minimal or least investment. They are effective in healing diseases, do not have financial cost, and are easily administrable.

Fig. 14: Status of knowledge of men and women on indigenous health care practices

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

Background

For economically and socially disadvantaged groups access to basic social services or infrastructure is perhaps far more important as they start with a disadvantage to benefit from mainstream national developmental initiatives. The mountain communities of Indian Himalayan region are a classic example of such socially and economically disadvantaged groups, and therefore improving their access to social infrastructure is so much important in embarking a path of poverty reduction in the region. Information on social infrastructure and services for the states of IHR are not readily available. Recognizing the

importance of social infrastructure in human development, it is essential to have base-line information on the current status, and develop 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, both in terms of quantitative measures and by reviewing policies and programmes.

2. Analyses of the social institutional and local governance issues as they affect the delivery system and determination of constraints in improving social infrastructural access and identification of gaps in the current knowledge base about their provisioning.

3. Recommendation for policies, strategies and programs aimed at improving access of social infrastructure for the target groups.

Results and Achievements

1. Despite voluminous development interventions, secondary information shows that poverty is rampant and increasing in all the states of IHR with exception to West Bengal (Table 15). It needs to be mentioned here that only one district of West Bengal, i.e., Darjeeling falls in IHR.

Table 15. Incidence of rural poverty in IHR (in percentage)

State	1973-74	1977-78	1983	1987-88	1993-94	Percentage change in 1993 over 1987
Arunachal Pradesh	52.7	59.8	42.6	39.4	45.01	(+) 5.61
Assam	52.7	59.8	42.6	39.4	45.01	(+) 5.61
Himachal Pradesh	27.4	33.5	17.0	16.3	30.34	(+) 14.04
Jammu &Kashmir	45.5	42.9	26.0	25.7	30.34	(+) 4.64
Manipur	52.7	59.8	42.6	39.4	45.01	(+) 5.61
Meghalaya	52.7	59.8	42.6	39.4	45.01	(+) 5.61
Mizoram	52.7	59.8	42.6	39.4	45.01	(+) 5.61
Nagaland	52.7	59.8	42.6	39.4	45.01	(+) 5.61
Sikkim	52.7	59.8	42.6	39.4	45.01	(+) 5.61
Tripura	52.7	59.8	42.6	39.4	45.01	(+) 5.61
Uttar Pradesh	56.4	47.6	46.5	41.1	42.28	(+) 1.18
West Bengal	73.2	68.3	63.16	48.3	40.80	(-) 7.57
All India	56.4	53.1	45.6	39.1	37.27	(-) 1.83

2. Data have been compiled at state level as well as district level of selected states on education focusing on number and physical status of educational institutions, distance of villages from educational facilities, literacy rates by gender, number of teachers and students, enrolment rates, drop-outs rates, education system, policies, plans and programmes. Data compiled on health care facilities include number and physical status of health care facilities, distance of villages from health care facilities, number of doctors and other medical and para-medical staff, prevalence of major diseases, infant mortality rate, fertility rates and policies, plans and programmes. Data have also been compiled on drinking water and sanitation that include rural water supply programmes, status of drinking water in different states, constraints and lacunae in the drinking water programmes, etc. Also data have been collected on nature of housing and electrification.

3.4.10. Assessment of Hill Slope Instabilities along the Road-Network of Sikkim State

Please see section on quick appraisal studies

3.5. ENVIRONMENTAL PHYSIOLOGY AND BIOTECHNOLOGY

Since plants are the primary producers, a thorough understanding of the factors that govern their productivity and functioning is of paramount importance, especially in the light of severe climatic conditions prevailing in the Himalaya, and current concern about the global climatic change. Judicious use and application of conventional techniques with the sophistication of biotechnology help increase efficiency and productivity as well as environmental health. 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. Nitrogen accretion studies and phosphate solubilizing by symbiotic N_2 fixers are being studied in perspective for their use in agroforestry management. 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* methods for several economically important plants. 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 asses performance of tree age and sex in terms of taxol level in the bark. Demonstration of various technologies, e.g., polypit, polyhouse, biocomposting, vermicomposting, biofencing, protected cultivation, clonal propagation, etc. are being conducted for betterment of rural people.

3.5.1. Rhizosphere microbiology of Himalayan plants

Background

Major groups of symbiotic as well as free living micobial associations on record are: (1) *Rhizobium*- legumes; (2) *Frankia* - actinorhizal plant species; (3) mycorrhizal – host plants; (4) free living microbes - plant species. Based on the basic knowledge, a number of microbes have been developed as 'inoculants' and are in use for inoculating seeds, seedlings, cuttings or growing plants to enhance plant productivity. In view of developing inoculants for mountains, extensive studies on isolation, characterization and selection of beneficial microbes are in progress. The overall success of such experiments will largely depend on the selection of an appropriate inoculant possessing the following properties, in order of preference: (1) biocontrol, (2) ecological specificity, and (3) growth promotion.

Objectives

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

Results and Achievements

1. Large-scale isolations have been conducted from the soil samples obtained from rhizosphere and the corresponding non-rhizosphere sites of dominant tree species of the Himalayan region. The soil samples belonged to 1200 to 3600 m altitudes representing subtropical, temperate and alpine climatic conditions. The rhizosphere effect in terms of rhizosphere to soil (R:S) ratios has been worked out. Three tree species belonging to alpine region were found to exert the negative rhizosphere effect.
2. The microbial isolates obtained from the soil samples have been screened for P-solubilizing and biocontrol properties. Biochemical characterization of these isolates is in progress. Field based inoculation trials using efficient cultures are being conducted.
3. Microorganisms are being maintained in the culture collection (Fig. 15).

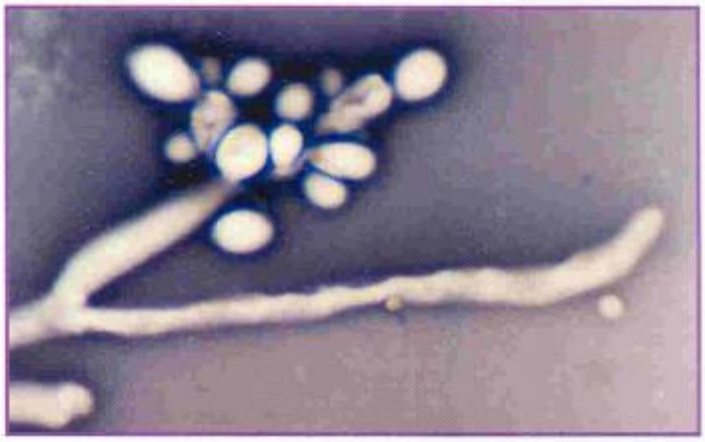


Fig. 15 : An yeast culture isolated from hot spring site

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 is 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 plant species

Results and Achievements

1. Scaling up of multiplication of important plant species for which propagation protocols have been developed.
2. Crosses and reciprocal crosses were made amongst three more species, namely *C. alolifolium*, *C. giganteum* and *C. mastersii*. The cultures were established from the

hybrid pods developed from the compatible crosses (only two crosses pollinated flowers developed pods). The cultures are now being proliferated to undertake further regeneration studies in these hybrids (Fig. 16).

Fig. 16. A flowering spike of *Cymbidium elegans*, one of the parent used in hybridizations studies

3. Crosses made between two species of Cymbidiums, namely *C. mastersii* and *C. elegans* developed pods. Seeds were subsequently cultured and complete plantlets were regenerated. These plantlets were hardened and established in the pots.

4. Attempts were made to establish the hybrid nature of these regenerated plants on the basis of SDS-PAGE profile of leaf proteins and peroxidase isozyme patterns.

3.5.3. Impact of stress and 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 kinds of stresses 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.

Objectives

1. To determine biochemical basis of adaptations in plant

2. To determine the physiological basis of adaptations in plants in terms of photosynthetic characteristics and growth

Results and Achievements

1. Considerable seasonal variations in amino acid and moisture contents were observed in the leaves of some multipurpose plant species Table 17

2. All the species showed the highest amino acid as well as percent moisture contents during spring season. However, their minimum contents in plant species varied with season

3. Of the seven species, *Grevia optiva* showed maximum amino acid content followed by nitrogen fixing plants irrespective of the season.

4. When averaged across the seasons, leaf moisture content was maximum in *Boehmeria regulosa* and minimum in *G. optiva*

5. In general, all plant species showed minimum moisture content during summer season, however, the magnitude varied with species

Table 17. Seasonal variation in per cent leaf moisture content in some multipurpose plant species.

Plant species	Season			
	Spring	Summer	Autumn	Winter
Alnus nepalensis	60	62	60	56
Boehmeria rugulosa	72	66	69	66
Celtis australis	65	45	56	59
Dalbergia sissoo	74	62	63	61
Ficus racemosa	73	61	62	63
Grewia optiva	45	47	57	57
Sapium sebiferum	75	62	63	-

3.5.4. Study of plant performance, ecology and interaction in the Himalayan region

Background

Due to dramatic differences in altitude within a map distance of 100-200 km, climate, physiography and soil, the Himalaya harbours perhaps the premier vegetational gradient on the earth and is considered world's largest plant diversity centre. Further, severe exploitation of one species may affect the growth and development of other species by affecting specific microsite and ecological niche of that species. Therefore, it is relevant to undertake studies on plant performance, ecology, canopy loss and interactions of various plant species in the Himalayan region. In view of the medicinal importance of *Taxus baccata* (also threatened in this region), studies were taken up on this species.

Objectives

1. To compare the performance of seedlings and cutting raised plants (5 and 8 year old) in terms of morphological characteristics, biomass and productivity.
2. To examine the performance of seedlings and cutting raised plants (as in above) in terms of leaf morphology and chlorophyll content.
3. To evaluate the performance of tree age (28- 160 yrs) and sex in terms of taxol levels in the bark.

Results and Achievements

1. Total plant height, leaf area, lateral shoot numbers and root length was found to be lower for 5 and 8 years old seedlings as compared to cutting raised plants of similar age (Fig. 17).

Fig. 17. A cutting raised plant of *T. baccata* growing in natural conditions.

2. Total biomass values were 1.23 and 6.01 g/plant, respectively for 5 and 8 years old seedlings. These values were about 87 and 69% lower as compared to cutting raised plants of corresponding age. The total productivity values were also recorded lower for seedlings as compared to cutting raised plants.
3. Values of leaf area and leaf weight ratio were also lower for seedlings as compared to cutting raised plants. However, a reverse trend was observed for root:shoot ratio (0.43-0.50 for seedlings and 0.29-0.32 for cutting raised plants of 5 and 8 year age).
4. Leaf area and weight were recorded to be significantly higher for cutting raised plants in comparison to seedlings. However, values for chlorophyll b and total chlorophyll were significantly lower for cutting raised plants as compared to seedlings.
5. Although the bark samples from male trees had higher taxol concentration (0.0376-0.1167%) as compared to samples from female trees (0.0129-0.0810%), a significant difference in taxol concentration was not observed between male and female trees. However, Analysis of Variance showed a significant difference in the taxol content of bark samples from trees of different age.

3.5.5. Effects of N_2-fixing Alnus on the mechanisms of accelerated phosphorus cycling in large Cardamom agroforestry in the Sikkim Himalaya

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 have 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 to fill the above gap. The work emphasizes to test the following two 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 is 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. The capsule (fruit) of the cardamom is used as a spice-condiment. It is cultivated usually on steep hill slopes under tree cover either in natural forest or plantation that forms a traditional agroforestry system in the 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. Soils from four agroforestry stands such as (a) *Alnus*-Cardamom Young, (b) *Alnus*-Cardamom Medium, (c) *Alnus*-Cardamom Old and (d) Mix-Tree Cardamom, were seasonally analyzed for pH, organic-C, total-N, total-P, fractionated-P, available-P (i.e. $NaHCO_3$ extractable), microbial biomass-P, oxalate and phosphatase enzyme activity.

2. Soils being acidic, most of the fractionated-P occurred in the form of occluded Fe-phosphate. Rhizosphere acidification in stands with *Alnus* could have increased P availability by solubilization of mineral phosphates from geochemical pools.

3. Available-P was statistically higher in rhizospheric soils compared to bulk soil, and ranged between 4-60 mg g^{-1} soil across all sites. Available-P in the rhizospheric soil types was greater during the rainy season in the stands with *Alnus*. However, microbial biomass-P in rhizospheric soils with *Alnus* association was statistically lower in the rainy season.

4. Phosphatase enzyme activity was recorded highest in the combined rhizospheres of cardamom and *Alnus*. Analysed collectively, the results suggest that *Alnus* rhizospheres promote acidification, oxalic acid formation and phosphatase enzyme activity, which increases the solubility of phosphorus in cardamom agroforestry systems of the eastern Himalaya.

5. Rhizospheric soil types between the different age groups of *Alnus*-cardamom stands showed consistently higher phosphatase activity in combined cardamom and *Alnus* tree rhizospheres, where their interactions have produced organic chelates that might have played role in enhancing P solubility. The role of N_2-fixing *Alnus* on P availability was however prominent. The rhizospheric activity of *Alnus* increased soil P availability in the large cardamom agroforestry systems by influencing rhizospheric acidification, chelating with oxalic acid, seasonal dynamics of microbial biomass-P and phosphatase enzyme activity.

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

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 (*Amomum subulatum*) 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 elevation. Out of 23000 ha area of large cardamom cultivation in Sikkim state, 1316 ha of reserve forest is used for under canopy large cardamom cultivation on lease to farmers and remaining area is under private large cardamom based agroforestry. Large cardamom is a low volume, high value and non-perishable crop that is providing ecological and economical benefits to the mountain people in Sikkim. 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. Study of 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* (cardamom) plantations.

4. Evaluation of the role of N_2-fixing *Alnus* in age series of *Alnus*-cardamom plantations on the maintenance of soil fertility.

5. Estimation of metabolites in large cardamom crop under different levels of *Alnus* shade.

Results and Achievements

1. Agronomic yield of large cardamom depends upon the age of the plantations. It was about 110 kg ha^{-1} $year^{-1}$ in the 5-year stand. The yield increased with increase in plantation age with 230 kg ha^{-1} $year^{-1}$ in 10-year, 310 kg ha^{-1} $year^{-1}$ in 15-year and a peak value of about 360 in the 20-year stand. In the 30-year and 40-year stand the yield declined sharply with 180 kg ha^{-1} $year^{-1}$ and 40 kg ha^{-1} $year^{-1}$, respectively.

2. 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}). Above-ground stand biomass increased with stand age while below ground-biomass peaked in the 15-year-old stand; this was mainly due to the contribution of cardamom.

3. 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.

4. The active root nodule biomass and annual production was highest in 15-year and lowest in 40-year plantation stand. 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 percentage contribution of active root nodule biomass was 51-56 and inactive root nodule biomass was 43-48 per annum.

5. Significant increase in the rate of nitrogenase activity from winter to rainy season was observed. The mean soil temperature during rainy season was 23^0 C and 11.9^0 C. A pyramidcal change was observed when the system starts rapid fruiting (for flowering and fruiting from April to October) and the activity inturn was also recorded increasing with the turn of seasons to its peak in rainy and a slight decline in autumn (Soil temperature, 18^0 C). 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.

6. Nutrient use efficiency (NUE) was higher (kg annual net primary productivity per kg nutrient taken up) for both N and P decreased with plantation age. NUE was 98 in the 5-year- old stand, decreasing with increasing age to 81 in the 40-year-old stand. Similarly, P use efficiency in the 5-year-old stand was 2439 and decreased with increasing age to a minimum value of 1914 in the 40-year-old stand. Average P use efficiency of all stands was approx. 25 times greater than that of N use efficiency.

7. *Alnus* is an excellent associate with large cardamom promoting higher performance until 20 years of age and modification in management to incorporate replantation after this age will be beneficial.

3.5.7. Bioprospecting of biological wealth using biotechnological tools: Chromosome fingerprinting and DNA bank-net of Himalayan endangered species

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 will also provide potential guidelines for the concerned species recovery and genetic enhancement programmes. The research work related to molecular biology is being carried out at Delhi University and is 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. Preliminary cytological studies and Phytochemical analysis

Results and Achievements

1. New germplasm of *P. kurrooa* from Himachal Pradesh as well as from Garhwal Himalaya was collected. Similarly *A. balfourri* was also collected from Garhwal Himalaya. In addition to this seed/tuber/rhizome of *P. hexandrum, P. kurrooa* and *Aconitum* species were also collected and planted in nursery/green house
2. Herbarium specimens of target species from different regions have been collected
3. Estimation of podophyllotoxin in various plant parts among different populations of *P. hexandrum* revealed that roots contained considerably higher amount (0.01-5.8% of dry wt); while leaves and stem also contained podophyllotoxin, the levels were much lower, i.e. 0.003-0.11% of dry weight in leaves and 0.003-0.2% of dry wt in stem. In general one leaved plant showed highest amount of podophyllotoxin and followed by two and three leaved plants.
4. Analysis of alkaloids content among different poulations of *Aconitum balfourii* and A. *heterophyllum* indicated wide variation in alkaloids contents.
5. Mitotic chromosome counts (2n) has been carried out in *P. hexandrum* (2n=12), *A. heterophyllum* (2n=16), *A. balfuorii* (2n=32), *A. violaceum* (2n=16), and *P. kurrooa* (2n=24) plants from various populations in Kumaun and Garhwal Himalaya. The numerical variation in chromosome number was not observed in different populations of *plants in these species.*
6. In vitro multiplication and subsequent rooting and hardening of A. violaceum has been achieved.
7. Germplasm of target species is being maintained at the field stations.

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 general studies on the environmental issues of the Indian Himalayan region, it is 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. Soil and root samples have been collected from the rhizospheres of the target species. The root and soil samples of five species of *Rhododendron* have been analyzed for their VAM associates.
2. Similar studies on other target species are in progress. Inoculation experiments using the VAM fungi are in progress.

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, namely (a) Rhizosphere microbiology of tea; (b) Microbial diversity in Mamlay watershed (Sikkim); (c) Isolation and selection of microbial inoculants for hill crops; (d) Plant –microbe interactions in conifers; and (e) Selection of biocontrol agents for providing cross protection. 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 for soil microbes from various locations including extreme conditions (for extremophiles).

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.

4. Establishment of microbial culture collection of Himalayan region.

Results and Achievements

1. In view of isolation of psychrophiles/psychrotrophes, soil samples have been brought from several temperate locations. Isolation, characterization and screenings are in progress for obtaining efficient strains of *Pseudomonas*, *Bacillus* and *Trichoderma*. Locations for isolation and characterization of thermophilic microbes have been selected in Garhwal region. Thermophilic bacteria and yeasts have been purified and their characterization is in progress.

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. Therefore, Sikkim is the most appropriate location for conservation and propagation studies of rhododendrons in India. 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 fire-wood 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.

The goal of the proposed project is to find out means of conservation, propagation and restoration of rhododendron population in the wild that have been planned as to, (a) develop protocols for local species, (b) mass propagation of selected rare and endangered species, (c) hardening of mass propagated plants, and (d) test trials in arboretum and fields. *Ex situ* conserved species at Pangthang arboretum will act as gene pool bank for rhododendrons in India. Biotechnological facilities (Figure 18) envisaged being developed will be unique for the north-east India and will benefit institutions in the region as well as ushering in collaborative works with related Institutions.

Objectives

1. Tissue culture protocol development (for the Sikkim Himalayan rhododendrons in particular and Indian Himalayan rhododendrons in general)

2. Development of mass propagation protocols of selected rare and endangered rhododendrons

3. Hardening trials of mass propagated plants

4. Survival and fitness trials of tissue culture raised seedlings in arboretum and fields

Results and Achievements

1. Several field surveys were made to North Sikkim (Lachung, Lachen), West Sikkim (Dzongri, Barsi), East Sikkim (Rate Chu) for collection of seeds of Rhododendrons. Seeds of 28 species were collected which included rare and endangered ones

2. Extensive *in-vitro* experiments were conducted on selected species. The sterilized seeds were germinated under aseptic conditions. Germination ranged between 40 - 90% on hormone free MS media

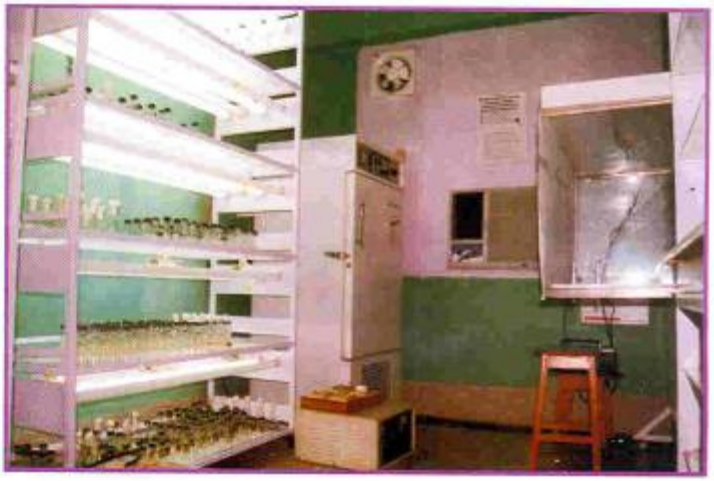


Fig. 18. Biotechnology laboratory set up at Sikkim Unit.

3. Seedlings of four species namely *R. maddeni*, *R. niveum*, *R. pendulum* and *R. micromeres* (all rare and endangered) have been raised under aseptic conditions. Experiments conducted for further multiplication. Extensive studies were conducted to see effect of light and temperature on seed germination. Germination did not occur in dark whereas under light and relatively higher temperature (26° C) it resulted in 60-70% success

4. These seedlings were further used for shoot multiplication. Apical dominance played a significant role. Removal of tips of seedlings was found essential for further shoot multiplication *in-vitro*. MS media fortified with 4 mM or 8 µM BAP and WP media with 4 µM BAP have been proved optimal for *in-vitro* shoot multiplication and maintenance in *R. maddeni*.

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

Background

Life supporting activities are limited in the Himalayan region and land constitutes the most precious resource of inhabitants. Majority of population is engaged in agricultural and allied activities, and more than 85% of the women workers are involved in such activities. Involvement in various household and agricultural operations from the early childhood is a major bottleneck for educational/ technical advancement of rural women in the hills. This factor in combination with other limitations such as dominance of rainfed agriculture, marginal and scattered nature of landholdings, etc. result in low crop productivity. Although, a number of technologies are available to increase production, 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 to areas where it is most needed. Development planners and extension experts, realising the critical importance of this link, strongly emphasize the need for large-scale establishment of resource (demonstration and training) centres in the mountains which can act as conduits between technology developers and the real users. 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 organisations, e.g., GOs, NGOs, local 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 modern technologies which are hill specific, and to supplement and evolve technology packages

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 group, and training of trainers (TOT) on a regular basis.

4. Guidance and support for field implementation of technology packages and subsequent monitoring.

5. To develop a frame work towards achieving self-sufficiency within the system in the long run.

Results and Achievements

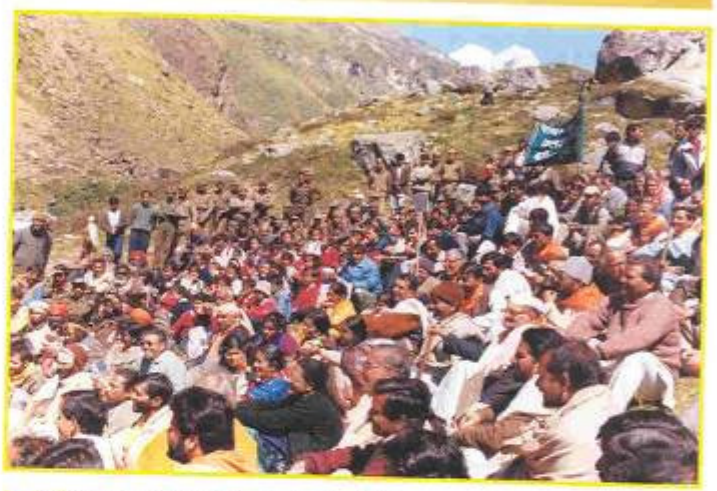
1. Major modification/ renovation/ works have been carried out at the Biotechnology Complex, Kosi, in order to accommodate (boarding and lodging) participants for the training/ demonstration programmes.

2. Demonstrations of various technologies viz., bio-composting, vermicomposting, biofertilizer, protected cultivation in polyhouse, polypit and polytrench, cultivation of medicinal plants, floriculture, mushroom cultivation, fish farming, cash crop cultivation, horticulture, tea cultivation, nursery, clonal propagation, biofencing, water harvesting, multiplication technology for bamboo, zero energy cool chamber (designed and developed at IARI, New Delhi), bio-briquetting, etc. have been setup in the Biotechnology Complex

3. Ten villages have been selected from different locations for some of the above mentioned technology demonstrations

4. The acquired skills and technologies for improvement in the existing knowledge are being disseminated through on-site training programs carried out in different villagers as well as at the Biotechnology Complex.

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 infrustructure, expertise and scientific manpower available in the Indian Himalayan region (IHR) are being complimented effectively. This programme is also complimenting/ achieving the mandate of the Institute and helping in the fulfillment of its broad objectives (particularly the second one, out of three). Furthermore, this programme supports Institute's role as a facilitator of R&D programmes in the IHR as well as in establishing institutional linkages. Besides above, library in any scientific institution is also considered one of the most crucial assets on which the quality of research and development (R&D) outcomes depends. Library services are essential for the development of human resource. In view of the above, the Core Institutional Networking and Human Investment (INHI) of the Institute was established in October 1993 and now serves as a nodal point for networking with associated Institutions /Universities/NGOs/Voluntary agencies etc. working on problems relevant to the Indian Himalayan region.

During the year, 17 new projects were sanctioned and funded to the various organizations/institutions/universities (for the execution of location-specific R&D activities in different parts of the North East and North West region of the country) under the Integrated Ecodevelopment Research Programme (IERP) of the Institute. Almost 46 projects were on-going in different parts of the Indian Himalayan region under the above-mentioned programme. An addition of 776 new books was done and subscription of almost 132 periodicals (80 international and 52 national) were continued in the library during the year. Environmental awareness was also created by the Core among the various identified target groups by organizing a three-day on-site training programme on the aspects of nursery development, tree plantation techniques and natural resource conservation and management. Besides above, Badrivan restoration programme was also completed successfully during the year.

3.6.1. Integrated Ecodevelopment Research Programme (IERP) in the Himalayan Region

Based on the recommendations of the Project Evaluation Committee (PEC), following seventeen projects were sanctioned and funded during the year 2001-2002.

1. Indigenous knowledge of Angami tribe in sustainable management of biodiversity in Nagaland, India by Dr. N.N. Zhasa, Rain Forest Research Institute, Deovan, Jorhat, Assam. [Total outlay : Rs. 4,99,330/-].

2. Elemental status of rigid materials derived from endangered animals species of NE India by Dr. Chira R Bhattacharjee, Department of Chemistry, Assam University, Silchar, Assam. [Total outlay : Rs. 4,86,240/-].

3. *In-situ* and *ex-situ* conservation of fresh water turtles in Barak valley, Assam, North Eastern India by Dr. Abhik Gupta, Department of Ecology, Assam University, Silchar, Assam. [Total outlay : Rs. Rs. 3,99,119/-].

4. Biomonitoring of water quality in coal mining areas of Maghalaya by Dr. O.P. Singh, Centre for Environmental Studies, NEHU, Mayurbanj Complex, Shillong, Meghalaya. [Total outlay : Rs. 4,49,200/-].

5. Assessment of biodiversity, utilization and conservation of aromatic and dye yielding plants of Manipur by Dr. P.S. Yadava, Department of Life Sciences, Manipur University, Imphal, Manipur. [Total outlay : Rs. 4,93,072/-].

6. Biodiversity and ecology of Zooplankton in tropical floodplain lakes of Assam and Manipur (N.E. India) by Dr. B.K. Sharma, Department of Zoology, NEHU, Shillong, Meghalaya. [Total outlay : Rs. 3,48,800/-].

7. Screening of medicinal plants used by herbal practitioners among the Khamtis in Lohit district of Arunachal Pradesh by Dr. A.K. Das, Department of Botany, Arunachal University, Doimukh, Itanagar, Arunachal Pradesh. [Total outlay : Rs. 4,16,560/-].

8. Design, economics and utilization of water harvesting pond – A case study by Dr. P.P. Dabral, Department of Agricultural Engineering, NERIST, Nirjuli, Arunachal Pradesh. [Total outlay : Rs. 4,49,236/-].

9. Studies on crop residue management for soil nutrient enrichment and sustainable production in rehabilitated jhum lands of Arunachal Pradesh by Dr. (Mrs.) Kusum Arunachalam, Department of Forestry, NERIST, Nirjuli, Arunachal Pradesh. [Total outlay : Rs. 4,48,730/-].

10. Diversity of use pattern of faunal resources in tribal communities in Arunachal Pradesh by Dr. G.S. Solanki, Department of Applied Science (Forestry), NERIST, Nirjuli, Arunachal Pradesh. [Total outlay : Rs. 3,99,280/-].

11. Documentation and analysis of indigenous knowledge system of the tribals of Arunachal Pradesh for sustainable management of natural resources by Dr. Tomo Riba, Department of Geography, Arunachal University, Arunachal Pradesh. [Total outlay : 3,81,800/].

12. Fishery potential of Kashmir Himalayas : Study of the Ichthyofauna of the river Jehlum and its important tributaries with special reference to the conservation of endemic fauna by Dr. A.R. Yousuf, Centre of Research for Development, University of Kashmir, Srinagar, J&K. [Total outlay : Rs. 4,47,280/].

13. Exploration of fish diversity in Jammu division, J&K along with development of methods for conservation of endangered fish species by Dr. K. K. Sharma, Department of Zoology, University of Jammu, Jammu, J&K. [Total outlay : Rs. 3,49,255/-].

14. Reproductive biology and conservation strategies of some important and endangered medicinal plants of Kashmir Himalayas by Dr. I. A. Nawchoo, Department of Botany, University of Kashmir, Srinagar, J&K. [Total outlay : Rs. 4,86,680/-].

15. Diversity, distribution and status survey of mammalian fauna of Jammu Himalayas by Dr. D. N. Sahi, Department of Zoology, University of Jammu, Jammu, J&K. [Total outlay : Rs. 3,93,530/-].

16. Introduction, acclimatisation, evaluation and development of agro-technology of *Chlorophytum arundinaceum* and *Asparagus recemosus*, medicinal plants of economic potential by Dr. A.K. Dhar, Regional Research Laboratory, Jammu, J&K. [Total outlay : Rs. 4,96,018/-].

17. Geo-environmental evaluation of landslide/slope failure hazards along Udhampur –Ramban sector of the National Highway (NH1A), Northwest Himalaya by Dr. G. M. Bhat, Department of Geology, University of Jammu, Jammu, J&K. [Total outlay : Rs. 5,50,000/-].

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

1. One hundred and fourteen (114) fresh project proposals were obtained during the year and screened carefully by the subject experts. Funds for nineteen (19) ongoing/completed projects were released after careful examination of the Utilization Certificates and Statement of Expenditures. First instalment of grant of seventeen (17) newly sanctioned projects were also released during the year.

2. Annual Progress Reports (APRs) of sixteen (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 sixteen (16) completed IERP projects, received by the Institute during the year, were mailed to the various Organisations/ Institutions/ Departments etc. for follow-up action on the recommendations of the project/ utilization of research findings of the project, and also to the subject experts for their comments/ suggestions.

4. Executive summaries of fourteen (14) completed IERP projects were published by the Institute in its ENVIS Bulletin [No. 9(1) and 9(2)]. Both the issues of the Bulletin were also distributed to the various organisations/user agencies by the ENVIS Centre of the Institute.

5. A two-day workshop entitled "*Creation of awareness among the prospective PIs/Groups/NGOs etc. of the J&K region for execution of location-specific action-oriented R&D activities under the IERP of GBPIHED : Project presentation cum evaluation*" was organized/ convened successfully at Jammu University, Jammu, J&K, on 28-29 December 2001. This workshop was attended by almost 124 persons/delegates of the J&K region and twenty nine (29) project proposals were evaluated by the subject experts at the time of the workshop.

6. Besides above, a two-day workshop entitled "*Creation of awareness among the prospective PIs/Groups/NGOs etc. of the North East region for execution of location-specific action-oriented R&D activities under the IERP of GBPIHED : Project presentation cum evaluation*" was also organized/convened successfully at Arunachal University, Doimukh (Itanagar), Arunachal Pradesh, on 21-22 January 2002. Almost 200 persons/delegates of the North East region attended this workshop and fifty eight (58) project proposals were evaluated by the subject experts during the occasion of the workshop.

7. Eleventh meeting of the Project Evaluation Committee (PEC) was organized/convened successfully at New Delhi in the Seminar Hall of the Van Vigyan Bhavan (of ICFRE, Dehradun) on 17 March 2002 mainly for the finalization of almost 120 pending project proposals under the IERP of the Institute. Eight members (including one Special Invitee) attended the above-mentioned meeting of the PEC. Follow-up action on the decisions of the 10th PEC meeting was completed during the year and on the recommendations of the 11th PEC meeting, it was initiated.

8. In all, follow-up action on almost one hundred and eighty six (186) project files (old/fresh/on-going etc.) was initiated/completed during the year and financial targets/objectives set for the programme were achieved successfully. Out of the total available grant of Rs. 65,03,810/-, only Rs. 45/- were remained unspent as on 31 March 2002.

3.6.2. Strengthening of Central Nursery at the Headquarters

(Summary of the completed project/ activity)

Nursery development activities for the establishment of a central nursery of promising plants (in almost 1 ha land) at Kosi campus (1,120m amsl) of the Institute were started w.e.f. 1992-93 with the main aim to ensure availability of sufficient plant material for Institute's R&D activities as well as supply of well-established saplings to various organizations/NGOs/ individuals etc. for afforestation programmes, especially on various degraded sites of the Indian Central Himalaya. The nursery was strengthened and maintained successfully from time to time. Seeds of almost thirty (30) promising mountain trees/shrubs were collected in large quantities (from time to time), sown in the nursery beds/seedlings trays/polybags, and their germination potential were recorded under natural conditions. In all, two lakhs eleven thousand and seven hundred eighty (2,11,780) seedlings/cuttings of almost 30 promising trees/shrubs were raised in the nursery in between 1992-93 and 2001-02 (i.e., within a span of 10 years) and out of these, only one lakh sixty six thousand and six hundred fifty one (1,66,651) seedlings/cuttings of various species were found survived. Out of the total seedlings/cuttings survived during the above-mentioned period,

ninety eight thousand and eight hundred ninety (98,890) seedlings/ cuttings of various trees/shrubs were distributed, free of cost, to the farmers, rural women, students, NGOs and government departments etc. for plantation purpose in mid altitude degraded areas. However, sixty five thousand and two hundred sixty one (65,261) seedlings/cuttings of various trees/shrubs were used, from time to time, for R&D and plantation purpose by the Institute. In addition to the above, the nursery was also remained income-generating during some of the years by the sale of a large number of saplings/cuttings of various promising trees/shrubs. After maintaining and strengthening the central nursery for almost 10 years, it was handed over to the staff of Biotech XII project (of the Institute) for demonstration of various hill technologies for the upliftment of rural populace of Central Himalaya.

3.6.3. 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 the year, a three day on-site training programme (tenth of its kind) on nursery development, tree plantation techniques and natural resource conservation and management was organized at Anandpuri village (District - Almora) of Uttaranchal from March 7 to 9, 2002 in collaboration with NIDHI (a NGO). The target groups included farmers, women, ex-service Army personnel, school children and teachers, and representatives of village/forest panchayats, self help groups and Mahila Mangal Dal etc. In all, sixty four (64) local participants attended this short-term on-site training programme. The participants were trained successfully by the staff of PARDYP/INHI Core of the Institute. World Women's Day (WWD) was also celebrated on 8th March 2002 with the active involvement/participation of a number of village women. The theme of the discussion on the occasion of the WWD was natural resource conservation and management. The above-mentioned on-site training programme was considered successful in terms of dissemination of scientific knowledge and developing close linkages with the village communities. The response of the participants indicated further extension of such activity in other remote villages of the region. (Fig. 19).

Fig. 19. Xth On site Training Programme (Anandpuri Village Jageshwar, Almora)

3.6.4. Strengthening and maintenance of Central Library at the Headquarters

Library is one of the most crucial assets on which the quality of research and development (R&D) outcome depends. Current and ongoing research findings are essential components to keep update in the R&D field. In view of the above, the central library of the Institute at its headquarters was started in 1989 with the purchase of 553 books. However, subscription of 18 journals in the library was started w.e.f. 1990 onwards. Before the closure of financial year 2000-2001, the library of the Institute at its headquarters was enriched by 10,493 books and a total of 132 journals were subscribed; out of which 80 were of international (foreign) publications and the remaining 52 were national (Indian) publications. The total cost of the books purchased and journals subscribed in the library by the Institute up to 2000-2001 was Rs. 3,04,95,429/-. The Central library of the Institute is now well furnished with significant collection of old, rare and latest books as well as journals, and equipped at present with Network Computer Systems using Novell NetWare Server with 5 additional node Computers. For the management of Central library of the Institute, a network Version of the Software Package PALMS (Prasad Automated Library Management Systems) was developed earlier by the Scientist (library and documentation) of the Institute, and by the use of this software package, the library of the Institute is providing many services (since its establishment) namely, Article Alert, Current Awareness, Computerized Selective Dissemination of Information (SDI), Reprographic,

References and Indexing, Abstracting and Bibliographic, etc. for the development of human resource.

During the year 2001-2002, the central library was maintained and strengthened properly at the headquarters of the Institute. All the databases in the library were also updated. An addition of 776 new books was done and subscription of one hundred and thirty two (132) periodicals (80 international and 52 national) was continued in the library during the year 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. 47,91,062/-. Year wise volumes of the GBPIHED published research papers, popular articles and books were compiled during the year. The bibliography (1989-2001) was also updated. The Central library of the Institute received 10 national journals from the ENVIS center of the Institute and also a number of books, periodicals and other materials as gratis/exchange from various national and international organizations.

3.6.5. 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 2001-2002, two volumes of the Hima-Paryavaran [12(1), 2000 and 12(2), 2000] were distributed to almost 212 individuals/subject experts working at various academic and scientific institutions including government departments and NGOs etc. Copies of the Institute's Annual Reports (1999-2000 and 2000-2001) were also distributed to almost 197 individuals/ subject experts. Besides above, Institute's folders/leaflets and other publications were distributed during the year to almost 1,840 individuals on the occasion of various workshops, seminars and meetings, etc.

3.6.6. Badrivan Restoration Programme

(Summary of the Completed Project)

Background

Badrinath Dham is situated in the gorge of sacred Nar and Narayan hills at an elevation of 3,133 m above mean sea level (amsl) in Chamoli Garhwal and remains closed between middle of November to middle of April/May. This shrine has been perennial source of attraction and pilgrimage to the inhabitants of Indian sub-continent from time immemorial. The mythological/cultural, historical and scientific evidences indicate that this shrine had dense vegetation/forest around it in the past. However, at present there is hardly any trace of forest around this shrine. In recent past, some government and non-government organizations had attempted tree plantations around the shrine and other adjoining areas. However, there has been hardly any success. The probable reason for the failure may be incorrect selection of tree/shrub species and the lower age of the seedlings/saplings at the time of plantation. Furthermore, no attempts were made (before the closure of the site) for the protection of seedlings during winter months (when the valley remained closed). In addition, none of the earlier attempts utilized the religious authority of the Chief Priest of the shrine (especially in plantation programmes) and involved pulgrims, local people, pandas (*purohits*) and Army personnel etc. In view of the above, it was considered to initiate mass scale afforestation programme (based on scientific, cultural and spiritual/religious values), particularly for the revival of Badrivan (the ancient sacred forest of Badrinath), in and around Badrinath shrine.

Objectives

1. To involve pilgrims and local people in environmental conservation and promote environmental awareness.
2. To prevent soil erosion and stabilize soil in and around Badrinath area.
3. To revive Badrivan at Badrinath in Chamoli Garhwal.

Results and Achievements

Badrivan restoration programme was launched at Badrinath, Chamoli Garhwal with effect from September 1993 and concluded during the year 2001-02. The summary of the achievements made under the above-mentioned innovative programme is as below:

1. Five (5) broadleaved (*Betula utilis*, Bhojpatra; *Quercus semecarpifolia*, Kharsu; *Prunus cornuta*, Jamun; *Populus ciliata*, Syan; and *Juglans regia*, Akhrot), five (5) narrowleaved (*Pinus excelsa*, Kail; *Juniperus macropoda*, Badri/Palmar; *Taxus baccata*, Thuner; *Picea morinda*, Kathela; and *Abies pindrow*, Raga) and five (5) shrub species (*Salix elegans*, Bhotiana; *Viburnum foetens*, Telanu; *Cotoneaster acuminata*, Chamruins; *Hippophae salicifolia*, Badriphal/ Chuk; and *Salix wallichiana*,

Bains) were identified scientifically for plantation in Badrinath valley.

2. The soil samples of Badrinath valley were analysed for their mineral nutrients. The soil was found coarser in texture, acidic in nature, medium in cation concentration, rich in organic carbon and poor in water holding capacity. Therefore, compost manure and dried leaves of plants/ grasses were mixed in the soils of pits for stabilization in Badrinath valley before plantation.

3. Environmental awareness was created among the pilgrims and local people etc., from time to time, by organizing six (6) Ritual Distribution of Tree Seedlings and Plantation Ceremonies (RDTSPCs) in and around Badrinath valley. Almost 27,500 participants including pilgrims, local inhabitants and Army personnel etc. attended these ritual ceremonies.

4. Five (5) Plant Distribution Ceremonies (PDCs) were organised from time to time at Badrinath in Chamoli Garhwal. Almost 4,500 well-established and hardened saplings of Bhojpatra (*Betula utilis*), Kharsu (*Quercus semecarpifolia*), Jamun (*Prunus cornuta*), Syan (*Populus ciliata*), Akhrot (*Juglans regia*), Badri/ Palmar (*Juniperus macropoda*), Kail (*Pinus excelsa*) and Badriphal/ Chuk (*Hippophae salicifolia*) etc. were distributed, free of cost, to the local inhabitants of Badrinath for plantation in and around their habitations.

5. A high altitude plant nursery was established at Hanumanchatti (2,500m amsl; 12 kms before Badrinath) in 1995 and subsequently strengthened and maintained. Almost 1,67,700 seedlings/saplings/cuttings of various high altitude trees/shrubs were raised in the above-mentioned nursery and almost 59,186 saplings of various high altitude trees/shrubs were distributed, free of cost, to the local villagers of Govindghat, Hanumanchatti and Badrinath for plantation purpose in the high altitude degraded areas.

6. Almost 71,000 seedlings/saplings/ cuttings of various high altitude trees/shrubs, after 2-3 years acclimatization at Hanumanchatti nursery, were planted at different hilly sites in Govindghat, Hanumanchatti and Badrinath valley under the above-mentioned programme with the participation of local people, villagers, pandas, Army personnel and others. Out of these, 50,060 plants were found well survived at these various sites.

7. Almost 21,670 saplings of various high altitude trees/shrubs have revived Badrivan (the ancient sacred forest of Badrinath shrine) in Badrinath valley. Before the execution of above-mentioned programme, not more than 100 robust trees were found growing in the whole of Badrinath valley, which is 4 kms in length and 1.5 kms in width.

8. Before the initiation of Badrivan restoration programme, majority of the local people and pandas were of opinion that trees can not grow in Badrinath valley because none of the trees from earlier plantings had survived. However, after the initiation of this programme and subsequently based on the survival potential of tree seedlings/ saplings in Badrinath valley (particularly in the premises of Garhwal Scouts Camp and Parmarthlok etc.) they reversed their opinion and started plantation of trees in and around their habitations in Badrinath valley.

9. A unique philosophy for plantation programme (that the pilgrims, local people, pandas and Army personnel etc. will be provided tree seedlings/saplings (in the temple premises) in the form of '*Briksha Prasada*' by the Chief Priest of Badrinath shrine when devotees go for 'darshana' of lord Vishnu in Badrinath temple so that they could have sentimental attachment with the saplings of the plants and plant them in Badrinath valley for the benefit/protection of environment as an act of devotion) was proposed for the first time and subsequently tested under Badrivan restoration programme by organizing six (6) Ritual Distribution of Tree Seedlings and Plantation Ceremonies (RDTSPCs) from time to time. The philosophy of the above-mentioned programme was also replicated in 1997 beyond the Hindu tradition. The approach/philosophy and activities of Badrivan restoration programme have been recognised and acclaimed at local/regional/ national and international levels.

10. A technology package for afforestation in remote high altitude snow-bound areas was developed on the basis of the experience gleaned from the execution of Badrivan restoration programme at Badrinath. Some of the meteorological data were also obtained, for the first time, for Badrinath valley with the help of an automatic meteorological station (Weather Master Mark 4). Besides this, triangular tin made devices for the protection of seedlings/saplings (from high

intensity of snow fall) in Badrinath valley during winter season were also designed and developed, and put over some of the newly planted seedlings/saplings before the closure of the site, and this special effort significantly increased the survival potential of the plants.

11. The above-mentioned programme has successfully inspired the pilgrims, Army personnel, local inhabitants and others to restore degraded lands in and around Badrinath shrine and also to initiate plantation in different parts of the Country. Furthermore, Badrivan restoration programme also illustrates the importance of blending science and religion for the benefit/protection of environment and conservation of biodiversity.

12. The plantation work carried out under Badrivan restoration programme, with its unique philosophy, has emerged an inspiring model for the rehabilitation of high altitude degraded lands and conservation of biodiversity not only in other parts of Himalaya, but also elsewhere throughout the world where sacred/pilgrimage sites exist and are threatened. (Fig. 20).

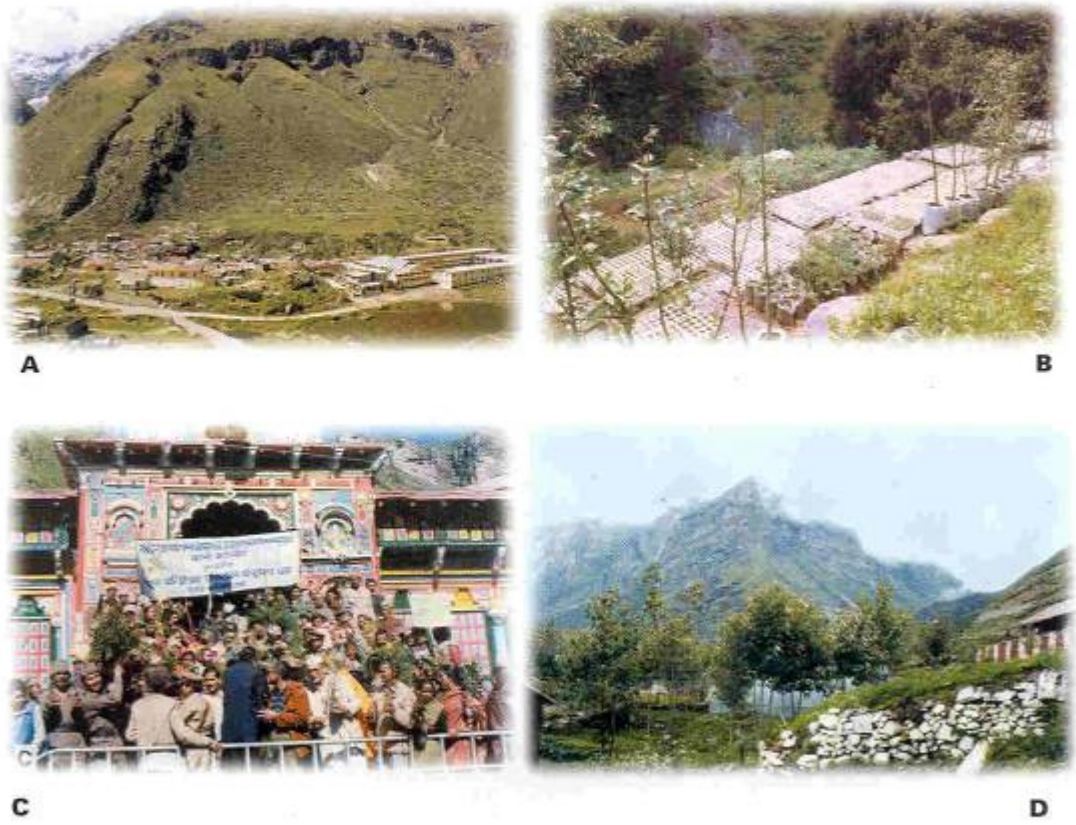


Fig. 20. (A) View of Badrinath valley in Chamoli Garhwal, Uttaranchal; (B) Plant nursery developed at Hanumanchatti; (C) Ritual distribution of tree seedlings and plantation ceremony at Badrinath; (D) Trees growing and surviving well in Badrinath Valley (i.e., in Garhwal Scouts camp).

3.7. INDIGENOUS KNOWLEDGE SYSTEMS

Mountain cultural heritage and traditional knowledge systems play significant role in sustainable use, management and conservation of resources. Restrengthening of culture and indigenous knowledge (IKS) base should lead to enhanced conservation practices. Integration of indigenous knowledge with modern techniques is possible. Value addition and validation of indigenous and traditional knowledge will create potential for enterprises, which, in turn should lead to economic upliftment of the locals. To address these issues, the IKS core has initiated documentation and analysis of indigenous knowledge and management practices of high altitude societies, and analysis of indigenous agricultural practices in the light of its efficiency and sustainability. This integration will be an appropriate approach for sustainable development of Himalayan societies.

3.7.1. Documentation and Analysis 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 available natural resources, giving rise to a cultural diversity on par with the high level of biological diversity found in the region. Preparation and use of fermented food and beverages using local food crops and other biological resources is very common amongst the high landers of 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 well developed to meet the local requirement. The traditional method of Bhotiya food fermentation and beverage making was designed in such a way, that it utilized those available crops, which did not make their main food crops. The common fermented drinks of this community are *jann* and *daru*. Among the fermented foods is the semi-fermented rice called *sez*, which is taken as a light snacks.

Objectives

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

Results and Achievements

1. The traditional catalyzing agent used in the preparation of fermented food and beverages is locally called as *balam*, which is not prepared by all villagers in the society. The alpine grazers called as *anwals* have specialized know how in the preparation of this starter culture. It is made up of wheat by mixing a number of herbs and spices (Fig. 21). The roasted wheat flour is mixed with spices like long *(Syzygium aromaticum)*, elachi *(Amomum* spp.), kalimirch *(Piper longum)*, leaves of mirchi-ghash (wild chilies), and seeds of pipal *(Ficus religiosa)*. In this mixture, powder of old *balam* prepared in the previous year is also added (Table 18). The mixture so prepared is then thoroughly mixed up with the required quantity of water, and is rolled into a thick paste. Doe of this mixture is then pressed between palms to make *balam* balls of the required size. These balls are then dried in shade and stored for future use for an indefinite period of time.

2. *Jann* is a traditional soft drink of the Bhotiyas of Munsyari, and contains very low concentration of alcohol. It is commonly prepared out of rice, however, it can also be made out of a good number of substrates of both cereals and fruits (Table 19). Amongst the fruits, apple is most desired and is also very delicious. But *jann*

Fig. 21. Indegenous starter culture called *Balam*

Table 18. Ingredients required in the making of *balma*

Name of the ingredient	Processing	Quantity required
Wheat *(Triticum aestivum)*	Flour	1 Kg
Clove *(Syzygium aromaticum)*	Powder	5 –10 gm
Cardmum *(Amomum* spp.)	Powder	5 – 10 gm
Pepper *(Piper longum)*	Powder	20 – 30 gm
Old balma powder	Powder	40 – 60 gm
Pipal seeds *(Ficus religiosa)	Powder	3 – 4 gm
Mirchi gash*	Powder	2 – 3 gm

*These are not often used.

prepared from *koni* is considered to be the best in quality. The quality of *jann* is best judged by its taste (sweetness), smell and strength.

3. The most commonly used rice *jann* was prepared almost in every household in this society, but now its preparation and consumption has declined. In the making of rice *jaan*, first rice is cooked or boiled for about half an hour or until it becomes soft and edible. The cooked rice is drained off the excess of water and then thoroughly mixed with *balam* powder. The quantity of the *balam* powder required is proportionate to the quantity of rice to be fermented (Table 20). This mixture is then kept in an airtight container and is kept in a dark and warm place for fermentation. But for a good quality *jann* slow fermentation at low temperature is a required condition. The process of fermentation takes place in the absence of oxygen, and usually after a week of fermentation *jann* is prepared. However, for a better quality of *jann* the fermentation period is extended as long as possible but not more than a year. After the completion of fermentation, the *jann* so produced is filtered with the help of a sieve. The filtrate is a whitish liquid, which is abandoned or fed to the animal. Earlier, when they migrated to their winter settlement in lower valleys, before their migration they prepared *jaan* material and left them for fermentation. For six months of winter, their entire settlement got submerged under snow, and as result of the internal heat generated due to the external pressure of ice from the top, the *jaan* fermentation was slow but steady. On their return to the place again in summer the people found their *jann* ready for drink, and *Jann* produced in this way is considered to be the best in quality.

4. Similarly, the preparation of *Jann* is same from other cereals like *koni*, wheat, *jaw*, *oowa*, *chuwa* and *china*. Like rice, first the seeds of any of these cereals are boiled in water until they become soft and edible. Then they are mixed with *balam* powder and the rest of the stages of storing and fermentation, and finally yielding of *jann* is the same. *Jann* is also prepared from fruits like apple, banana, pumpkin and orange. Apples are first cut into pieces and then are mixed with *balam* powder for fermentation. The rest of the method is the same, except in case of orange, where either the juice or the complete fruit after peeling is mixed with *balam* powder and fermented for yielding *jann*. Banana is used without removing its outer skin. The preparation of *jann* from pumpkin is slightly different, where a small cut is made in a large sized pumpkin in such a way that the cut piece is again fitted back to its place. First the seeds and loose tissues contents of the fruit is removed through the opening, and boiled rice or other substrate mixed with *balam* powder as usual is poured into the empty space of the fruit. It is then sealed again by placing back the cut piece in its place. The process of fermentation takes place inside as a result of which along with rice the inner soft tissue of the fruit also gets digested, and thus yields *jann* in due course of time.

3.7.2. Analysis of indigenous agricultural practices in the light of its efficiency and sustainability

Background

The Himalayan agriculture is mostly characterized as predominance

Table 19. Preference of cereals in the preparation of *jaan*

Cereals	Most common	Best quality	Less preferred
Rice (*Oryza sativa*)	*		
Koni (*Sotaria italica*)		*	
Wheat (*Triticum aestivum*)			*
Jau (*Hordeum vulgare*)	*		
Oowa (*Hordeum himalayans*)	*		
Chuwa (*Amaranthus* sp.)			*
China (*Panicum miliaceum*)			*

Table 20. Yield rate of local beverages using rice as a substrate

Beverages	Input				Yield Rate
	Rice	Balma	Jaggary	Fuel wood	
Jaan	5 Kg	40 gm	-	-	3-4 Liters (partially fermented) 6-7 Liters (fully fermented)
Daru	5 Kg	100 gm	2 Kg	10-12 Kg	3-4 Liters

of rainfed conditions, subsistence economy, and dependence on natural resources for viability. In these circumstances, varied topography, climate, various local methods and techniques have been evolved in the agricultural practices to meet the area specific or season specific need. These indigenous practices have been continuing in the fields through school of traditions. Documentation of these practices is important to save Intellectual Property Right of the mountain farmers, and for most of the practices scientific rationale have not been explored.

Objectives

1. Documentation of various traditional agricultural practices
2. Scientific analysis of various agricultural practices and crops
3. Documentation of various landraces of traditional crops and their role

Results and Achievements

1. In the rainfed cropfields under fallow system during winter season weeds appear throughout the length of fallow period. In the beginning of a fallow period weed density was found high (~290 indi./m^2) but by the end of the fallow period the density was reduced to (~79 indi./m^2).
2. In the initial phase of fallow period total weed biomass (Fig. 22) was 63.50 g/m^2 that reached to a minimum of 11.56 g/m^2 during mid-January, after which a slight increment was observed (14.91 g/m^2) due to reappearance of favourable climate.
3. Among the studied parameters, soil pH had a negative influence on weed species number ($r = -0.428$, $P < 0.02$) as well as total weed density ($r = -0.473$, $P < 0.01$) of the fallow cropfields, however, total weed biomass was not influenced by pH. Presence of organic carbon in the soil influenced greatly the weed community parameters, viz., species number ($r = 0.385$, $P < 0.05$), density ($r = 0.540$, $P < 0.001$), and total biomass ($r = 0.441$, $P < 0.02$).
4. Multiple cropping is a traditional mechanism to increase crop production per unit area and time. Finger millet based multiple cropping is more common in the area. Cultivation of finger millet with leguminous crop soybean or black soybean (a local variety) in two crop combination was more common in village Matela.

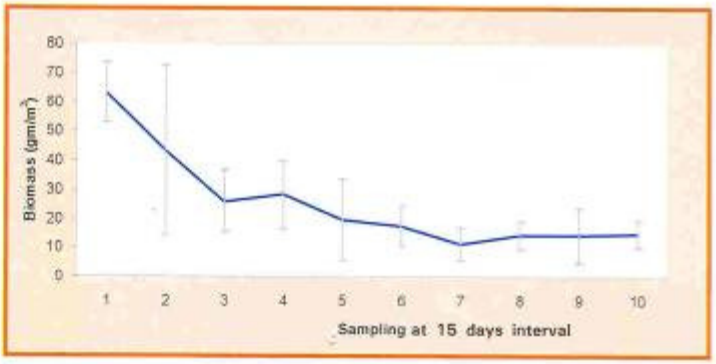


Fig. 22. Total weed biomass along the length of fallow period.

Table 21. Efficiency of multiple cropping patterns during *Kharif* season.

Pattern/Crop	Agronomic Yield (q/ha)	Harvest Index
Single Crop	**Village Matela**	
Finger millet	0.33-0.45	0.23-0.25
Paddy	0.39-0.55	0.34
Millet	0.67-1.03	0.30
Two Crops		
Finger millet + Soybean	1.13-1.75	0.16-0.19
Finger millet + Black Soybean	1.53-2.08	0.27
Three Crops		
Finger millet + Black Soybean + Lima Bean	1.34-1.82	0.24-0.25
Single Crop	**Village Katarmal**	
Finger millet	0.95-1.39	0.30
Three Crops		
Finger millet + Black Soybean + Horse Gram	4.33-5.97	0.36-0.37
Finger millet + Black Soybean + Lima Bean	2.43-3.47	0.29

Agronomic yield of soybean based pattern ranges from 1.13 q/ha to 1.75 q/ha in the village, however, agronomic yield and harvest index were observed greater (1.53-2.08 q/ha and 0.27, respectively) for local variety of soybean (black) based multiple crop association of finger millet (Table 21).

5. Among the three-crop combinations in village Katarmal horse gram with finger millet and black soybean was found more efficient (agronomic yield between 4.33 and 5.97 q/ha, and harvest index ~0.36) than the lima bean crop with finger millet and black soybean (2.43-3.47 q/ha and 0.29, respectively). Between the two villages three crop combinations were more productive and efficient in this village than village Matella.

3.7.3. Indigenous knowledge and uses of medicinal plants by *Vaidyas* in Uttaranchal Himalaya

Background

Since the advent of modern allopathic drugs the traditional healing practices have been declining all over the world. The centuries old knowledge on the surrounding natural resources those have been used in preparing various important medicine have also been declined sharply. Plants have always been one of the major ingredients in preparing traditional medicine. The Himalaya is the storehouse of such medicinal plants and it is believed that each plant grows in the Himalayan region has amazing potential in eradicating the ailments but there is a need to find out its medicinal properties. Unfortunately, the knowledge occupied over the years of experiments and experiences has been declined and thus there is a loss in knowledge on the use of many important plant species and techniques of preparation local drugs.

Table 22: Major plant species as per the use for therapy

Sl. N.	Species	Part used	Local name	No. of diseases cured
1	*Vitex nigundo* L.	Lf, St	Begna	48
2	*Azadirachta indica* A.H.L. Juss.	Bk, Lf, St	Neem	40
3	*Woodfordia fruticosa* (L.) Kurz	Fl	Dhaulu	35
4	*Centella asiatica* (L.) Urban	Lf, Fr	Brahmi	32
5	*Aegle marmelos* (L.) Corr.	Lf, Fr	Bel	31
6	*Cuscuta reflexa* Roxb.	Wp	Amarbel	31
7	*Butea monosperma* (Lumk.) Taub.	Sd, Fl	Dhak	30
8	*Phyllanthus emblica* L.	Fr, Sd	Awala	29
9	*Euphorbia hirta* L.	Wp		29
10	*Solanum nigrum* L.	Fr, Fl	Bhamboaln	27
11	*Achillea millefolium* L.	Fl	Gandan	25
12	*Acorus calamus* L.	Rh	Bhuch	25
13	*Cannabis sativa* L.	Lf	Bhang	25
14	*Gloriosa superba* L.	Rh	Karihari	25
15	*Ricinus communis* L.	Sd	Arandi	25
16	*Allium cepa* L.	Bb	Pyaz	24
17	*Ficus racemosa* L.	Bk, Rt	Gular	23
18	*Ficus bengalensis* L.	Fr	Bargad	22
19	*Argemone maxicana* L.	Lf	darudi	22
20	*Ficus religiosa* L.	Lf, Fr, Bk	Pipal	22
21	*Ziziphus mauritiana* Lam.	Fr	Ber	21
22	*Cynodon dactylon* (L.) Pers.	Rt	Doob	21
23	*Anogeissus latifolia* Bedd.	Bk	Bakla	19
24	*Oxalis corniculata* L.	Lf	Vilmora	19
25	*Shorea robusta* Roxb. ex Gaertn. f.	Bk	Sal	19
26	*Nardostachys grandiflora* DC.	Rt	Masi	18
27	*Ocimum sanctum* L.	Lf	Tulsi	18
28	*Terminalia chebula* Retz.	Fr	Haidu	17
29	*Swertia chirayita* (Roxb. ex. Flem.) Karsten.	Rt	Chairyita	16
30	*Zanthoxylum armatum* DC.	Fr, St	Timur, Timroo	16
31	*Allium sativum* L.	Bb, Lf	Lahsun	16
32	*Bauhinia variegata* L.	Bk, Lf	Kachnar	15
33	*Zinziber officinale* Roscoe	Rt	Adrak	15

Code for plant parts used: Rt- Root; Lf- Leaf; St- Stem; Bk- Bark; Bb- Bulb; Fr- Fruit; Rh- Rhizome; Wp- Whole plant; Sd- Seed

Objectives

1. Documentation of various ingredients and techniques used in the preparation of local drugs by the traditional *Vaidyas*

2. Analyzing the causes for the preference of *Vaidyas* system of medication

3. Documenting the local and regional variation in the *Vaidyas* system of treatment

Results and achievements

1. The preliminary observations have indicated that the loss of vaidyas system of medicare is due to the decline in number of *Vaidyas*. However, there are a few women and men in the villages who know the healing properties of medicinal plants. The various indigenous uses of about 300 plants species have been documented.

2. *Vitex nigundo* L. is used to cure the highest number of indigenous illnesses, followed by *Azadirachta indica* A.H.L. Juss., *Woodfordia fruticosa* (L.) Kurz, *Centella asiatica* (L.) Urban and *Aegle marmelos* (L.) Corr. (Table 22).

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 maping 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). In total 15 sites in the India have been identified and due to rich traditional knowledge and high agrobiodiversity high altitude areas of Munsyari dist. Pithoragarh is one of them.

Objectives

1. Exploration of agrobiodiversity, landraces and natural ecosystems.

Results and achievements

1. The study is just initiated and maps based on toposheet and other information of the area has been generated (Figs. 23 & 24).

2. Field work and satellite data procurement is in progress.

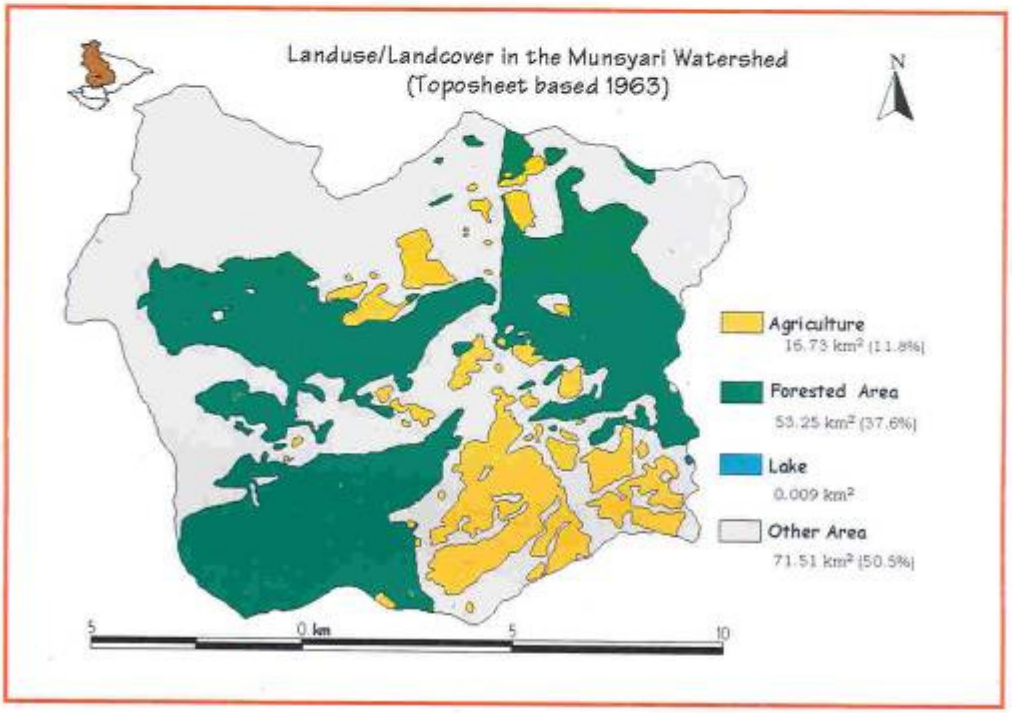


Fig. 23. Landuse /Landcover map of Munsyari watershed.

Fig. 24. Landuse /Landcover map of Munsyari watershed.

QUICK APPRAISAL STUDIES

3.4.10. Assessment of Hill Slope Instabilities Along the Road Network of Sikkim State

Background

Sikkim state in the Indian Himalayan Region (IHR) has a high road density amongst the Himalayan states including metalled and unmetalled stretches. These consist of categories such as National Highway, State Highway, Major District Roads and Other District Roads. Like other hilly regions of the country, Sikkim experiences landslide problems (Fig. 25) along various road alignments particularly during monsoons mainly triggered by heavy rainfall conditions. Other conducive conditions being the host terrain itself in terms of geologically fragile rock formation as well as steep physiographic disposition. This leads to traffic disruptions as well as other associated problems from time to time.

Objectives

1. An evaluation of hill slope instabilities along the road network of Sikkim.
2. Observations on their field dispositions in the monsoon season.
3. Analyse and derive the preferred alignments.

Results and achievements

1. Hill slope instability assessment was conducted during monsoon season of the current year (2001) along the road network of Sikkim state. This covered 8 road stretches viz. NH31A (Phenengla to Melli stretch of 73 km), Phenengla to Pangthang (GBPIHED Sikkim Unit site; stretch of 9 km), Indira Bye Pass (Bojogari to Tadong; stretch of 11 km), JLN Road (Zero Point to Hanumantok; stretch of 7 km), Northern Bye Pass (2 Mile to Tashi View Point; stretch of 5 km), Melli to Jorethang State Highway (35 km), Jorethatng to Sombaria Highway (30 km), and Jorethang to Geyzing State Highway (41 km).
2. This assessment along the network of roads include alignments such as slopes, valleys and ridges. These cover major portions of physiographic, geologic, climatic and ecological variations of the region. The findings are included in the Table 23 which provides an estimate of average number of unstable sites, non-functional culverts, subsidence sites etc.
3. It was observed that maximum number of landslips per km occurred upstream of the road along the slopes followed by valley and the least along the ridge alignments. Same trend was observed in respect of road side cutting/subsidence sites. But unstable slopes were found to be highest along the slopes followed by ridges and least along the valleys. Unstable slopes had average highest angle along the ridge followed by slopes and least along the valleys.

Fig. 25: Mile 9 landslide on NH31A.

Table 23. Hill slope instabilities along road network of Sikkim state.

	Road Segment	*Alignments*		
		Along slope	*Along ridge*	*Along valley*
1.	Number of road surveyed	6	3	3
2.	Length of road surveyed (km)	113	25	73
3.	Elevation range (m above msl)	300-2010	1400-2200	300-900
4.	Average number of landslips (per km) upstream of road	3.68	1.39	1.8
5.	Average number of road side cutting/subsidence sites (per km)	7.69	3.21	3.49
6.	Average number of unstable slope (per km)	1.61	1.17	0.31
7.	Average slope at unstable site (degrees)	46	47	45
8.	Average number of natural cross drainage works (per km)	7.6	8.33	1.54
9.	Average number of culverts (per km)	8.38	16.29	3.09
10.	Average number of culverts (non-functional) (per km)	0.47	0.89	0.23
11.	Average number of culverts closed/choked (per km)	0.81	0	0.22
12.	Av. no. of sites where slope is unstable below culvert (per km)	0.97	0.49	0.26
13.	Average number of passing places per km (only in single lane)	4.96	3.27	2.14

4. Natural cross-drainage works per kilometer was observed to be highest along the ridges followed by slope and least along the valley. Culverts were found to be highest along the ridge alignments followed by the slope and valley alignments respectively. Similar trend was observed in respect of average number of non-functional culverts per km. But, ridge alignments had negligible choked culverts whereas, slope alignments had highest followed by valley alignments. Average number of sites where slopes are unstable below culverts are highest per kilometer along slope followed by ridge and valley alignments respectively. In case of single lane passing places per kilometer, the highest could be observed along slope followed by ridge and valley respectively.

4. MISCELLANEOUS ITEMS

4.1. Membership of Professional Societies/Committees

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

Member, National Geographic Society, USA. (**J.C. Kuniyal**)

Member, Society for Environmental Communication, New Delhi (**J.C. Kuniyal**)

Member, International Society for Tropical Ecology (**S.C.R. Vishvakarma**)

Life Member, Society of Ethnobotanists, Lucknow, U.P. (**P.P.Dhyani**)

Life Member, Indian Society for Plantation Crops, Kasaragod, Kerala. (**P.P.Dhyani**)

Member, Central Himalayan Environment Association (**Kireet Kumar, P.K. Samal & H.C. Rikhari**)

Indian Association of Soil and Water Conservationists, Dehradun (**D.K. Agrawal**)

Indian Society of Soil and Water Conservation, New Delhi (**D.K. Agrawal**)

Life Member, Indian Society for Agricultural Development & Policy, Ludhiana (**K.S. Rao**)

Life Member, Indian Society of Remote Sensing, DehraDun (**K.S. Rao**)

Member, Commonwealth Forestry Association (**R.K. Maikhuri**)

Member, People's Association for Hill Area Research, Nainital (**R.K. Maikhuri & S.S. Samant**)

Life Member, Indian Society of Ecological Economics, New Delhi (**N.A. Farooquee, R.S. Rawal & G.C.S. Negi**)

Life Member, U.P. Association for the Science and Technology Advancement, Lucknow (**Kireet Kumar**)

Member, International Association of Hydrological Sciences, UK. (**Kireet Kumar**)

Life Member, International Society of Environmental Botanists (**S.C. Joshi & H.C. Rikhari**)

Life Member the Indian Botanical Society (**U. Dhar**)

Life Member National Academy of Sciences, Allahabad, India. (**U. Dhar**)

Life Member, Association of Administrative Staff College of India, Hyderabad (**S.S. Samant**)

Life Member, Orchid Society of India, Chandigarh (**S.S. Samant**)

Member, Microbiologist Society (**Anita Pandey**)

Member, Geological Society of America (**A.P. Krishna**)

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

Fellow, Geological Society of India (**Sanjib Kundu**)

Member, National Geographic Society (**D.S. Rawat**)

Member, International Association for landscape Ecology, USA (**S. Sharma**)

Member, World Cultural Council, Mexico (**S. Sharma**)

4.2. Award/Honour

Fellow National Academy of Sciences, Allahabad, India (**U. Dhar**)

Identified Nodal Person for Management of Research by the Ministry of Environment and Forests, New Delhi (**S.S. Samant**)

Member, National Biodiversity Strategy and Action Plan, Uttar Pradesh (**S.S. Samant**)

Elected as the member of Working Group of the State Biodiversity strategy and Action Plan, by Department of Forest Government of Arunachal Pradesh (**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, State Level Steering Committee of National Biodiversity Strategy and Action Plan for the Uttaranchal State (**R.K. Maikhuri**).

4.3.1. Scientific Papers

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4.4.1. Authored/Edited Books

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4.4.2. Popular Articles

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Singh, A., J.N. Gautam and R.C. Prasad (2001). Himalayan information system: A proposed model. *IASLIC Bulletin*, 46(2): 111-115.

4.5. Symposia/ conferences/ training courses/ workshops organized by the Institute

"Field training on "Application of SWEET" at Gaijol, Almora on 23rd March, 2001 (Convener: Kireet Kumar)

NBSAP-SWG Uttar Pradesh Consultation Meeting GBPIHED-Head Quarters, June 8, 2001 (Convener: U. Dhar)

Medicinal Plants related Workshop *(Jari-buti sambandhit karyashala)* for villagers at village Shat-Kullu, H.P., under the Department of Biotechnology, New Delhi sponsored project. 1 June 2001 (Convener: H.K. Badola)

Orientation Workshop for Summer Students from Canadian Universities, June 21-22, 2001 at GBPIHED, Kosi-

Katarmal, Almora. (Convener: P.K. Samal)

Contour Hedgerow Farming System Technology at Bhiri (Rudraprayag) on 27-28 June 2001 (Convener: R.K. Maikhuri)

Organised Meeting with the Director, Nanda Devi Biosphere Reserve, Forest Officers and other staff of the Forest Department on July 23, 2001 at Gopeshwar (Convener: S.S. Samant)

DST's Bio-Geo data base for sustainable development of Uttaranchal 4-6 September 2001 (Convener: K.S. Rao).

PARDYP On-site Training Programme on Pisciculture, Apiculture and Farm Based Livelihood in Uttaranchal, Bora Gaon, Pithoragarh, September 24-26, 2001. (Convener: B. P. Kothyari).

Village level workshop on landslide control and stabilisation on upland farms, October 13, 2001 at Upper Kamrang village, Mamlay watershed, South Sikkim (Convener: A.P. Krishna)

Training Programme on "Environmental Economics for Practicing Scientists and Ecologists" GBPIHED-Head Quarters, October 16-20, 2001 (Convener: U. Dhar)

PARDYP On-site Training Programme on Community Forestry, Nursery Development, Farm Based Techniques and Natural Resources Management and Conservation, Lawbanj, Bageshwar, Uttaranchal, November 10-13, 2001. (Convener : B. P. Kothyari).

One-Day Training Workshop on Cultivation of Medicinal Plants (*Jari-buti ke krishikaran se sambandhit*) at village Silha-Kullu, H.P. under the Department of Biotechnology, New Delhi sponsored project. 26 November 2001 (Convener: H.K. Badola)

NBSAP- TWG Wild Plant Diversity Consultation Meeting IIRS, Dehradun, November 26, 2001(Convener: U. Dhar)

Creating awareness for conservation of plant genetic resources and Farmer- to - Farmer technology transfer at Baragaon village on 30th November, 2001 (Convener : K.S. Rao).

Workshop on the Creation of Awareness Among the Prospective PIs/Groups/NGOs etc. of the J&K Region for Execution of Location-Specific Action-Oriented R&D Activities Under the IERP of GBPIHED : Project Presentation cum Evaluation, Jammu University, Jammu, J&K, December 28-29, 2001. (Convener : P.P. Dhyani and I.A. Hamal).

NBSAP- TWG Wild Plant Diversity Consultation Meeting, Jeewajee University, Gwalior, M.P. January 14, 2002 (Convener: U. Dhar)

Workshop on Creation of Awareness Among the Prospective PIs/Groups/ NGOs etc. of the North East Region for Execution of Location-Specific Action-Oriented R&D Activities under the IERP of GBPIHED : Project Presentation cum Evaluation, Arunachal University, Itanagar, Arunachal Pradesh, January 21-22, 2002. (Convener : P.P. Dhyani and R.S. Yadava).

Training Workshop VIII "People's Participation in Himalayan Biodiversity Conservation", GIC Syalde, February 2-3, 2002 (Convener: U. Dhar)

Creating awareness for conservation of plant genetic resources and Farmer- to - Farmer technology transfer at Phaparsali village on 26th February 2002 (Convener : K.S. Rao).

Science motivation and awareness contact programme for talented high school students of Sikkim (February 26 to March 2, 2002), Gangtok (Convener: A.P. Krishna)

Tenth INHI On-site Training Programme on Nursery Development, Tree Plantation Techniques and Natural Resource Conservation and Management, Anandpuri, Jageshwar, Uttaranchal, March 7-9, 2002. (Convener: B. P. Kothyari).

Eleventh meeting of the project evaluation committee (PEC) for integrated ecodevelopment researchg programme (IERP) in the Himalayan region, New Delhi, March 17, 2002. (Convener : P.P. Dhyani).

International Workshop on "*Endangered Medicinal Plant Species in Himachal Pradesh*" organised by GBPIHED at Himachal Unit, Mohal-Kullu, H.P.; sponsored by World Resource Foundation, GBPIHED Kosi-Almora, Rothamsted International (IACR) UK and CASA, New Delhi. 18-19 March 2002 (Convener: H.K. Badola)

Workshop on Awareness and Importance of Indigenous Knowledge Systems in the context of Indian Himalaya, Joshimath, Garhwal, Uttaranchal, March 24th, 2002 (Convener: N.A. Farooquee)

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

Second-First Year Planning Meeting of Collaborating Institutions for "People Centered Land Use Development in the Shifting Agriculture Affected Buffer Zone of Namdapha National Park" organized by the Mac-Arthur- UNESCO Project during 6– 8th April, 2001 at Itanagar (R.C. Sundriyal).

Participated in the "IInd Uttaranchal Medicinal Plants Grower's Workshop" held at Timta, Gangolihat from 7-8 April, 2001, organized by Shri Hari Prasad (Farmer), Gangolihat (S.S. Samant)

Participated in National workshop of NATP (Plant Biodiversity) programme at NBPGR, New Delhi on 19-20th April 2001. (K.S. Rao)

IUCN-RSUP Himal Planning Workshop for Biodiversity Conservation in Indian Himalaya India International Centre,

New Delhi, 25-26 April, 2001 (R.S. Rawal)

National Workshop on Environmental Education, May 18-20, 2001, Uttarakhand Seva Nidhi (Sponsored by Department of Education, Min. of Human Resource Development, Govt. of India). (P.K. Samal)

National Workshop on Development and Mitigation Plans for Transhumance and Tribal Groups of Siwaliks, May 21, 2001, Chandigarh (Sponsored by IWDP hills, Punjab and Haryana). (D.K. Agrawal, P.K. Samal, N.A. Farooquee and S. Sharma)

Participated in a Workshop on Recent Earthquake in Chamoli and Bhuj organized by University of Roorkee at Roorkee on 24-26 May 2001 (V. Joshi).

Training cum Workshop for GEF stabilization project FRI, Dehradun, May 31-June 2, 2001 (U. Dhar)

Meeting on Marginal Farms', organized by Mountain Farming Division, ICIMOD during May 25-27, 2001 at Kathmandu, Nepal (R.C. Sundriyal, Manju Sundriyal, Uma Shankar).

Participated in Second SERC School on Cloud Physics and Atmospheric Electricity – Frontier organized by Indian Institute of Tropical Meteorology at Pune on 5 June – 7 July 2001 (V. Joshi).

National Session of LEAD at Leh on "Learnings from Laddakh", from June 25 – July 7, 2001 (Kireet Kumar)

Participated in the Workshop on Medicinal Plants of Uttaranchal at Bageshwar on June 26, 2001, organized by Forests Minister, Uttaranchal Government, Uttaranchal. (S.S. Samant)

A training was organised on Contour Hedgerow Farming System Technology with the help of Garhwal Unit of GBPIHED at Banswara, District Rudraprayag in Uttaranchal during 27-28 June 2001 (K.S. Rao, R.K. Maukhuri, G.C.S. Negi and R.C. Sundriyal).

International conference on Tropical Ecosystems: Structure, diversity and human welfare. Meeting hosted by Ashoka Trust for Research in Ecology and Environment (ATREE), sponsored by Association for Tropical Biology (ATB), during July 15-18, 2001 at Banglore (R.C. Sundriyal).

Comprehensive Siwalik watershed development strategy" in the National Workshop on Watershed Management Strategies in Uttaranchal, July 20-21, 2001, ICFRE, Dehradun (Sponsored by Watershed Management Directorate; Directorate of Agriculture; and Rural Development Departmnet, Uttaranchal). (D.K. Agrawal and P.K. Samal)

Participated and presentation in Initial Meeting on Scoping Workshop on Global Change Impact Assessment for Himalayan Regions organized by Institute for Development and Innovation, Kathmandu, Nepal. 21-22 July 2001 (G.C.S. Negi).

National Workshop on WARASA-Jan-Sahayogita (Watershed Areas Rainfed Agriculture Systems Approach), July 22, 2001 at ICFRE, Dehradun (Sponsored by Min. of Agriculture, Govt. of India). (D.K. Agrawal and P.K. Samal)

A State Biodiversity Strategy and Action Plan working group meeting, organised by SFRI on 23rd July 2001 at Itanagar (R.C. Sundriyal).

Participated in a Symposium on Plant Genetic Resources Management: Advances and Challenges organized by National Bureau of Plant Genetic Resources at Pusa Campus, New Delhi on 1-4 August 2001 (R.K. Maikhuri).

First State level workshop on 'State Biodiversity Strategy and Action Plan. Organized by State Forest Research Institute (SFRI) on 3rd August 2001 at Banquet Jubilee Hall, Itanagar (presented a paper) (R.C. Sundriyal and Manju Sundriyal).

Fifth Working Group Meeting of the State Biodiversity Strategy and Action Plan, organised by SFRI on 16th August 2001 at Itanagar (R.C. Sundriyal).

Two-day training course on Contour-Hedgerow-farming-system and other allied technologies to the 15 farmers of Future Generations, an NGO, and local farmers during August 17-18, 2001 at Multidisciplinary Training Centre at Doimukh, Itanagar (R.C. Sundriyal).

Attended Medicinal plants training programme at NBRI, Lucknow (Org. UNESCO-IDRC), September 2-13, 2001 with focus on bioresources, processing and litigation aspects of the medicinal plants (L.K. Rai).

Department of Biotechnology sponsored training program on micropropagation of disease free planting material: a basic course for growers. Organized by Institute of Himalayan Bioresource Technology (IHBT) Palampur, September 2 to 15, 2001 (C. P. Kuniyal)

Participated in the Regional Training Programme on Biodiversity Systematics: Evaluation and Monitoring with emphasis on Medicinal Plants, sponsored by UNESCO, New Delhi and Co-sponsored by IDRC, New Delhi and Organized by NBRI Lucknow from September 3-13, 2001 (S.S. Samant).

DST's Workshop on Bio-geo Database for the Generation of Sustainable Development Plan for Uttaranchal, Kosi - Katarmal (Almora), Uttaranchal, September 4-6, 2001. (P.P. Dhyani, D.K. Agrawal, R.K. Maikhuri, P.K.Samal, N.A. Farooquee and G.C. S. Negi).

Participated in a UNDP-GEF workshop regarding formulation of a project proposal on Carbon Sequestration and Biodiversity Conservation on Uttaranchal Hill by Holistic Initiatives in Village Agroecosystems at FRI,

Dehradun, September 6, 2001 (S.C. Joshi).

Training course "Regional Ecosystem Monitoring Technology" sponsored by JICA and Organized by APN Centre, Japan. September 17 to December 16, 2001 (R.S. Rawal)

Attended a meeting related to Germplasm collection of High Altitude Medicinal Plants in the alpine field station of HAPPRC at Tungnath, September 23, 2001 (S.C. Joshi).

Attended "Workshop on watershed management" (October 2, 2001) at Guwahati organized by American Center, Kolkata (A.P. Krishna and R.C. Sundriyal).

Participated and presentation in Scoping Workshop on Global Change Impact Assessment for Himalayan mountain Regions organized by Institute for Development and Innovation, Kathmandu, Nepal. 2-5 October 2001 (Kireet Kumar and G.C.S. Negi).

Attended and presented poster in "2001 Open meeting on human dimensions and global environmental change" (October 6-8, 2001), Rio de Janeiro, Brazil (S.C. Rai).

Short term training course on Disaster management at NERIST during 4-9 October (presented a paper on October 9, 2001, "Man made disaster and land rehabilitation"). Organised by Faculty of Natural Disaster Management Centre, NERIST, Nirjuli, Itanagar (R.C. Sundriyal and Manju Sundriyal).

Sixth Meeting of SBSAP (State Biodiversity Strategy and Action Plan) working group, organized by SFRI on 10th October 2001 at Itanagar (R.C. Sundriyal and Manju Sundriyal)

Short term training course on GPS for crustal deformation studies, organised by Wadia Institute of Himalayan Geology, Arunachal Centre during 11-20 October 2001. Attended Inaugural (on 11th October) and Valedictory (on 20th October) functions (T.C. Upreti, M.K. Tiwari, Manju Sundriyal and R.C. Sundriyal).

Participated at a 'State level Children Science Congress' held at Govt. Sr. Secondary School, Kullu organised by State Council for Science, Technology and Environment, H.P., Shimla, in collaboration with the Department of Education, H.P., S.C.E.R.T. and National Council of Science & Technology Communication (NCSTC, Network, Department of Science & Technology, Govt. of India, November 21-24, 2001 (J.C. Kuniyal, and S.C.R Vishvakarma).

Workshop on "Himalayan ecology: Main issues and Concerns", organized by TERI (The Energy and Resource Institute) at Delhi on November 29, 2001 (R.C. Sundriyal).

Participated in a 6th National Seminar in Orchid Diversity in India: Science & Commerce and Orchid show at IHBT, Palampur October 11 – 13, 2001 (A. Kumar)

Training Programme on "Environmental Economics for Practicing Scientists and Ecologists" GBPIHED-Head Quarters, October 16-20, 2001 (U. Dhar, P.P.Dhyani, D.K. Agrawal, S.S. Samant, P.K. Samal, N.A. Farooquee, G.C.S. Negi and Uma Shankar)

Participated in an UNDP-GEF workshop regarding formulation of a project proposal on Carbon Sequestration and Biodiversity Conservation on Uttaranchal Hill by holistic initiatives in village agroecosystems in the department of Forestry, HNB Garhwal University, Srinagar, October 17-18, 2001 (R.K. Maikhuri and S.C. Joshi).

Participated in a UNDP-GEF sponsored workshop on "Carbon Sequestration and Biodiversity Conservation using integrated approaches to develop an optimal village agro-ecosystem in Uttaranchal " held at GBPIHED, Kosi-Katarmal, 7 & 8 November 2001 (S.K. Nandi, D.K. Agrawal, S.C.Joshi, G.C.S. Negi, N.A. Farooquee, Subrat Sharma).

Training Course on DNA based marker technologies and its application in Plant Biology held at Tata Energy ResearchInstitute, New Delhi, November 20-30, 2001 (S.K. Nandi).

Participated in a UNDP workshop on India's initial National Communication to United Nations Framework Convention on Climate Change *UNFCCC) at India Habitat Centre, New Delhi, November 22-23, 2001 (S.C. Joshi).

Participated in a Project Monitoring workshop organized by the Dept of Biotechnology (DBT) at New Delhi on 6 December 2001 (R.K. Maikhuri).

Participated in a DST coordinated programme on Bio-Geo Data Base for the Generation of Sustainable Development Plan for Uttaranchal at Dehra Dun on 8-9 January 2002 (R.K. Maikhuri & G.C.S. Negi).

Participated in Regional Workshop on Water-Induced Disasters in the Hindu Kush Himalayan Region organized by ICIMOD and UNDP at Kathmandu, Nepal on 10-14 December 2001 (V. Joshi).

Attended "Workshop on Montreal Protocol" (December 14, 2001) organized by Department of Forest, Environment and Wildlife, Govt. of Sikkim in coordination with Ozone Cell/ PMU, MOE&F, GoI and UNEP, Gangtok (A.P. Krishna).

"Resource conservation as a tool for economic development in Uttaranchal – problems and prospects" in the Workshop on Conservation Oriented Development Policies for the newly carved States of Chhatisgarh, Jharkhand and Uttaranchal, December 14-15, 2001, India International Centre, New Delhi (Sponsored by Society for Promotion of Wasteland Development,

New Delhi and World Bank). (P.K. Samal)

Attended in the international conference on Biology and Biotechnology of Thermophilic microbes at University of Delhi, South Campus, New Delhi, December 3-7, 2001 (Bhavesh Kumar).

Organised a Consultation workshop on "International Year of Mountains 2002" in the collaboration of The Mountain Institute, on 15th December 2001 at Itanagar (R.C. Sundriyal).

International Congress of Chemistry and Environment, ICCE-2001, Indore, 16-18th Dec. 2001 (Prashant Mukherjee)

Attended Training Programme on "Climate change: vulnerability assessment and adaptation strategies" (December 17-19, 2001), Jadavpur University, Kolkata (S.C. Rai & S.C.Rai).

A one day training come exposure trip was organised for the participants of "Integrated watershed development and management" on 22nd December 2001 at Midphu demonstration site. A total of 20 participants attended the meeting (R.C. Sundriyal).

International Conference on Advances in Civil Engineering, IIT Kharagpur, 3-5th, Jan. 2002 (Prashant Mukherjee)

Attended "Stakeholders workshop for capacity building for the sustainable development of Darjeeling Himalayan Railway" (January 14-18, 2002), Darjeeling organized by Ministry of Railways, Govt. of India (A.P. Krishna and K.K. Singh).

ICIMOD: PARDYP country coordinator workshop/Meet, Kathmandu, Nepal, January 14-18, 2002. (B. P. Kothyari).

Attended "South Asia regional conference on ecotourism 2002" (January 21-25, 2002), Gangtok organized by Ecotourism and conservation society of Sikkim (Mohinder Pal and A.P. Krishna).

Attended The Indian Social Science Congress and Seminar on The Emerging Challenges of Globalization and Food Security in the Twenty First Century, University of Kerala, Tiruvananthapuram from January 28, 2002 to February 1, 2002 (N.A. Farooquee)

Training on "Non Conventional Energy Resources with Emphasis on Small Hydro Power Projects" by National Water Academy Pune, Jan 29-Feb 4, 2002 (Prashant Mukherjee)

Participated in the Training Workshop VIII on "People's Participation in Himalayan Biodiversity Conservation", GIC Syalde, organized by GBPIHED, Kosi-Katarmal from February 2-3, 2002 (U. Dhar, K.S. Rao, S.S. Samant, R.S. Rawal, S. Airi, I.D. Bhatt, Bhawna Pandey, S. Majhkhola, AK. Bisht, Meena Joshi, C.P. Kala, Gitika Joshi, Mitali Joshi, A. K. Bhatt, S. Gairola and S. Pant)

Participated in one day Training Programme on Medicinal Plant Cultivation and Conservation organized by GBPIHED at Almora on 26 February 2002 (R.K. Maikhuri).

"National Science Day Celebration 2002", organized by Arunachal Pradesh State Council for Science & Technology, Itanagar, February, 28th 2002 (T.C. Upreti).

Regional session of LEAD on "GIS application in Environmental Management" at Okinawa, Japan, Feb 28- March 7, 2001 (Kireet Kumar)

National workshop on NATP-CGP Projects, organised by ICAR-NATP Project Implementation Unit during March 1-2, 2002 at CCS Haryana Agriculture University, Hissar (R.C. Sundriyal).

Participated in zonal review workshop at NBPGR Regional Station Bhowali on 5-8th March 2002. K.S. Rao)

Attended "Workshop on remote sensing and GIS for sustainable development and management in the Himalayas and adjoining areas" (March 8-9, 2002) organized by the Indian Society of Remote Sensing (ISRS) Kolkata Chapter at North Bengal University; made presentation "Assessment of statistical landslide hazard along selected state highways in West Sikkim: a remote Sensing and GIS based approach (Sanjib Kundu).

Training Programme on Management of Research, sponsored by Ministry of Environment & Forests, New Delhi and organized by Administrative Staff College of India, Hyderabad from 11 to 15 March, 2002 (S.S. Samant)

Participated in a Workshop on Conservation, Multiplication and Cultivation of Medicinal Plants in Uttaranchal organized by Jari-Buti Sodh Evam Vikas Sansthan, Gopeshwar at Dehradun on 18 March 2002 (R.K. Maikhuri).

International Workshop on "*Endangered Medicinal Plant Species in Himachal Pradesh*" organised by GBPIHED at Himachal Unit, Mohal-Kullu, H.P.; sponsored by World Resource Foundation, GBPIHED Kosi-Almora, Rothamsted International (IACR) UK and CASA, New Delhi. 18-19 March 2002 (U.Dhar, N.A. Farooquee, J.C. Kuniyal and S.C.R. Vishvakarma)

Participated in National review workshop of NATP programme at NBPGR, New Delhi on 20th March 2002. K.S. Rao)

Imparted training on Farmers on Wasteland Development at Nana-Kosi Watershed, 23 March 2002 (G.C.S. Negi).

4.5.2. Meetings

Participated in the "IInd Uttaranchal Medicinal Plants Grower's Workshop" held at Timta, Gangolihat from 7-8 April, 2001, organized by Shri Hari Prasad (Farmer), Gangolihat (S.S. Samant)

Meeting of High Level Committee To Assess the Magnitude of Past Floods and Landslides in Alaknanda Basin organized by Ministry of Agriculture (Govt. of India), at IIPA, New Delhi on 20 April 2001 (V. Joshi).

IUCN-RSUP Himal Planning Workshop for Biodiversity Conservation in Indian Himalaya India International Centre, New Delhi, 25-26 April, 2001 (R.S. Rawal)

Meeting on "Marginal Farms, organised by the Mountain Farming Division, ICIMOD, during May 25-27, 2001 at Kathmandu, Nepal (Manju Sundriyal).

Participated a Meeting of Director GBPIHED with Scientist of Space Applications Centre, Ahmedabad on Alaknanda Valley Project and Future Collaboration on 30 May 2001 (V. Joshi).

Training cum Workshop for GEF stabilization project FRI, Dehradun, May 31-June 2, 2001 (U. Dhar)

Participated in the "IIIrd Uttaranchal Medicinal Plants Growers Workshop" from June 22-23, 2001 held at Bharari, Bageshwar, organized by Shri Kishan Singh Danu (Farmer), Bharai (S.S. Samant)

Participated in Review meeting of DST at FRDC, Dehra dun on 30th July 2001. (K.S. Rao)

Meeting with the officials of HITESHI (NGO) and farmers on farm based techniques and community based natural resource management and conservation, August 1, 2001. (S. S. Bisht, A. K. Mishra).

Participated in Global Environment Facility Meeting on Carbon Sequestration and Biodiversity Conservation in Uttaranchal Hills organized by Forest Research Institute, Dehradun on 6 August 2001 (V. Joshi).

Interaction Meeting on the Department of Biotechnology funded Programmes at Uttaranchal held at Hotel Aketa, Dehradun, August 10, 2001 (L.M.S. Palni, S.K. Nandi, D.S. Rawat).

Participated in PAMC Meeting of Mission Mode Project on Environment Impact of Recession of Himalayan Glaciers – A Case Study of Dokriani Bamak organized by Wadia Institute of Himalayan Geology, Dehradun on 20-21 August 2001 (V. Joshi).

Presentations were made at PMC Glaciology meeting on Aug 20-21, 2001 at WIHG, Dehradun (Kireet Kumar)

Meeting on Conservation of Plant Genetic Resource organized by NBPGR, New Delhi at Garhwal Unit of GBPIHED, Srinagar Garhwal on 25 August 2001 (R.K. Maikhuri, G.C.S. Negi & V. Joshi).

Meeting on IWDP Scheme, District Panchayat, East Sikkim with Forest Department's Social Forestry wing (September 6, 2001), Gangtok (A.P. Krishna).

Zonal group meeting of NATP cooperators of central Himalayan region (Zone V), Kosi - Katarmal (Almora), Uttaranchal, September 14, 2001. (P.P. Dhyani).

Farmers group meeting at Moledhar, Bageshwar, Uttaranchal, September 19, 2001. (B. P. Kothyari, S. S. Bisht, B. S. Bisht and A. K. Mishra).

Attended PEC meeting of DST of landslides on Sep 21, 2001 (Kireet Kumar)

Meeting Related to Germplasm Collection of High Altitude Medicinal Plants in the Alpine Field Station of HAPPRC at Tungnath, September 23, 2001 (R.K. Maikhuri & S.C. Joshi).

Interaction Meeting on the Department of Biotechnology supported project on Bioprospecting of Biological Wealth using Biotechnological tools (for Phase II) held at National Chemical Laboratory, Pune, October 3-4, 2001 (S.K. Nandi).

Executive Committee Meeting of the State Council of Science and Technology for Sikkim (October 12, 2001), Department of Science and Technology, Government of Sikkim (A.P. Krishna).

Participated in Global Environment Facility Meeting on Carbon Sequestration and Biodiversity Conservation in Uttaranchal Hills organized by HNB Garhwal University, Srinagar on 17-18 October 2001 (V. Joshi).

Parliamentary Standing Committee on Science and Technology; Environment and Forests on visit to Sikkim Unit, Pangthang complex (October 20, 2001) and meeting (Director and all the Sikkim Unit staff).

Participated in Society Meeting of our Institute in Ministry of Environment and Forests, New Delhi on 6 December 2001 (V. Joshi).

Second Meeting of the State Council of Science and Technology for Sikkim (November 27, 2001), Department of Science and Technology, Government of Sikkim (A.P. Krishna).

Second State Level Meeting of the National Biodiversity Strategy and Action Plan (NBSAP) Process in Sikkim (December 7, 2001), Department of Forest, Environment and Wildlife, Govt. of Sikkim, Gangtok (A.P. Krishna).

Meeting of Almora District Watershed Advisory Board on Jan 25, 2002 (Kireet Kumar)

Programme Steering Committee Meeting on Bioprospecting and Molecular Taxonomy for presentation of project at the Department of Biotechnology, New Delhi, February 4-5, 2002 (S.K. Nandi).

State level advisory committee meeting, WWF-India, Sikkim Center (February 25, 2002), Gangtok (A.P. Krishna).

4.5.3. Delivered Lectures as Resource Person

Delivered lecture on "Diversity, distribution and conservation of orchids of Kumaun Himalaya" in the "Second Meeting of the Indian Sub-continent Regional Orchid Specialist Group (ISROSG) organized by Wildlife Institute of India, Dehradun from 17-19 April, 2001 (S.S. Samant)

Participated in Task force meeting on Bio-Geo data base on Himalaya and Ecological modelling at DST, New Delhi on 18th April, 2001. (K.S. Rao)

Delivered lecture on "Medicinal Plants on Indian Himalayan Region. Gaps and priorities" IUCN-Himal Planning Workshop, IIC, New Delhi, April 25, 2001 (R.S. Rawal)

Contact Programme - 2001, for Talented Students of District Almora, Uttaranchal 21-27 October 2001, (D. S. Rawat)

As resource person in the Students Seminar on Harit Sankalp II, organised by WWF-ICEF through H.P. coordinator, Shimla, 20 November 2001. (H.K. Badola, J.C. Kuniyal, S.C.R. Vishvakarma)

Attended "Gangtok 2001 workshop" (December 5, 2001) and delivered the invited theme lecture on "Environment", organised by Forum of Architects, Sikkim (A.P. Krishna).

Workshop to discuss the role of TERI on Improvement of Agricultural, Horticultural and over all Rural Development (December 11, 2001) organised by Department of Horticulture, Govt. of Sikkim and delivered lecture (K.K. Singh).

Presented invited lectures on Prospects of Tea Cultivation in Uttaranchal during Workshop on Research Prioritization for Diversification of Agriculture and Rural Industries held at G.B. Pant University of Agriculture & Technology, Pantnagar, April 26, 2001 (L.M.S. Palni & S.K. Nandi).

Participated the Thirteenth Zonal Research cum Extension Advisory Committee (ZREAC) Meeting Mid Hills Subhumid Zone-II of Himachal Pradesh, CSKKV, Regional Research Station Bajaura, District Kullu (H.P.), June 1-2, 2001 (J.C. Kuniyal and S.C.R Vishvakarma).

Delivered lectures on Environmental Impact Analysis to forest officials (CCFs, CFs, DFOs, etc.) on August 07, 2001 at Forest and Forest Panchayat Training Institute, Haldwani. (D.K. Agrawal and P.K. Samal)

Delivered a lecture on 'Jaiv-vividhita ka Jaliya evam Mrida Paryavaran se Antarsambandh' at VII Workshop on Himalaya ki Jaiv-vividhita organized by GBPIHED at Dhwarahat, March 3-4, 2001. (D.K. Agrawal)

Delivered Lecture to Officers of Frontier Academy, Gwaldam on June 28, 2001 at GBPHIED, Kosi- Katarmal, Almora, on "Medicinal and Wild Edible Plants of the Himalaya" (S.S.Samant)

Delivered lecture on "Parvatiya Kshetron Ke Chara Vriksh Evan Prabandhan" in the State Level Training Course on "Fodder Production in Hills" from 01-05 August 2001, organized by VPKAS, Almora (S.S.Samant)

Delivered a lecture on 'Public Awakening in Solid Waste Management in Kullu-Manali complex' on the occasion of 'Public Awakening on Urban Planning' organised by Urban and Rural Planning, Kullu under NORAD funded scheme, Harbans Palace, Bhuntar, 10 August, 2001 (J.C. Kuniyal).

Delivered Lectures to Forest Officers on "Herbarium methods, identification of plants and methods of assessment of plant diversity" from August 15-17, 2001 at FTI, Haldwani (S.S.Samant)

Delivered Lecture on "Medicinal and Aromatic Plants of Uttaranchal" in the "Uttaranchal Medicinal and Aromatic Plants Development Boards: Meeting of Institutions and Departments on August 20, 2001 at Academy of Administration, Nainital, organized by Government of Uttaranchal, Dehradun (S.S. Samant)

Participated a meeting on 'Kiwi Phal Diwas' organised by Dr. Y.P.S. Parmar University of Horticulture and Forestry, Regional Research Centre, Bajaura-Kullu, 9 October, 2001 (J.C. Kuniyal, and S.C.R Vishvakarma).

Delivered a lecture on 'Solid Waste Management' on the occasion of 'Environment Education & Awareness in the State of Himachal Pradesh through National Green Corps (Eco-Club)' organised by 'Society for Advancement of Village Economy and State Science and Technology', Shimla, Kullu, 20 October, 2001 (J.C. Kuniyal).

Delivered lecture to schoolteachers on Conservation of Biodiversity in training workshop, Environment Education and Awareness in the State of *Himachal Pradesh*, Kullu, 20 October 2001 (H.K. Badola)

Delivered lecture at Forest Research Institute, Dehradun, October 20, 2001 (U. Dhar)

Delivered Lecture on "Plant Diversity of Uttaranchal State" to "Talented Students (High School and Intermediate level) on October 22, 2001 at University Campus, Almora, organized by PAHAL and sponsored by D.S.T., New Delhi (S.S. Samant)

Delivered lecture in the National Forestry Liaison Meeting. FRI, Dehradun. November 20, 2001 (U. Dhar)

Delivered Lecture on "High Altitude Medicinal Plants of India" in the "International Training Programme on Sustainable NTFP Management for Rural Development" (December 6-8' 2001) to the Trainees at GBPIHED, Kosi-Katarmal, Almora (S.S.Samant).

Delivered final representative speech on behalf of course participants for Regional Ecosystem Monitoring Technology Training at Hyogo International Center, Japan, December 13, 2001 (R.S. Rawal)

Delivered a lecture on 'Motivation and Education: Solid Waste Management in Kullu Town' organised by Municipal Council under NORAD Project at Municipal Council, Kullu, 20 December, 2001 (J.C. Kuniyal).

Delivered a lecture on 'Motivation and Education: Solid Waste Management to the NSS Students of Govt. Degree College, Kullu organised by Municipal Committee under NORAD Project at Municipal Committee, Kullu, 8 January, 2002 (J.C. Kuniyal).

Delivered a lecture on Integrated Natural Resource Management to Farmers/NGOs participating in nursery and plantation technology training organized by High Altitude Plant Physiology Research Centre, Srinagar Garhwal, 14 March 2002 (R.K. Maikhuri).

Simple technologies and rural development- Organised by HEMA at Kwarali, Almora, 17 March,2002, (D.S. Rawat).

Delivered a lecture on Rehabilitation of Degraded Land and Protected Area Management with Focus to Medicinal Plant Cultivation to Farmers/NGOs participating in nursery and plantation technology training organized by High Altitude Plant Physiology Research Centre, Srinagar Garhwal, 23 March 2002 (R.K. Maikhuri).

M/S A.K. KASHYAP & CO.
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672966, 672836
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Email: akkashyap@hotmail.com

THE DIRECTOR,
G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT,
KATARMAL-KOSI,
ALMORA - 263 643 UTTARANCHAL

Dear Sir,

We have audited the Balance Sheet of **G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT, ALMORA,** as on 31-03-2002, 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 required by the law have been kept by the Head Office and the Units of the above name 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 true and fair view :-

i) In the case of Balance Sheet of the State of Affairs of the above named Institute as on 31-03-2002 and

ii) In the case of Income & Expenditure Accounts of the INCOME of its accounting year ending 31-03-2002.

For A.K. KASHYAP & CO.,
Chartered Accountants,

Sd/-
(ASHOK KASHYAP)
F.C.A. Partner

Dated :2nd July, 2002
Place : Dehra Dun

M/S A.K KASHYA & CO.
CHARTERED ACCOUNTANTS
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G.B.PANT INSTITUTE OF HIMALIYAN ENVIRONMENT & DEVELOPMENT

KATARMAL, KOSI (ALMORA) UTTARANCHAL

BALANCE SHEET AS ON 31ST MARCH 2002

PARTICULARS	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
CORPUS / CAPITAL FUND	1	7940827.55	2554276.74
RESERVE AND SURPLUS	2	333257833.84	298298833.84
EARMARKED / ENDOWMENT FUNDS	3	20678471.30	17351214.55
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	21051934.61	16498164.05
TOTAL		**382929067.30**	**334702489.18**
ASSETS			
FIXED ASSETS	8	333257833.84	298298833.84
INVEST. FROM EARMARKED/ENDOWMENT FUND	9	4570315.00	4570315.00
INVEST. OTHERS	10	0.00	0.00
CURRENT ASSETS , LOANS, ADVANCES ETC.	11	45100918.46	31833340.34
MISCELLANEOUS EXPENDITURE			
TOTAL		**382929067.30**	**334702489.18**
		0.00	0.00
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES & NOTES ON ACCOUNTS	25		

AUDITOR'S REPORT
As per our separate report of even date annexed.
FOR A.K.KASHYAP & CO.,
CHARTERED ACCOUNTANT

Sd/-
(ASHOK KASHYAP)
F.C.A PARTNER
DATED : 2nd July, 2002
PLACE : DEHRA DUN

Sd/-
(DR. MOHINDER PAL)
(DIRECTOR)

Sd/-
DR. U DHAR
(D.D.O)

Sd/-
SURYA KANT
(FINANCE OFFICER I / C)

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G.B.PANT INSTITUTE OF HIMALIYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA) UTTARANCHAL
INCOME & EXPENDITURE A/C FOR THE YEAR ENDED 31ST MARCH 2002.

PARTICULARS	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
INCOME			
Income from Sales/Services	12	44066.00	9800.00
Grants/Subsidies	13	72308048.50	46423792.30
Fees/Subscriptions	14	162505.00	195505.00
Income from Investments (Income on Invest. from earmarked/endow Fund transferred to Funds)	15	0.00	0.00
Income from Royalty, Publication etc.	16	1100.00	255.00
Interest Earned	17	123964.41	300005.08
Other Income	18	2054648.00	656802.57
Increase (decrease) in stock of Finished goods and work in progress)	19	0.00	0.00
TOTAL (A)		74694331.91	47586159.95
EXPENDITURE			
Establishment Expenses: a) Institute	20	12010568.00	12116885.00
b) Projects (As per Annexure)		4623022.00	3882030.00
c) F.C (Projects)		1714313.00	1849729.00
Administrative Expenses : a) Institute	21	32404552.50	19276351.30
b) Projects (As per Annexure)		13292537.00	5574314.00
c) F.C (Projects)		2014352.00	1481739.00
Expenditure on Grants, Subsidies etc.	22	6248437.00	2242744.00
Interest	23	0.00	0.00
Depreciation (Net Total at the year-end-as per Schedule 8)		0.00	0.00
TOTAL (B)		72307781.50	46423792.30
Balance being excess of Income over Expenditure (A - B)		2386550.41	1162367.65
Transfer to special Reserve			
Transfer to/ from General Reserve			
BAL.BEING SURPLUS TRF.TO CORPUS/CAPITAL FUND		2386550.41	1162367.65
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

AUDITOR'S REPORT
As per our separate report of ven date annexed.
FOR A.K.KASHYAP & CO.,
CHARTERED ACCOUNTANT

Sd/-
(ASHOK KASHYAP)
F C A PARTNER
DATED : 2nd July, 2002
PLACE : DEHRA DUN

Sd/-
(DR. MOHINDER PAL)
(DIRECTOR)

Sd/-
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Sd/-
SURYA KANT
(FINANCE OFFICER I / C)

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G.B.PANT INSTITUTE OF HIMALIYAN ENVIRONMENT & DEVELOPMENT

KATARMAL, KOSI (ALMORA) UTTARANCHAL

RECEIPTS & PAYMENTS A/C FOR THE YEAR ENDED 31ST MARCH 2002.

RECEIPTS	CURRENT YEAR	PREVIOUS YEAR	PAYMENTS	CURRENT YEAR	PREVIOUS YEAR
I. Opening Balances			**I. EXPENSES**		
a) Cash in hand	5763.05	9480.55	a) Establishment Expenses (Corresponding to Schedule 20)	12010568.00	11548133.00
b) Bank Balances			b) Administrative Expenses (Exclusive Of Capital Exp (Corresponding to Schedule 21)	19075721.50	12377249.30
i) In current accounts	7989773.74	1236939.00			
ii) In deposit accounts			**II. Payments made against funds for various proje**	24163996.00	11479326.00
iii) Savings accounts	2568076.03	719481.15	**III. Investments and deposits made**		
c) Advances & Others	25258876.80	21002128.97	a) Out of Earmarked/ Endowment funds	0.00	0.00
(As per annexure Attached)			b) Out of Own Funds (Investments Others)	0.00	0.00
II. Grants Received			c) General Fund	5500000.00	0.00
a) From Government of India			**IV. Expenditure on Fixed Assets & Capital W.I.P.**		
i) Institute	53600000.00	27500000.00	a) Purchase of Fixed Assets	13328831.00	7584198.00
ii) Projects	22151274.00	24378776.60	b) Expenditure on Capital Work-in-progress	0.00	0.00
b) From State Government	0.00	0.00	**V. Refund of Surplus money / Loans**		
c) From other sources	0.00	0.00	a) To the Government of India	17087.00	43.00
III. Income on Investments from			b) To the State Government	0.00	0.00
a) Earmarked/ Endow.Funds	582514.18	465885.00	c) To other provident of funds	0.00	0.00
b) Loans, Advances etc.	0.00	292865.08	**VI. Finance Charges (Interest)**		
IV. Interest Received			**VII. Other Payments (PF TRf./Withdrawals etc.)**	628848.00	835090.00
a) On Bank deposits	83947.55	0.00	**VIII. Closing Balance**		
b) Loans, Advances etc.	714.00	0.00	a) Cash in hand	9342.05	5763.05
V. Other Income	2069324.00	869502.57	b) Bank Balance		
(As per annexure Attached)			i) In current accounts	1776108.50	7989773.74
VI. Amount Borrowed	0.00		ii) in deposit accounts	0.00	0.00
VII. Any other receipts.	3454053.57	3171470.00	iii) Savings accounts	12986112.34	2568076.03
(As per annexure Attached)			c) Advances & Others (As per annexure attached)	28267702.53	25258876.80
TOTAL	**117764316.92**	**79646528.92**	**TOTAL**	**117764316.92**	**79646528.92**
				0.00	0.00

AUDITOR'S REPORT

As per our separate report of even date annexed.
FOR A.K.KASHYAP & CO.,
CHARTERED ACCOUNTANT

(ASHOK KASHYAP)
F C A PARTNER

DATED : 2nd July, 2002
PLACE : DEHRA DUN

Sd/-
DR. MOHINDER PAL
(DIRECTOR)

Sd/-
DR. U DHAR
(D.D.O)

Sd/-
SURYA KANT
(FINANCE OFFICER I / C)

M/S A.K KASHYAP & CO.
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRADUN-248001
PHONE : (OFF)652346,655634
(RES) 672966,672856
FAX : (0135) 655634
E - MAIL : akkashyap@hotmail.com

STATEMENT OF OPENING & CLOSING BALANCES

PARTICULARS	OPENING AMOUNT	CLOSING AMOUNT
Cash & Bank Balances		
Cash in hand:		
Srinagar	186.64	12.78
Sikkim	707.60	378.60
Kullu	3863.17	3→87.17
Itanagar	0.00	68827.61
Cash & Bank Balances		
SBI Almora A/c No. 01170003256	31208.15	32466.33
SBI Tadong A/c No. 01000050044	2203160.42	352335.42
SBI Kullu A/C No. 01100076038	479134.01	380425.01
SBI Itanagar A/c No. 0110005033'	787962.61	826844.34
SBI Srinagar A/c No.01100030432	130837.14	808953.49
SBI PF A/c No. 01100003255	62140.40	1100650.97
Advances		
House Building Advance	2326873.00	2555555.00
Moter Cycle/Car Advance	668672.00	468512.00
Festival Advance	19800.00	24000.00
PF Advance	328143.00	389903.00
G.L.S.I	(117.34)	(12958.06)
CPF	36.00	36.00
Revenue Stamp Recovery	0.00	(2.00)
Units of Institute		
Sikkim Unit	46082.00	36136.00
H.P. Unit	2320.00	(78335.00)
Garhwal Unit	0.00	4983.21
N.E Unit	0.00	6424.66
Fixed Deposits		
With SBI Endonment Fund	4570315.00	4570315.00
Interest accrued on FDR(Endow Fu	591314.00	1172570.00
SBI PF	7075024.00	8035518.00
CBI PF	2611416.00	2911416.00
Interest accrued on FDR(PF)	2081725.00	2465632.00
FDR (Margin money/L/C A/c)		
DST(HCR)	95000.00	95000.00
DST(KK)	176000.00	176000.00
ISRO (APK)	39000.00	39000.00
Biotech-IX	390000.00	163000.00
Institute	359979.00	1064995.00
Biotech XI	0.00	213000.00
Biotech-XII	0.00	79777.00
Due Staff/ Other IC A/c		
Allen Press Inc.	7711.00	7711.00
Hardley Brothers	1877.00	1877.00
A.S. Parihar	389.00	389.00
Post Master GPO Almora	12653.00	139.00
NRSA Hydrabad (SK)	90000.00	0.00
Employment News	15050.00	13287.00
Sigma Aldrich Chemicals	10590.00	10590.00
Siltep Chemicals Limited (Biotech-I	408.00	408.00
NRSA Hydrabad	8400.00	8400.00
R.K. Nanda & Sons	28517.00	28517.00
Elsevier Science (CSIR-AP)	0.00	5000.00
S.K. Gurani	0.00	(75.00)
NRSA Hydrabad (MOEF-KSR)	0.00	138000.00
Combatt Mathew (ICCR)	0.00	2000.00
IUCN Switzerland	0.00	86000.00
Journal of Horticulture	0.00	2500.00
Allen Press Inc (Kansas).	0.00	5600.00
FC Inter A/c	2500.00	2500.00
TOTAL	**25258876.80**	**28267702.53**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA) UTTARANCHAL
SCHEDULE OF FIXED ASSETS AS ON 31st MARCH 2002

PARTICULARS	COST AS ON 1/4/2001	ADDITION DURING THE YEAR	COST OF SALES/TFD. DURING THE YEAR	TOTAL
Land :	**75639.23**	**0**	**0.00**	**75639.23**
Building	**2749848.00**	**0.00**	**0.00**	**2749848.00**
Furniture & Fixture:	**11413513.40**	**921905.00**	**0.00**	**12335418.40**
(Details)				
Institute	11395906.40	921905.00	0.00	12317811.40
ICIMOD SALT	11000.00	0.00	0.00	11000.00
ICIMOD ISSMA	6607.00	0.00	0.00	6607.00
Scientific Equipments :	**59478045.11**	**13679362.00**	**0.00**	**73157407.11**
(Details)				
Institute	44283034.19	10207980.00	0.00	54491014.19
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)	46119.00	66040.00	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)	192930.00	140200.00	0.00	333130.00
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

CONT.....

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA) UTTARANCHAL
SCHEDULE OF FIXED ASSETS AS ON 31st MARCH 2002

BIOTECH (VI)	322986.00	2979.00	0.00	325965.00
BIOTECH (IX)	11320.00	706979.00	0.00	718299.00
BIOTECH (XI)	95659.00	207351.00	0.00	303010.00
BIOTECH (XII)	0.00	1084900.00	0.00	1084900.00
CSIR (AP)	0.00	105004.00	0.00	105004.00
DST (HCR)	0.00	11144.00	0.00	11144.00
DST (KK)	341166.00	167536.00	0.00	508702.00
CSIR(SCR)	507339.00		0.00	507339.00
MOE&F (RSR)	0.00	13541.00	0.00	13541.00
MED.ARO. PLANT	0.00	76320.00	0.00	76320.00
ISRO (APK)	94829.00	3371.00	0.00	98200.00
MOE&F (NDMD)	148900.00	0.00	0.00	148900.00
DST (GCSN)	48331.00	3200.00	0.00	51531.00
BIOTECH VIII	46904.00	0.00	0.00	46904.00
MOE&F (US)	11076.00	0.00	0.00	11076.00
DST(MANJU SUND.)	0.00	29877.00	0.00	29877.00
ICAR (RCS)	0.00	646298.00	0.00	646298.00
CSIR(RKM)	0.00	149400.00	0.00	149400.00
DST (SCR)	0.00	57242.00	0.00	57242.00
Office Equipments :	**4878252.35**	**425146.00**	**0.00**	**5303398.35**
Institute	4761908.35	425146.00		5187054.35
I.E.R.P	116344.00			116344.00
Fire Fighting Equipmen	**60962.00**	**0.00**	**0.00**	**60962.00**
Library :	**30495429.50**	**5307798.00**	**0.00**	**35803227.50**
Vehicles :	**4015099.25**	**724789.00**	**0.00**	**4739888.25**
(Details)				
Institute	2931435.30	0.00	0.00	2931435.30
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	0.00	724789.00	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..	**116735369.84**	**21059000.00**	**0.00**	**137794369.84**

SUPPORTING STAFF

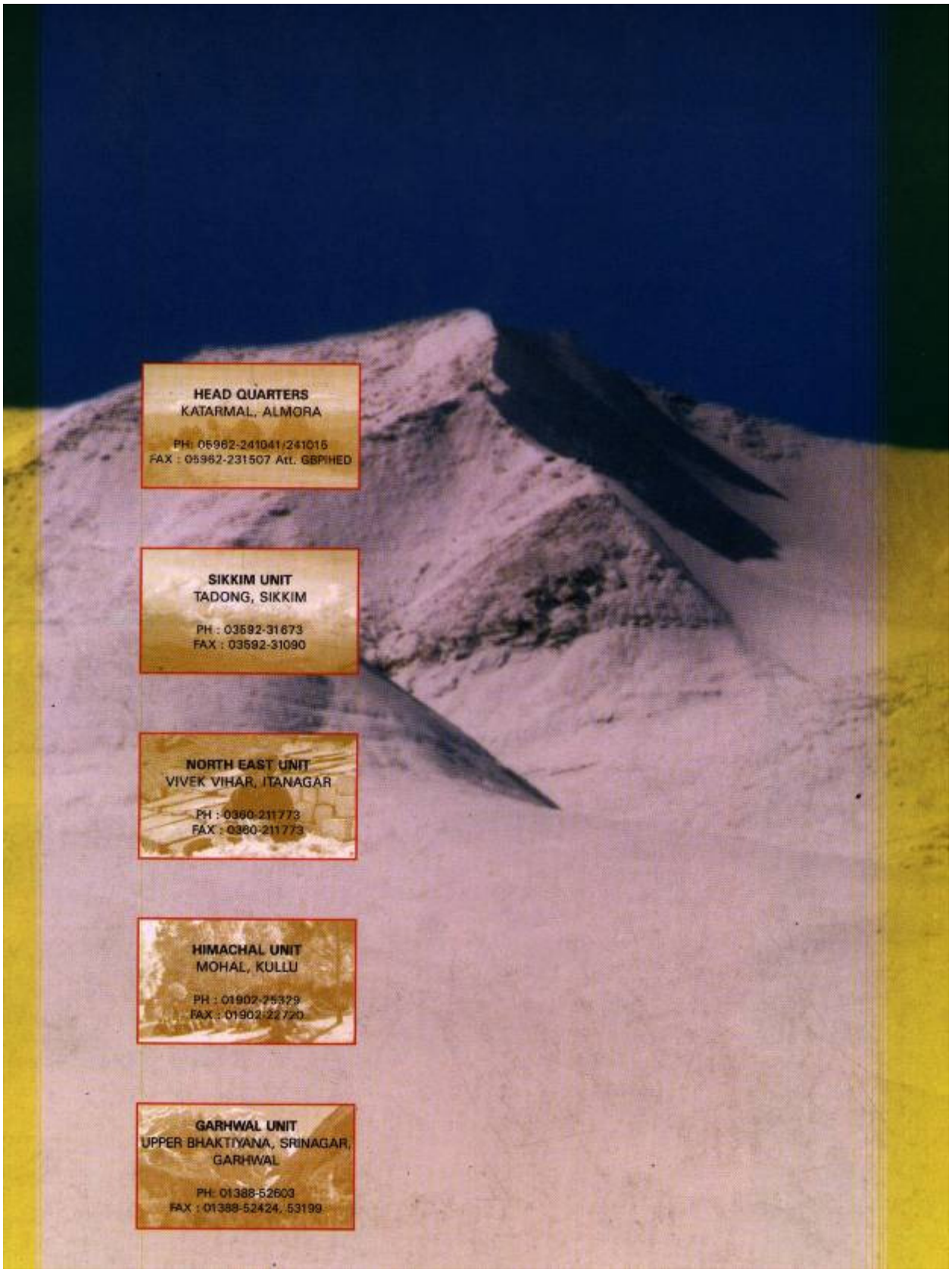
Mr K.K. Pande	A.C.O.	Mr R.C. Bhatt	Driver
Mr Suryakant Longyan	OS(A)	Mr Chandra Lal	Driver-Cum F.A.
Mr S.P. Maikhuri	O.S.	Mr M.P. Nautiyal	Driver
Mr Sanjeev Higins	Estate Manager	Mr J.M.S. Rawat	Driver
Mr L.M.S. Negi	U.D.C.	Mr Musafir Rai	Peon
Mrs Sarita Bagdwal	Steno Gd III	Mr Shyambir	Peon
Mr Jagdish Kumar	Steno	Mr Pan Singh	Peon
Mrs Mamta Higgins	U.D.C.	Mr K.N. Pathak	H.K./Att.
Mr Heera Singh	U.D.C.	Mr G.D. Kandpal	Peon/Mali
Mr K.K. Pant	U.D.C.	Mr Diwan Singh	Peon/Mali
Mrs Hema Pandey	L.D.C.	Mr Nathu Ram	Peon/Mali
Mr S.K. Gurani	L.D.C.	Mr R.P. Sati	Peon
Mr Suraj Lal	L.D.C.	Mr Daulat Ram	Peon
Mr Jagdish Singh Bisht	L.D.C.	Mr R.C. Nainwal	Field Asstt.
Mr D.P. Kumeri	L.D.C.	Mr Jagnnath Dhakal	Field Asstt.
Mr R.K. Das	L.D.C.	Mr P.K. Tamang	Peon
Mrs Sabita Krishna	L.D.C.	Smt Ganga Joshi	Peon

ABBREVIATIONS USED

BIOTECH	:	Department of Bio-Technology
CSIR	:	Council of Scientific & Industrial Research
DOS-(DBT)	:	Department of Space (Department of Bio-Technology)
DST	:	Department of Science & Technology
ENVIS	:	Environmental Information System
FAO	:	Food and Agricultural Organization
ICAR	:	Indian Council of Agricultural Research
ICIMOD	:	International Centre of Integrated Mountain Development
IEG	:	Institute of Economic Growth
IERP	:	Integrated Eco-Development Research Program
INSA	:	Indian National Science Academy
ISRO	:	Indian Space Research Organization
MoE&F	:	Ministry of Environment and Forests
MRE	:	Mountain Risk Engineering
NDBR	:	Nanda Devi Biosphere Reserve
NEC		North Eastern Council
NWDPRA	:	National Watershed Development Project for Rainfed Areas
PTCA	:	Plant Tissue Culture Association
SALT	:	Sloping Agriculture Land and Technology
TSBF	:	Tropical Soil Biology Fertility
UNDP	:	United Nations Development Programme
UNESCO	:	United Nations Educational Scientific and Cultural Organization
UNICEF	:	United Nations Children Fund
WWF	:	World Wide Fund for Nature

INSTITUTE FACULTY

Mohinder Pal	Director
L.M.S. Palni	Plant Physiology; Biochemistry; Biotechnology
U. Dhar	Plant Taxonomy; Conservation Biology
P.P. Dhyani	Plant Physiology; Restoration Ecology
K.S. Rao	Plant Ecology; Rural Ecosystems
K. Kumar	Environmental Engineering; Hydrology
D. Choudhury	Animal Biology; Entomology
S.K. Nandi	Plant Physiology; Biochemistry
D.K. Agrawal	Soil and Water Conservation Engineering; Impact Assessment
R.C. Sundriyal	Plant Ecology; Rural Ecosystems
S.C.R. Vishvakarma	Plant Ecology; Rural Ecosystems
R.K. Maikhuri	Plant Ecology; Rural Ecosystems
S.C. Rai	Rural Geography; Hydrology
A.P. Krishna	Geotechnical Engineering; Impact Assessment
Anita Pandey	Microbiology
H.K. Badola	Morphoanatomy; Conservation Biology
P.K. Samal	Social Science; Anthropology
S.S. Samant	Plant Taxonomy; Conservation Biology
S.C. Joshi	Plant Physiology; Stress Physiology
B.P. Kothyari	Plant Pathology; Restoration Ecology
D.S. Rawat	Settlement Geography; Rural Ecosystems
R.C. Prasad	Information Systems
R.S. Rawal	High Altitude Ecology; Conservation Biology
H.C. Rikhari	Plant Ecology; Energy System Dynamics
K.K. Singh	Plant Physiology; Stress Physiology
Uma Shankar	Plant Ecology; Seed Biology
N.A. Farooquee	Social Science; Indigenous Knowledge Systems
G.C.S. Negi	Forest Ecology; Watershed Management
J.C. Kuniyal	Development Geography; Waste Management
S. Sharma	Agro Ecology; Remote Sensing/GIS
R.G. Singh	Applied Arts; Photography
B.S. Majila	Forest Ecology; Restoration Ecology
V. Joshi	Environmental Geology
L.K. Rai	Plant Taxonomy
Y.K. Rai	Rural Ecosystems
R. Joshi	Natural Resource Management; Econometrics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GARHWAL
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