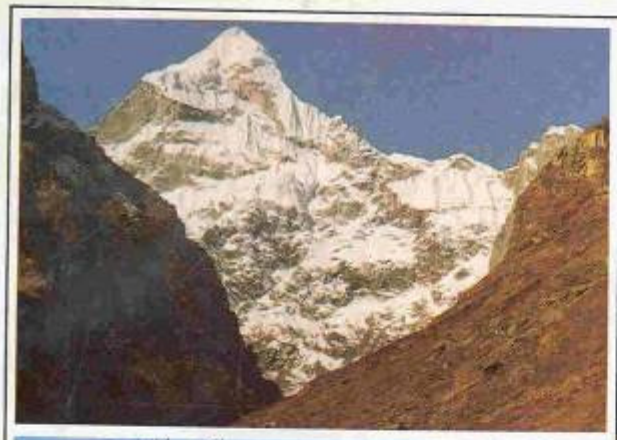

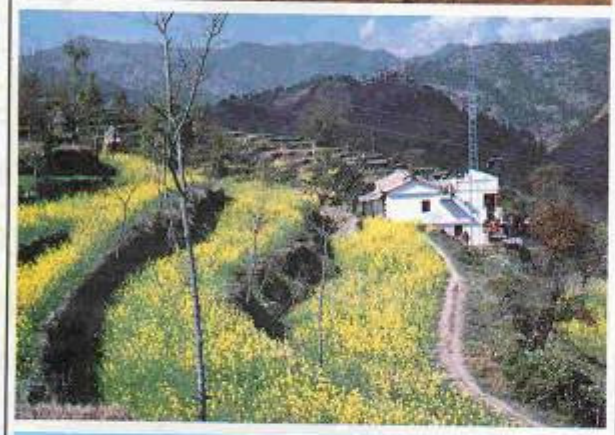

ANNUAL REPORT

1997-98

G.B. Pant Institute of Himalayan Environment and Development

(An Autonomous Institute of Ministry of Environment & Forests, Govt. of India)

Kosi, Almora-263643

INDIA

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ANNUAL REPORT

1997-98

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
(An Autonomous Institute of Ministry of Environment & Forests, Govt. of India)
Kosi-Katarmal, Almora – 263 643
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CONTENTS

THE YEAR 1997 – 98 : AN OVERVIEW

This was an important year for the Institute, especially in terms of its infrastructural expansion, creation of new facilities and initiation/strengthening of collaboration with national and international agencies. The inauguration of the Institute's Library and Information Centre has helped further the ongoing research activities, and effective networking and dissemination of R & D outputs. The VII G.B. Pant Memorial Lecture and a number of academic activities of the Institute were the notable events of the year 1997-98. During the year Institute also initiated the quantification of tectonic activity in Kumaon Himalaya using global positioning system (GPS) for generating base data for such measurements, in collaboration with the Indian Institute of Astrophysics and the Centre for Mathematical Modelling and Computer Simulation (CMMACS), Bangalore. A permanent GPS reference station has been set up at Katarmal campus, and the data is being processed along with data generated from other reference points.

The Institute's effort in the logical understanding of the ground realities has led to the initiation of a new research effort on Mountain Risk Engineering based on the immediate requirement of the Himalayan environment. The Institute has further strengthened its ties with a number of National and International partners committed to the cause of research and development in the Himalayan region. A detailed 9th plan document has been prepared in consultation and with the guidance of the Science Advisory Committee and the same was approved by the Board of Governors of the Institute. In addition to the six ongoing core programmes it is envisaged to start a new programme on Indigenous Knowledge Systems during the plan period. The Institute has also added four new publications to its credit, which were released during the Annual Day function at Katarmal in December 1997. The milestone events, mentioned in subsequent pages in this report, clearly specify the important achievements made in 1997-98. Comments and suggestions of all those interested in the welfare of Himalaya and its inhabitants would be welcome.

L.M.S. PALNI

Director

MAJOR ACHIEVEMENTS

A Global Positioning System (GPS) has been established in the Katarmal Campus, the geodetic mode receivers enable resolution of ground displacement with great accuracy and would help in quantifying the rate of ground movement across tectonic boundaries in Kumaun Himalaya.

Demonstrations of Mountain Risk Engineering to address small hill slope instabilities using local resources and simple physical and bioengineering measures have been set up in two villages.

Action oriented developmental activities have been initiated in selected buffer zone villages of Nanda Devi Biosphere Reserve to integrate conservation with economic return, e.g., cultivation of medicinal plants by the villagers.

Successful development of a high altitude plant nursery at Hanumanchatti (2500 m amsl) and expansion of arboreta at Suryakunj (Katarmal) and Panthang (Gangtok).

Identification and prioritization of conservation sites in timberline zone of West Himalaya, and further development of participatory approaches to biodiversity conservation, including preparation of an Action Plan on Himalayan Biodiversity.

Inauguration of Library and Information Centre at Katarmal and the establishment of e-mail (gbpihed@nda.vsnl.net.in) and internet connectivity.

Documentation of indigenous cattle breeding practices and livestock management strategies used by transhumant societies in selected Himalayan states.

"Developing a paradise in peril" – 7th Pt. G.B. Pant Memorial Lecture by Prof. K.S. Valdiya, FNA.

Shifting and functioning of NE Unit of the Institute at Itanagar in Arunachal Pradesh.

Successful demonstration of a model to increase discharge of a natural spring in a remote village in Garhwal Himalaya using simple biological and physical measures.

Training and demonstration of useful technologies for hill farmers, e.g., polypit, polyhouses, biocomposting, water harvesting and nursery development and maintenance.

Linking of ecotourism activity with biodiversity conservation and influencing policy interventions in a model study in Sikkim.

Development of a waste management model for the mountain ecosystem based on carrying capacity assessment of Kullu-Manali Complex.

1. INTRODUCTION

The reporting year 1997-98 is the ninth financial year of research and development activities being carried out by the Institute at various locations in Himalaya and addressing region specific issues, with emphasis on development of tangible solutions. 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, both national and international. The Institute is also supporting activities of various partner Institutions in various Himalayan states through IERP Programme. The Science Advisory Committee of the Institute provides approval general guidance and help for all programmes *ab initio*.

At present, the activities of the Institute are centered around six designated core programmes. Some 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 1997-98 on various ongoing and newly initiated projects and brief account of academic and other activities, along with the statement of accounts, has been presented in this report. We would be most grateful for critical comments, suggestions for improvement and for indication of our shortcomings by anyone interested in the well-being of Himalaya and its people.

2. MILESTONE EVENTS

The Institute celebrated its Annual Day Function in the Katarmal Campus, Almora on December 18, 1997; on this occasion the Institute's Library and Information Centre was inaugurated by Shri Vishwanath Anand, Chairman Governing Body of the Institute and Secretary Ministry of Environment and Forests, Govt. of India. The function was attended by many dignitaries which include Prof. K.S. Valdiya, FNA; Dr. R.S. Tolia, Director U.P. Academy of Administration; Prof. J.S. Singh, FNA; distinguished members of Governing Body and Science Advisory Committee of the Institute. The highlight of the function was VII G.B. Pant Memorial Lecture entitled "Developing a paradise in peril" delivered by Prof. K.S. Valdiya. He dwelt on different aspects of Himalayan development considering the health of environment and its people. He mentioned that having no voice in the affairs of planning for development, the mountain people not only feel marginalized by are also quite disillusioned. Later, four publications of the Institute namely Himalayan Biodiversity – Action Plan; Development dilemma, Indian scenario and Rural Himalaya : A Central Himalayan perspective; Perspectives of Mountain Risk Engineering in the Himalayan Region; Research and Development Initiatives of the Institute – A Pictorial Glimpse, were released. The Governing Body of the Institute met on December 17, 1997 and reviewed the developments in the Institute and took several decisions for furthering the cause of Himalayan environment and development.

The North-East Unit of the Institute was shifted from Dimapur in Nagaland to Itanagar in Arunachal Pradesh in the first week of June, 1997. A number of workshops including Review Workshop-Cum-Training Programme on Biosphere Reserves; Participatory Approach in Biodiversity Conservation-IV Workshop; Consultation Meeting on Prioritization of Himalayan Biodiversity; Workshop on Mountain Risk Engineering (MRE) were organised at various locations by the Institute.

3. RESEARCH AND DEVELOPMENT PROGRAMMES

In order to achieve the sustainable development of the Indian Himalaya, research and development programmes of the Institute have been based on a multi-disciplinary and holistic approach with particular emphasis on interlinking of natural and social sciences. In this effort special attention is placed on the preservation of fragile mountain ecosystems, indigenous knowledge and customs. A conscious effort is made to ensure participation of the local population for long term acceptance and success of various programmes. The R & D activities of the Institute are centered around six core programmes, viz., Land and Water Resource Management, Sustainable Development of Rural Ecosystems, Conservation of Biological Diversity, Ecological Economics and Environmental Impact Analysis, Environmental Physiology and Biotechnology and Institutional Networking and Human Investment. The achievement of goals and progress made in various projects during the year has been placed under appropriate core programmes in the text. The project implementation sites are carefully 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 prescriptions. To meet the targets, and 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 1997-98, alongwith a brief, conceptual background, specific objectives and major achievements are summarized for individual projects. Brief summaries of projects completed during the year are placed in the text and detailed findings will be made available subsequently.

3.1 LAND AND WATER RESOURCE MANAGEMENT

3.1.1 Integrated Watershed Management: A Case Study in Sikkim Himalaya (Phase II, 1994-1998)

Background

The second phase of the project has been initiated in 1994 as a follow-up action with a view to develop a model at the farm level for demonstration. Based on the results of first phase of study as well as farmer's priorities, agroforestry models have been proposed at two different villages (one each in the subtropical and temperate zones) of the watershed. Various interventions in the form of technology packages, such as intensification of traditional crops, strengthening of fodder component, weed composting, use of symbiotic nitrogen-fixers and root associated diazotrophs for crop management, germination and growth of rare and potential wild edible species, introductory trails of some high value cash crops and resource management will be made.

Objectives

1. Estimation of runoff and erosion in improved cropping practices. In addition, soil, water and nutrient conservation under different cropping systems will also be studied.

2. Use of Nitrogen fixing species and estimation of nitrogen accretion in upland farming systems.

3. Study of the role of bund species on conservation and their competition with crops, and identification of ecologically and economically useful agroforestry trees for the region.

Results and Achievements

1. Based on the requirement of the farmers and other villagers of the watershed, agroforestry model is being developed at two different sites, viz. at Chhamgaun for the temperate region, and at Debrong for subtropical region since 1994 and 1995 respectively.

2. The response of plant canopy to radiation in various spectral regions, and the absorbing and transmitting properties of large cardamom (*Amomum subulatum* Roxb.) were studied at different altitudes in Sikkim. Photosynthetically Active Radiation (PAR) estimated in the cardamom growing areas ranged between 696 to 1493 mol m^{-2} s^{-1} which was lower during winter and rainy seasons, but peaked during the months of April and May. Total chlorophyll contents were relatively higher in leaves of cardamom grown under *Alnus* trees than mixed tree species, while it decreased in cardamom leaf in open areas with the direct light 3irradiance.

3. Mean annual precipitation in the watershed ranged from a low hill values of 1448 mm, the mid hill 1792 mm and high hill 2099 mm. About 90% of the annual precipitation were recorded during June to September at all stations. All the streams attain significant sizes during rainy season. The highest discharge of 11677 l/second was recorded in rainy season and 1331 l/second in summer season from the outlet of the watershed during 1996-97. The stream water temperature ranged from minimum level of 9°C to 21°C in different streams of the watershed during the winter season and maximum as 14°C to 24°C in summer seasons. The average pH values fluctuated mostly within a range of 7.0 to 8.5, although minimum value recorded was 6.5 in Tiri khola in the summer season. The pH varied significantly only in seasons and not with the streams. The physio-chemical characteristics of the stream waters from different micro-watersheds mostly varied significantly between both seasons and streams.

4. The sediment concentration during 1994 to 1997 ranged from 21-84 mg/l in winter, 1-79 mg/l in summer and 58-387mg/l in rainy seasons. The highest sediment concentration in rainy seasons was mainly because of high precipitation and extensive agriculture practices followed in this season. The soil loss from different micro-watersheds ranged from 398-2908 t/year. The soil loss rate from the entire watershed was 16545 t/year. Highest soil loss of 2908 t/year was observed in agriculture based Tirikhola micro-watershed. Sombarey khola micro-watershed showed lowest soil loss and it was dominated by forest and agriculture. Nutrient loss from soil-sediment in stream water of micro-watersheds and total watershed was also quantified.

5. Upper Kamrang landslide/gully erosion on an upland farm caused by diversion of a stream as impact of road construction has been undertaken as integrated intervention for stabilisation / erosion control experimentation. An estimated 2 ha area and 20-25 farm families on the up slope portion are benefited in terms of protection from future impending risk as well as social

and economic gains out of these rehabilitation efforts. These families participated in these activities from time to time appreciating the long-term ecological, environmental and economic benefits to accrue. At the end of first calendar year, assessments and performance evaluations are being carried out which include monitoring of plant survival, soil erosion rates and overall site conditions as per the annual calendar of activities prepared.

3.1.2 Resource Utilization Models for Himalayan Watersheds: A case study in Garhwal Himalaya

Background

Erosion is the greatest destroyer of land resource in the Himalayan region. Estimation of soil loss is, therefore, a valuable design, extension and planning tool. Its most immediate advantage is that a well-defined conservation objective can be formulated, namely, to reduce soil losses to acceptable levels. The satellite remote sensing and geographic information system (GIS) can play a very important role for the purpose of evolving an integrated approach for the management of land and water resource at a larger scale in the Himalaya.

Objectives

1. Socio-economic and environmental studies on representative watersheds in the Himalaya.
2. Identification of factors leading to land abandonment, and to assess future landuse trends and alternative land management systems.
3. Monitoring soil loss and water yield under representative landuse practices currently operating in the region, on a long term basis.
4. Performance evaluation of vegetative measures for conservation of land and water resource.

Results and Achievements

1. Study of main streams indicated that annual runoff from Dugar Gad watershed (26.1% of total annual rainfall) was about two times more than that of Srikot Gad watershed. This indicated the effect of better vegetation cover on surface runoff in Srikot Gad watershed . Similar effect was also observed in terms of lower soil loss in Srikot Gad Watershed.
2. After three years of plantation at the experimental site in Dugar Gad watershed, *A. nepalensis* attained the maximum height (262 cm) but a poor survival (26%). The maximum survival (77%) was attained by *G. optiva* with a poor growth of 64 cm across all species planted (Table 1). People accepted *D. sissoo* among all other species for plantation in their wasteland based on its good performance in the experimental site.
3. In Dugar Gad watershed, soil depth was found varying from 17.0 ± 2.7 cm in grazing lands to 77.7 ± 9.0 cm in irrigated crop fields. Organic carbon ranged from 0.91 percent to 2.39 percent between current fallow and protected grass land, respectively.

Table 1. Growth characteristics and proportion of MPTs in native vegetation and peoples' preference for them

Species	Height (cm)	Survival (%) vegetation	Proportion in local by people (%)	Proportion planted (%)
Non-nitrogen fixing				
Bauhinia variegata	143.7±7.1	62	0.9	1.0
Celtis australis	75.9±5.9	70	64.1	1.9
Grewia optiva	63.9±3.9	77	24.2	4.5
Melia azedarach	66.3±5.9	65	1.1	1.8
Prunus cerasoides	167.8±10.9	36	5.6	0
Quercus leucotrichophora	115.7±8.1	25	4.2	12.3
Nitrogen fixing				
Albizia stipulata	93.9±5.6	51	0	12.5
Alnus nepalensis	262.8±15.0	26	0	2.5
Dalbergia sissoo	134.0±15.0	69	0	62.9
Ougeinia dalbergiodes	60.0±3.3	66	0	0.7

3.1.3. Management of irrigation water and rural water supply in the Himalaya

Background

Water, being the basic input for any developmental activity, has a great impact on the agriculture of an area. Irrigation changes low-priced grazing land into expensive cropland. New crops can be grown, and much of the risk taken out of growing established crops, even in humid mountainous region. In most cases, irrigation schedules are not designed to match the physiological demands of the crops. This is mainly because of inadequate attention paid to the characterization of soil, water, plant environment and farmer interactions. Drinking water is becoming a scare commodity in the mountains. Needless to emphasize that safe drinking water-supplies and environmental sanitation are vital for protecting the environment, improving health and alleviating poverty.

Objectives

1. Field evaluation of existing irrigation systems and possible enhancement in their efficiency.
2. Studies on drinking water supply and sanitation including hydrological aspects of springs.
3. Investigations on hydrology and water balance in selected watersheds under various landuse, and employing vegetative manipulations.

Results and Achievements

1. Irrigation systems has been classified in terms of water discharge at the head of the system. For Kumaun Himalaya, the head

discharge is classified as small (below 1 cum), medium (between 1-5 cum) and large (above 5 cum). The largest culturable command area (69.84% of total CCA) is covered under medium class schemes. Only14.79 percent of total CCA falls under small category schemes of below 1 cum discharge. Large schemes cover 15.37 percent of total CCA. About 780 villages are benefitted from medium scale schemes. Large schemes provide irrigation to 101 villages whereas small schemes are found to be beneficial to 240 villages.

2. Large category schemes have greater potential capacity in both Kharif and Rabi seasons (65.86% and 71.63%, respectively). However, difference between irrigation capacities of Kharif (62.11%) and Rabi (60.31 of CCA) was minimum in medium class schemes.

3. Drinking water scenario was studied in two catchments of Garhwal Himalaya under rural water supply component. On an average, the per capita drinking water consumption was 1.5 1/d with total water consumption of 29 1/c/d. Marginal changes were found in water consumption pattern (Table 2). Most of the people were dependent on spring water for rural water supply and each head load of water collection required 30 minutes.

4. Recharge zone of near-extinct spring on which the people were dependent for water supply was treated with bio-engineering measures. Water recharge was increased quite substantially, the net increase in spring yield during summer season in 1997 is depicted in (Fig. 1).

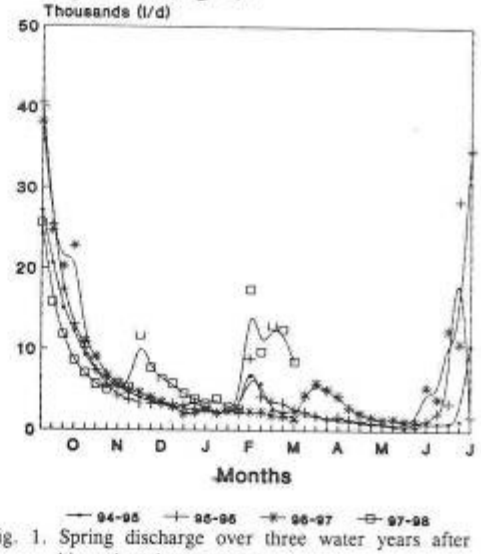

Fig. 1. Spring discharge over three water years after bioengineering measures.

Table 2. Household water consumption in the two watersheds (values are percentages to the total water consumption)

Household activities	Dugar Gad	Srikot Gad	Average
Cooking	13.1	13.2	13.2
Cleaning utensils	20.0	28.6	24.6
Bathing	14.4	25.3	20.2
Washing clothes	25.0	23.1	24.0
Cleaning houses	10.6	9.9	10.2
Toilet	16.9	--	7.9
Total water consumption(l/d)	160±7.	182±10.0	171.0

5. Rainfall is the main factor which controls the spring discharge. The drop in spring discharge from its peak value was ranging from 70.4 (fracture/ joint related spring) to 100 percent in seasonal springs. Annual water yield of springs was only 0.6 to 3.4 percent of annual rainfall.

3.1.4 Performance study of the existing soil and water conservation practices in Himalaya

Background

Soil and water conservation has been identified as the need of the present time. A number of conservation practices are employed in the region which are of different scales and nature. Some age old traditional practices such as bench terraces, slope stabilization and vegetative measures are also used in the Himalaya. Quantitative and qualitative assessment of traditional and modern conservation practices is needed to suggest the most appropriate technology for different regions of Himalaya.

Objectives

1. To identify the traditional and existing soil and water conservation practices in Himalaya and documentation of widely used conservation measures in different regions

2. Quantification of soil loss in different land uses with or without the conservation practices in selected study areas and performance evaluation of low cost conservation measures.

3. To estimate the suitability of the conservation practices in terms of techno-economic feasibility and sustainability for development of the technology model for soil and water conservation.

Results and achievements

1. A study was initiated to carry out some performance tests of low cost bio-engineering measures for controlling man induced erosion in hills to assess their techno-economic feasibility's and adaptability by local farmers. To conduct the study 5 plots of 20m x 5m were prepared for different treatments and 1 plot was kept as control. Plots were treated with physical measures like embedded waste cement bags filled with soil and brush wood structures. One plot was covered with polythene sheet anchored on all sides with small holes for plantation. Vegetative measures with species were applied on all treated plots. The species were selected for plantation on the basis of their ecological behaviour, root characteristics, socio-economic values and availability.

2. The study is in progress from mid June 1997 and all plots are in initial phase of establishment. No marked change in the hydrologic behaviour of plots 2-5 was noticed. However, as might be expected, control plot 1 is generally producing more silt in comparison.

3. Soil analysis of plots indicated acidic nature of the soil (Table 3). Water holding capacity varied between 14.89 to 21.51 percent. The available organic carbon and nitrogen were found low as expected in case of degraded soil. The particle size distribution is presented in figure 2.

Table 3. Soil physio-chemical properties at Katarmal.

Plot No.	pH	Percent Organic Carbon	Percent Nitrogen	Percent W.H.C.	Sulphate (mg / g)	Chloride (mg / g)
1	6.4	0.65	0.114	21.1	0.30	0.66
2	5.5	1.15	0.174	14.8	0.32	0.26
3	6.1	1.04	0.473	18.5	0.17	1.28
4	6.6	0.88	0.121	21.5	0.17	1.32
5	6.0	1.00	0.239	19.5	0.18	1.28
6	6.2	0.73	.320	20.2	0.16	1.99

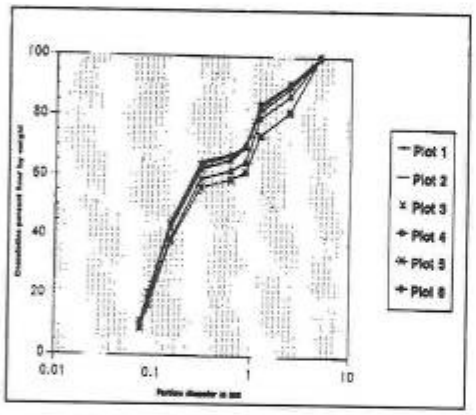

Fig 2. Particle size distribution curve for the soils in the study area.

3.1.5. Mountain Risk Engineering in the Indian Himalayan Region

Background

The constraints of difficult terrain, physiographic features, climatic variability in addition to natural calamities in the form of landslides, earthquakes, cloud bursts, etc. pose real threats to the Indian Himalayan Region (IHR). On the other side the complex web of ever increasing population and its developmental needs of construction, mining, food, fuel, fodder, tourist/pilgrims inflow, etc. have already disturbed the region considerably. In view of the accelerated soil erosion rates and mass wasting processes and the growing concern for effective stabilisation of hill slope instability, a consensus is developing regarding the urgent need for co-ordinated efforts not only from civil engineering and geological sciences but also from the relevant disciplines of soil and water conservation, plant and social sciences. Careful and systematic approach to site selection, process identification, hazard mapping and representation of mass wasting processes is needed to define the level of risk and its mitigation. This has helped in the development of the concept of Mountain Risk Engineering (MRE). The subject is considered as the science and art of engineering mountain infrastructure giving due consideration to natural and human processes, and the tolerable risks to and from infrastructures. Thus, this is an integrated approach to solving the infra-structural engineering problems of hilly and mountainous area. Its aim is to evolve cost-effective and site-specific design, as well as environmentally conscious construction and maintenance practices. MRE is being practised in mountainous regions of various counties for few years now.

Objectives

1. Formation of a multidisciplinary team

trained on the integrated approach of MRE to sustainable hill slope instability control,

2. Testing of framework for the proposed on-the-job, on-the-site training activities,

3. Development of suitable approach to be adopted for local community participation in the stabilisation work,

Results and Achievements

1. To develop a comprehensive package for the proposed on-site training and monitoring of the MRE activities in IHR, it was planned to develop few identified potential sites in the Kumaun Lesser Himalayan region using norms of MRE. Sites representing the local conditions were selected on the basis of preliminary reconnaissance survey in this region with the possibility of implementing varied engineering, biological and bio-engineering measures, accessibility from the logistics considerations.

2. The nature, extent and causes of landslides for each of the site are different and hence all these together can serve as Pilot project for application of the concept of MRE. The experiences gained in terms of degrees of success and / or failure for the various hill area development activities, have justified the need for an integrated approach for future developmental activities involving basic skills and knowledge of the relevant disciplines of engineering, geological, hydrological and social sciences.

3. Land slide and soil erosion prone Kutmaria micro watershed, Hawalbag : The identified site is situated between 79°38'8" to 79°39' 2" longitude and 29°38' 20" to 29°38'43" latitude below Joshiana village of Hawalbagh block in Almora district of Uttar Pradesh, India. The site comprises of small and medium landslips on both the flanks of Kutmaria gadhera (stream), a tributary of Kosi river. In all 6 treatment patches for implementation of varied MRE treatments have been identified. The different bio-engineering and engineering measures to be adopted are Gabion structure in the stream, stone pitching of the stream bed/banks, stream profiling and alignment, slope profiling of landslips for plantation using brush layering and Jute netting. Additionally, to provide incentives to local people and have their participation, horticultural and multi purpose trees plantation in abandoned agricultural terraces / old landslide area is being taken up.

4. Land slide site below Khoont village : The site is situated below Khoont village of Hawalbagh block in Almora district of Uttar Pradesh, on the right flank of Khulgad stream. The site comprise of medium landslide of about 200m length and 30 m width. The primary cause of landslide is presence of an underground water source at the crown portion. In consultaion with the MRE experts, action plan has been worked out for rehabilitation of this site and is proposed to be taken up for implementation during summer of 1998. The main bio-engineering and engineering measures to be adopted are Gabion structure in toe section to provide support to the loose debris from further sliding down, stone rip-rap drain construction for disposal of all surface and subsurface runoff, construction of vegetative hedge rows for diversion of runoff to the main drain and plantation using brush layering and Jute netting at suitable locations. Additionally, to provide incentives to local people and have their participation, horticultural and multi

purpose trees plantation in abandoned agricultural terraces / old landslide area is being taken up.

3.1.6. Badrivan Restoration Programme

Background

Badrinath Dham is situated in the gorge of Nar and Narayan hills at an elevation of 3133 m above mean sea level and remains closed between middle of November to middle of May. In recent past, some government organizations have attempted tree plantations around the shrine and in adjacent areas. One of the reasons for this failure may be incorrect selection of species and age of the seedlings/saplings. Probably the species planted earlier did not tolerate the harsh climatic conditions during winter months. Therefore, proper selection of tree/shrub species would seem essential before initiating any afforestation drive in and around the shrine of Badrinath Dham.

Objectives

1. To involve pilgrims and local public in environmental conservation and promotion of general environmental awareness.

2. Prevention of soil erosion and stabilization of the soil around Badrivan.

3. Revival of Badrivan.

Results and Achievements

1. The nursery of high altitude trees/shrubs at Hanumanchatti (2,500m amsl) in Chamoli Garhwal was maintained and strengthened properly and successfully during the year (i.e. from the middle of May 1997 to the middle of November 1997; the opening period of the site). Seeds of fourteen promising high altitude trees/shrubs (namely, *Betula utilis*, *Betula alnoides*, *Juglans regia*, *Cedrus deodara*, *Pinus excelsa*, *Taxus buccata*, *Alnus* spp., *Quercus* spp., *Aesculus indica*, *Pyrus armenica*, *Salix* spp., *Prunus cornuta*, *Viburnum contifolium* and *Hippophae salicifolia*) were also collected during the year and subsequently sown both at Hanumanchatti nursery and Kosi nursery of the Institute. Out of 29,066 seedlings of 14 plant species, which were available in Hanumanchatti nursery upto November 1996, only 26,080 seedlings of plants survived upto the middle of May 1997. During the year, Hanumanchatti nursery was enriched by 10,085 seedlings of various high altitude trees/shrubs.

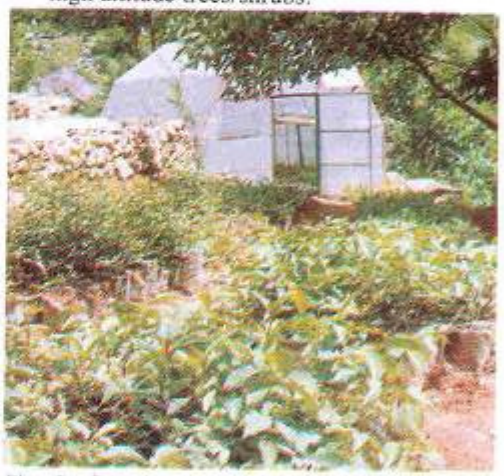

Fig. 3. Central nursery of high altitude plants at Hanumanchatti.

2. Project site development work for the development of Hanumanvan was also carried out at Hanumanchatti during the year. Three thousand and ten (3,010) seedlings of various high altitude trees/shrubs were also planted at the project site. Data on height and growth of the seedlings survived at Hanumanchatti project site were also recorded during the year. The project site was also maintained and the

care of plants for winter season was also done at the site during the year.

3. All the project sites at Badrinath Dham were also maintained and strengthened successfully during the year. Two thousand five hundred and fifty five (2,555) seedlings of various high altitude trees/shrubs were planted during the year at different project sites in Badrinath valley. Survival potential of the trees, which were planted in Badrinath valley before November 1996, was also monitored in May 1997 and November 1997 and 61% plants were observed well survived. However, the seedlings of *Alnus* spp. were not observed survived probably due to the prevailing harsh climatic conditions at Badrinath from November 96 to April 97. Data on height and growth of the seedlings survived at Badrinath valley were also recorded at different project sites.

4. On the request of the local inhabitants of Badrinath Dham, Jamun Distribution Ceremony (second of its kind under Plant Distribution Ceremony, PDC) was organized on 19th August 1997 at Badrinath. Over 300 well established seedlings of Jamun (*Prunus cornuta*) were transported from Hanumanchatti nursery to the Badrinath and distributed from the premises of Badrinath Temple, free of cost, among local inhabitants, priests, saints and army personnel for plantation in and around their habitation. Scientific and technical inputs by the INHI core staff members were also provided to the concerned persons.

5. As per one of the objectives of Badrivan Restoration Programme, environmental awareness in and around Badrinath area was also created among the people from all walks of life. Fourth Ritual Distribution of Tree Seedlings and Plantation Ceremony (RDTSPC) was organized at Govindghat (25 kms before Badrinath) on 3rd October 1997. This ceremony was organized after getting an invitation from the Manager of Govindghat Gurudwara, Govindghat, Chamoli Garhwal, U.P. The ceremony was inaugurated by the Chief Granthi (Mr. Jaswant Singh) of the above-mentioned Gurudwara. Establishment of `Sacred Guruvan' at Govindghat was initiated during the occasion.

6. Fully inspired by the activities of Badrivan Restoration Programme at Badrinath Dham, the ITBP officials posted at Mana in Badrinath agreed to start plantation in ITBP premises under the guidance of INHI core of the Institute. In its initial phase, 300 seedlings of various high altitude trees were provided, free of cost, to the jawans of ITBP during the month of August and September.

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

Background

The overall goal of the project is to improve the understanding of environmental and socio-economic processes associated with degradation and rehabilitation of mountain ecosystems and to generate wider adoption of proposed solutions by the stakeholders. For achieving this goal, this project has a vision of a long term-commitment to foster better field work, more appropriate interventions, enhanced participation, and wider communication between researchers, policy-makers, and the communities. The watersheds selected for the studies and programme implementation are Bhetagad and Garur-Ganga watersheds (29° 50'

and 29° 55' N and 79° 2' to 79° 30'E). These watersheds are a part of the Gomti watershed of the U.P. Central Himalaya. Bhetagad has been selected for detailed study for meeting the prime objectives of the project, whereas, Garur-Ganga has been selected for socio-economic studies and changes in landuse during last 30-40 years.

Objectives

1. To generate relevant and representative information and technologies about water balance and sediment transport related to degradation on a watershed basis;

2. To identify technologies and strategies to improve soil fertility and to control erosion and degradation processes in a farming systems' approach;

3. To generate socio-economic information on resource management and degradation;

4. To systematically apply community-based participatory generation, testing, and evaluation of natural resources' management strategies and technology.

Results and Achievements

1. A close network of meteorological and hydrological stations has been established after selection of appropriate stations to optimise data gathering and evaluation of the key processes in the watershed. These stations reflect and address the spatial as well as the temporal variety in forest, grazing, and cultivated and degraded lands, as well as in common and private lands.

2. Five meteorological stations have been established and their sites' selection was based on nearness to the gauging station and erosion plots, representative altitude of the catchment, availability of suitable land. The stations are recording rainfall, temperature, humidity, wind velocity and direction, and sunshine hours by using various digital, analog and logging instruments. Six hydrological stations have been established based on land use, slope aspect, soil characteristics and forest cover. Four stations are equipped with automatic water-level recorders and manual gauges, and the rest two, which are on seasonal streams, with meter gauges only. Discharge measurements are done throughout the year using current meters in high tides and salt dilution technique in low tides.

3. Four erosion plots of 100 meter sq. (20x5m) each have been established in four land use systems viz. tea garden, Pine forest, upland agriculture field and degraded open grazing land.

4. The rainfall inputs, evaporative losses, crop requirements, runoff and stream-flow dynamics are being examined with emphasis on seasonal variations (pre-monsoon, monsoon, and post-monsoon) individual storm events, and land use.

5. An action research approach is being used, adopting PRA technique to study and analyse the diversity of farming practices in crop and livestock combinations (forest, agriculture and livestock interrelationship), fertility management, and use of other resources (farm and non-farm).

6. Detailed socio-economic information on management of various natural and human resources are being collected as an essential prerequisite to interventions. Secondary data from various sources have already been collected to know about the decadal changes on land use, essential amenities, transport network, use of organic and inorganic fertilizers, irrigation system, forest-agriculture-livestock interrelationships.

3.2. SUSTAINABLE DEVELOPMENT OF RURAL ECOSYSTEM

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

(a) Natural Resource Management for Sustainable Development

Background

This project was initiated in 1992-93 for imparting advanced training to some of the Institute's staff for advancing scientific knowledge on watershed processes and, for developing and demonstrating the utilization of local resources for sustainable rural development based on participatory approaches.

Objectives

1. To quantify soil loss, run-off and productivity in the selected watersheds
2. To survey and review land use practices in the region in view of prevailing socio-economic conditions for groups and individuals including issues for entitlement, equity and gender.
3. To work out tree-crop-animal interactions in different agroforestry systems, need of the people and ecological and economic potential.

Results and Achievements :

For Himachal case study

1. Crops grown with *Pinus wallichiana* leaf litter and without the litter showed that in case of paddy and finger millets, yield was always higher in the litter conditions than the crops grown without litter. However, in case of maize, not much difference was noted except yield which ranged 23.74 to 10.12% at Tichi and Rolgi, respectively. Yield of paddy and finger millet were always higher on lower elevation at Tichi (1600m) than on higher elevations at Rolgi (2200m). In general, maximum positive impacts were shown by paddy and finger millets.
2. Structure of agricultural system during summer cropping season (*Kharif*) was studied for Tichinal watershed. Out of 38 plant species found, 15 were summer crops and 23 were trees and bushes of various uses. Nearly 94.26 % of total density was occupied by summer crops and remaining 5.74 % by trees and bushes. However, 54.6 % of total Important Value Indices (IVI) was of summer crops and 45.62% of tree and bushes. Food grains were maximum in IVI (27.07% of total) followed by fodder and fuel wood (24.74), pulses (19.47%) and fruit crops (15.71) (Fig. 4).

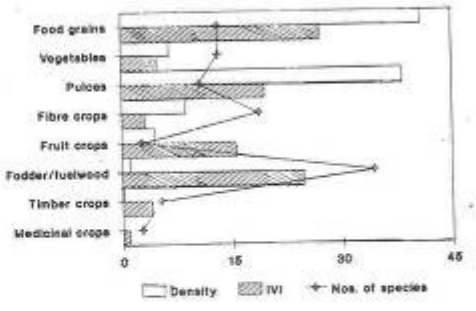

Fig 4. Number of plant species, density and IVI (all in %) of summer crops, trees and bushes maintained along terraces of agricultural system.

3. Energy (MJ/ha) output/input ratio in three micro-agro climatic zones of Tichinal watershed showed that villages < 1800m represented more or less similar pattern of energy input/output ratio. But, there were considerable variations of energy and monetary (Rs/ha) output/input ratios in the crops cultivated above the ranges of 2200m. On an average in both-energy and monetary indicators, crops grown in the upper most micro belt were found quite productive rather than the crops in the mid and lower altitudes. One of the most important reasons for this might be close proximity to surrounding mixed forests which brings high nutrients and humus through downstream surface runoff to crop fields along with high application of manure inputs as compared to low lying crop fields.

4. Considering the whole watershed as a single system, it was found that output/input ratio of barley (< 1800m), finger millet and wheat (> 2200m) in energy aspect were noted to be profitable. On the contrary black gram (< 1800m) and lentil (> 2200m) were found to be beneficial as compared to other crops. Most of the crops were nearer to achieving no profit and no loss but they were again very few throughout the system.

5. Perishable fruit crops like apple, pear and plum are not profitable crops of Tichinal watershed due to lack of road link. Farmers of Tichinal watershed area were encouraged to plant and develop nut fruits as cash crops. Each house hold of all the villages falling in the area were given nut saplings (5 walnut and 1 pecanut) in month of December to develop nut fruit as a source of income.

For U.P. Himalaya case study :

Resource status mapping was completed and the map outputs are ready for publication. Land use, land cover change analysis have been completed. However, the remote sensing data interpretation accuracy verification using ground truthing is pending to finalise the maps and tables. Some of the significant findings are

1. Conversion of forests under civil or *vanpanchayat* area to agriculture is the most significant land cover change between 1963 and 1996. However, the rate of change is quite less between 1986 to 1996 and it could be attributed to the world bank watershed development programme where the afforestation and other infrastructural development works were carried out. This perhaps met the fuel, fodder and other minor economic requirements.

2. The ground verification of most afforestation sites indicated that though the success of such efforts were good during the implementation phase, the resources developed were already extracted after the project monitoring staff were with drawn from the area. This suggests that there is requirement of constant inflow of money in order to maintain the environmental balances. Detailed technical reports are under preparation.

(b) Agroforestry and Restoration Models for U.P. and H.P. Hills

Background

Agroforestry is argued to be a sound land management option meeting both environmental and developmental imperatives in the hills, particularly on the slopes. Agriculture, forests and animal husbandry are interlinked across the Himalaya. However, the nature and magnitude of these linkages vary. Agriculture in the Himalaya continues to be of subsistence type and productive potential of cropland depends upon the organic inputs derived directly from the forests in the form of litter or indirectly through

animal dung. There is a need to evaluate the costs and benefits of introducing trees in croplands, identifying potential species, standardizing the propagation and cultivation techniques of the identified species and rejuvenating the traditional agroforestry systems with appropriate science and technology inputs.

Objectives

1. To identify agricultural land use practices suited to the ecological and socio-economic attributes of the area and their implementation in the field on experimental basis.

2. To evaluate the acceptability of the identified management practices by the people.

3. To undertake fundamental researches so as to design refinements in the existing/identified agricultural land use practices for sustainable development.

Results and Achievements

1. Magnitude of nutrient return through litter (kg/ha) of six different multipurpose tree species were studied in the Garhwal region. Maximum was recorded for *F. glomerata* and minimum for *F. roxburghii* on agroforestry site. However, on restoration site, of the two species studied, *A. nepalensis* showed significantly higher nutrient return than *A. lebbek* (Table 4). The rate of leaf litter disappearance of these species showed inverse relationship with the C:N ratio.

2. The impact of shade on the productivity was more pronounced in the Kharif crops than in the Rabi crops. Kharif crops were generally grown on the plots where the canopy of the MPTs were left intact. About 50 times less grain yield was recorded when compared with crops grown on control plots or on the plots where only 25% canopy of the MPTs was left intact.

3. Among the total 13 MPTs planted on the agroforestry site after 5.5 year *Alnus nepalensis* showed significantly higher (52.60 kg/individual) biomass than others while lower value (8.00 kg/individual) was observed for *Pyrus pashia*. On restoration site, *A. nepalensis* once again had the maximum (40.00 kg/individual) biomass than the other (17) planted species. Lowest biomass was, however, recorded for *Quercus glauca*.

4. Impact of different MPTs on soil chemical properties in different seasons, depths and distances was also analyzed on agroforestry site. Organic carbon showed significant variations in different seasons under each species. Higher soil organic carbon was observed in spring and summer seasons while it decreased significantly in rainy season. Generally, the upper soil horizon (0-15 cm) under each studied species had higher organic carbon, total nitrogen and phosphorus than the lower soil horizon (16-30 cm). Total soil nitrogen was observed higher under nitrogen fixing species than non-nitrogen fixing species. Percentage of C, N and P generally observed higher in rhizosphere soil than the soil at 2 m distance from the tree.

5. Physico-chemical properties (moisture, water holding capacity organic carbon and total nitrogen) of the composite soil samples of agroforestry and restoration sites showed significantly positive change (750%) in the above properties after 5.5 year of plantation when compared with the same properties observed at the time of plantation.

6. Studies of status of indigenous agroforestry system was studied at 5 locations in lower Kullu valley (Bajaaura 1100 m, Garsa 1200 m; under sub-temperate agro-climatic conditions and in Upper Kullu valley (Phozal 1400 m, Khumarti 1600 and Malana 2700 m; under temperate agro-climatic conditions). Total 51 woody species (35 trees and 16 bushes) were found in all the 5 locations. Studies from Bajaura to Malana showed that, for trees, percentage number, density and IVI were reducing with increase of altitude. The reverse trend was noted for bushes. Among the trees, density of fodder/fuel wood trees were maximum ranging from 22.9% to 11.5% with increase of altitude. Density of fruit/fuel wood tree ranked second after fodder/fuel wood trees. Among the bushes, bushes used as fencing material around agricultural fields were first in rank ranging from 40.0% to 43.2% with increase of altitude.

7. In the areas like Phozal and Khumarti, where fruit trees has been extensively introduced as cash crops, diversity and density of fodder/fuel wood crops has been significantly reduced. Large number of fodder/fuel wood trees from edges of the terraces has been replaced by some fruit crops of commercial value.

8. In temperate agro-climatic conditions of upper Kullu valley, temperate fodder/fuel wood trees (*Pyrus malus, Pinus wallichiana, Prunus armeniaca, Quercus delatata, Q. incana, Morus serrata* and *Ulmus wallichiana* were found in higher density and IVI. Except *Morus serrata* all are lopped after 3 years and has shade effect on under story crops.

9. In Khumarti about 13% of one ha area was affected by shades of tree crops maintained on the edges of terraces. Apple contributed 4.8% of one ha area, followed by Pinus wallichiana 2.7%. Percentage shades of *Prunus armeniaca, Quercus delatata*, and *Q. incana* ranged in between 1.7 to 1.4% .

10. In general, 23.8±4.4% plant height and 26.4±6.1% diameter increment were reduced for maize crops grown under shades than open. Lowest negative impacts (13.9 % in plant height and 5.5 % in diameter increment) was observed under *Q. incana,* and reverse was with *Prunus armeniaca* and *Pinus wallichiana* (44.2 to 47.9 %).

11. Shade effect was not noted under *Celtis australis, Ficus palmata* and *Robinia pseudoacasia* which are lopped annually. Larger trees of *Grewia oppositifolia* has shade effect on understory crops, but farmers chop down the thick branches after 5-7 years interval for fuelwood and manage smaller crown size to minimize shade effect. Except *Grewia oppositifolia*, other species are also found in upper Kullu valley in relatively lower densities upto 1600m elevation.

(c) Resource use pattern of transhumant pastoralists

Background

Transhumance is a historical phenomenon evolved as an adaptation to extremities of physical environment in remote and high Himalayan mountains. It encompasses essentially varying degrees of dependence on agriculture and pastoralism to secure human beings. The very existence if this life support system and preservation of cultural values by the societies practicing them for centuries offer a scope for deeper understanding of sustainability and for getting an integrated view of the social, cultural, economic and environmental facets of development.

Table 4. Nutrient return through litter (kg/ha/yr) of various multipurpose tree species on land rehabilitation sites at Banswara.

Site/Species	Nutrients		
	Carbon	Nitrogen	Phosphorus
Agroforestry site			
Albizia lebbek	399.25	26.93	1.40
Alnus nepalensis	656.50	45.60	2.67
Boehmeria rugulosa	615.94	23.57	4.27
Dalbergia sissoo	354.13	24.35	1.91
Ficus glomerata	666.63	45.53	4.36
Ficus roxburghii	217.00	6.28	1.07
Restoration site			
Albizia lebbek	323.90	14.15	0.79
Alnus nepalensis	1114.33	76.16	4.50

Objectives

1. To compile and analyze the historical accounts of social, cultural, religious, political and economic setup of these transhumanic people.

2. To analyze the spatial patterns and temporal trends of the fundamental requirements of these people.

3. To estimate the efficiency of resource use in terms of both economic and ecological costs, and to analyze the question of their sustainability.

Results and Achievements

For Garhwal case study :

1. Major factors which influence these communities to migrate were the absence of grazing lands and heavy snowfall in the area. Among the communities, Tolchhas cultivated various crops in mixed and monocropping where as Merchhas practiced only monocropping.

2. The major proportion of the cultivated land of Jadhs is occupied by potato (79 %) where as, 33 % land area occupied by buckwheat and potato in Tolchhas and 46 % land area occupied by potato in Merchhas.

3. Labour allocation pattern by male, female and children were studied in agriculture and kitchen garden among these communities at their both dwellings. It was found that the male and female of Tolchhas spent maximum labour in hours than Merchaas and Jadhs.

4. It was observed that 95.8 % of sheep disposed were sold by Jadhs where as in Merchhas and Tolchhas it was about 80.7 %. This was because the Merchhas and Tolchhas depended more on their livestock for wool, meat and transport services than Jadhs.

For Arunachal case study :

1. Yak herding and grazing is the main occupation of Monpas in three of their pure nomadic villages than compared to semi-agriculturists. Sale and barter exchange of Yak milk and milk products is the main

source of their livelihood, which is done with the semi-agriculturist Monpa.

2. The Monpa yak grazers are strictly polyandrous society, and still practice it in their traditional manner, but, have started considering it as backward and old practice . They are able to maintain and graze their yaks in the forests and meadows for a longer period of time, due to the polyandrous nature of their society which takes care of their family.

3. The non-transhumant Monpas are semi-agriculturist, and cultivate maize, barley, millet, soyabean and potato. Agriculture is done in mostly rainfed conditions, and in general energy input in the form of organic manure and labour was quite high in their cultivation as compared to the agriculture down below in the lower elevation.

4. The agriculturists Monpas use 70 % of their produced crops of millet, barley and maize in the making of local drinks after fermentation, and depend on the supply of food grains through public distribution system for their food requirement.

3.2.2 Designing, Developing and Testing Sustainable Natural Resource Management Models through Peoples' Participation in Critical Villages in Nanda Devi Biosphere for Achieving the Objective of Conservation of Biological Resources in the Himalaya

Background

Reconciling economic development with biodiversity conservation has become one of the most important elements in the search for sustainable development. This problem is particularly acute in remote rural areas of the country where biodiversity is concentrated and where poverty tends to be pervasive. Facing a range of developmental crises with limited public funds, most of the region/area has invested little in biodiversity conservation as is the case of Nanda Devi Biosphere Reserve. Partly as a result, fragile and unique ecosystems are being degraded or converted to agricultural use on a large scale. As the habitats are destroyed, countless plant species face considerable danger of extinction. Many of these species may be unknown to science fully, their potential benefits therefore remain unknown or unrealized.

Objectives

1. To design, develop, and field test natural resource management models.

2. To study qualitative and quantitative changes of resources.

3. To study socio-economic impacts of various programmes on the development of the rural systems.

Results and Achievements

1. Every year a large number of livestock are killed by the leopards in the villages of buffer zone. The highest number of reported losses include sheep (352) and goats (276). The total monetary loss of livestock killed by wildlife for whole buffer zone villages during the period of eight years (1988-96) was estimated about Rs. 10,24,520 (Rs. 384.0/family/yr).

2. The wildlife causing crop damage include ungulates, monkeys, wild boar and bear. The total crop damage in the buffer zone villages was evaluated about 65654 kg/yr which is equivalent to the monetary costs of Rs 5,38,620/yr. Besides, the damaged done by wild bear to honey hives quantified and estimated about to be Rs 60,280/yr.

3. About eight economically promising species (*Allium humile, A. stracheyi, Saussurea costus, Angelica glauca, Pleurospermum angelicoides, Megacarpaea polyandra, Carum carvi* and *Dactylorrhiza hatagirea*) used for medicine, spices, condiments and vegetables are being cultivated by the Bhotiya tribes for the last two to three decades. These were studied in relation to their agronomic practices, uses, ethnobotany, yield potential and cost-benefit analyses associated with the cultivation.

4. Among the medicinal plants, per ha yield per year was found highest for *Saussurea costus* followed by *Pleurospermum angelicoides* and *Angelica glauca* under cultivation as compared to wild. The output/input analyses using monetary values indicated *Carum carvi* provided highest returns and *M. polyandra* provided least returns.

5. Due to lack of organized marketing, majority of the cultivated medicinal plant produce is still used to barter for food items. Of the total produce (7694 kg/yr), least (550.5 kg/yr) is used for self consumption and maximum (4038 kg/yr) is used for barter and the rest is being marketed directly (Table 5).

6. Most of the local people of the buffer zone villages were found dependent on herbal treatment (traditional health care system). Out of the total population, 92-93% were found dependent on herbal treatment and also preferred it, while only 7-8% were preferring allopathic medicine. For fifteen major ailments assessed in detail, 95-96% of households were found dependent on traditional health care system to cure these specific diseases (Fig. 5).

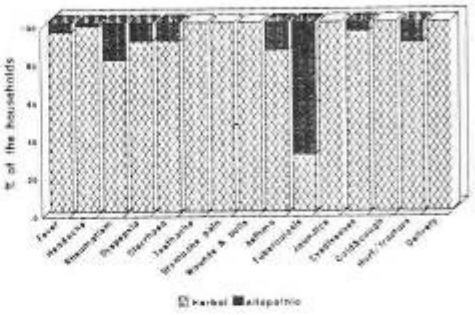

Fig. 5. Dependency of the buffer zone villages of NDBR on traditional health care system and allopathic treatment for different ailments.

7. Various action oriented developmental activities have been initiated in the buffer zone villages to integrate conservation with human needs as to resolve reserve-people conflicts. These activities includes land rehabilitation, promoting medicinal plant cultivation, horticulture, value addition of wild edibles and eco-tourism in the buffer zone areas, etc.

8. The average survival percentage of various multipurpose trees after six months of plantation declined from 76% to 59% and from 78% to 67%, respectively, at two different land rehabilitation sites in the buffer zone area of NDBR. Various cost-effective technologies such as water harvesting, mulching and seedling guards (made up of locally available resources) were introduced to enhance the survival and growth of the seedlings and also to protect them against frost and snow.

Table 5. Quantity (kg) and monetary equivalent (Rs) of different cultivated medicinal plants consumed, exchanged and sold in the market by the villagers of buffer zone of NDBR.

Scientific Name	Quantity consumed (kg)	Monetary equivalent (Rs)	Quantity exchanged /barter (kg)	Monetary equivalent (Rs)	Quantity sold to trader /in market (kg)
Allium humile	86	4730	2232	122760	1402
Allium stracheyi	25	1375	686	37730	433
Sausurea costus	123	3075	341	8525	565
Angelica glauca	170	4250	472	11800	303
Megacharpea polyandra	105	1575	65	975	-
Carum carvi	8	640	140	11200	252
Dactylorrhiza hatagirea	1.7	382	9.8	2205	52.5

3.2.3. Inventory, Commercial Utilization and Conservation of Agrobiodiversity for Sustainable Development of the Buffer Zone villages of Nanda Devi Biosphere Reserve. (funded by M E&F, Govt. of India)

Background

Traditional crops constitute an important component of the agriculture of the buffer zone villages of Nanda Devi Biosphere Reserve (NDBR). These crops though are low yielding, are preferred because they are stress-tolerant, resistant to disease and pests, have a good nutritional qualities and adapted to crude agronomic practices, and dependable. These crops have not been so tested for their potential and no attention has been paid for their improvement. But in recent years the agro-diversity of this region is under severe threat of depletion. There are several interacting factors that are directly and indirectly responsible for this genetic erosion and for creating an imbalance in traditional agro-ecosystems of this region. With rapid depletion of genetic diversity of crop plants there is considerable interest in traditional under-utilized crop of food value for meeting the needs of increasing population, particularly in the developing world.

Objectives

1. To survey all plant species of potential food value which have been domesticated by the traditional societies.
2. To work out the extent of area under cultivation with the allocation of land to traditional under-utilized crops by individual families in relation to the total cultivable land of a family.
3. To analyze the land management cultural practices and eco-physiological requirements of traditional under-utilized crops and their comparison with common crop agro-ecosystems.
4. To study the contribution of traditional under-utilized crops in meeting the food requirements of traditional societies in terms of quantity, energy and protein.
5. To compare the nutritional attributes of the traditional under-utilized crops with those of common food and cash crops.
6. To identify strategies for yield improvement and conservation of the traditional under-utilized crops.

Results and Achievements

1. In-depth survey has been carried out in the buffer zone villages to enumerate the crop diversity and their wild relatives which include cereals, pseudo-cereals, minor millets, pulses, oil yielding crops, vegetable, spices and condiments, fiber, domesticated or semi-domesticated medicinal plants and fruits. So far, a total of 55 species of above categories have been recorded along with their scientific name, vernacular name and distribution range.

2. The survey also reveals that the traditional crop diversity of the buffer zone villages have declined rapidly during a very short-period of two and half decades (1970-1995). These crops have mostly been replaced by high yielding varieties of wheat and traditional cash crops like potato, kidney bean, amaranth and buckwheat (Fig. 6).

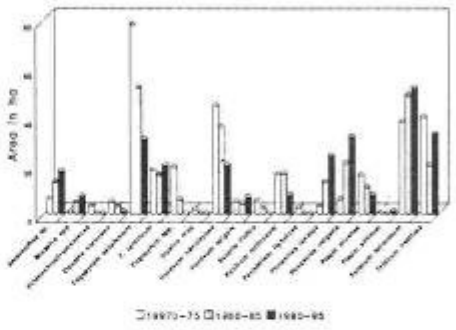

Fig. 6. Change in area (ha) under different crops at three different time periods in the buffer zone of NDBR.

3.2.4. An assessment of agricultural production and strategy for sustainable development of bioresources.

Background

Keeping in view the ever increasing population of human and livestock in the rural mountain areas, it has become imperative to assess the production of bioresources such as agriculture, fodder and fuel in the different geo environmental conditions. It is not possible to study and quantify the entire mountain region, hence, a representative site in Hawalbagh block of Almora district has been selected for the detailed study. In order to assess the production of bioresources, the whole block has been divided into three altitudinal zones, and around 13 villages in each zones have been selected for the detailed study.

Objectives

1. To quantify the agricultural production in the existing prevailing conditions

2. To assess the contribution of agricultural production to the total food requirement.

3. To quantify the total production and consumption of fuel and fodder resources.

4. To assess the total production of different land use category.

5. To identify the possible alternate for improving the productivity of these landuse categories.

Results and Achievements

1. Secondary information regarding agriculture, livestock, various land use categories and demographic trends have been collected and compiled.

2. Based on the digital and thematic information, villages have been selected for the detailed study.

3. Primary survey of 32 villages for demographic parameters and livestock have been completed.

4. Based on toposheets drainage pattern, landuse map, altitudinal zone and phsiography have been prepared.

3.3. CONSERVATION OF BIOLOGICAL DIVERSITY

3.3.1. Studies on Biodiversity: Fragmentation and Conservation of Ecologically Sensitive Habitats of the Himalaya

Background

In view of the increasing population in the Himalaya many habitats are being constantly converted into simpler systems for providing more harvestable goods to the people. As a result the scenario of habitat heterogeneity and species diversity is changing. 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. The consequences of habitat fragmentation are multiple. Therefore, the whole process has a negative effect on the population size, extinction rates and dispersal capacity.

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.

Results and Achievements

West Himalaya - Askot Wildlife Sanctuary

1. The quantification of alpine vegetation in different habitats was done. Representing a total of 147 species of angiosperms (135 taxa) and pteridophytes (12 taxa) of which 71.43% are native to Himalaya.

2. Among the Himalayan natives *Aconitum falconerii* and *Kobresia duthiei* are narrow range endemic and *Pimpinella acuminata, Pleurospermum densiflorum, Lactuca macrorhiza, Scrophularia himalensis, Athyrium rubricaule* and *A. duthiei* are wide range endemic. The low density of all the endemic except *Kobresia duthiei* in their respective habitats is revealing (Table 6).

3. The low density of anthropogenic species like *Aconitum balfourii, A. heterophyllum, Allium humile, A. wallichii, Dactylorhiza hatagirea, Jurinella macrocephala, Meconopsis aculeata, M. paniculata, Nardostachys grandiflora, Picrorhiza kurrooa, Rheum speciforme* and *Saussurea obvallata* indicate their poor availability in the area (Table 6).

4. Considering frequency distribution of all the species/habitats together, 90 (61.2%) taxa showed low (<20%). The high frequency taxa are relatively few (12.2%).

5. Among habitats, the alpine slopes (South West, North West, North East, North and West aspects) were species rich (>30 taxa). Shannon's Index of diversity ranged between 1.43 to 3.58. Alpine slopes (NE, NW and SW) exhibited higher values (>3).

6. The evenness values for all the habitats ranged between 0.40-0.94. Fourteen habitats showed evenness value >0.80 indicating almost regular distribution of species.

7. Continuing with previous studies on crop diversity, six species were monitored for biomass and production(grain yield) in different elevations. The total biomass of *Triticum aestivum* (Kalyan var.) and *Lens esculenta* decreases along the altitudinal gradient. However, in *Pisum sativum, Zea mays* and *Eleusine coracana* the total biomass is high in mid-elevational village (Chopta) compared to low (Baram) and high (Maitli) elevational villages (Table 7).

8. The grain production (yield) of *Triticum aestivum* (Kalyan var.), *Hordeum vulgare* and *Lens esculenta* decreases with the increasing elevation. However, the yield for *Pisum sativum, Zea mays* and *Eleusine coracana* is high in the mid elevational village compared to low and high elevational villages (Table 7).

North West Himalaya (Kanawar Wildlife Sanctuary- KWLS)

1. Analysis along Sirkut-Opti Thach, a high altitude transect (2100-3700m) of KWLS, revealed presence of a total of 61 woody taxa, comprising 30 trees (9 evergreen and 21 deciduous) and 31 shrubs (16 evergreen and 15 deciduous) species. The zone between 2501-2700m in upper temperate forests supports maximum woody taxa (30). The two transition zones, viz. 3101-3300m and 3501-3700m have been identified on account maximum species turnover/diversity ratio, i.e. 1.5 and 1.57, respectively (Fig. 7). Both the zones have been identified as rich habitats for wildlife.

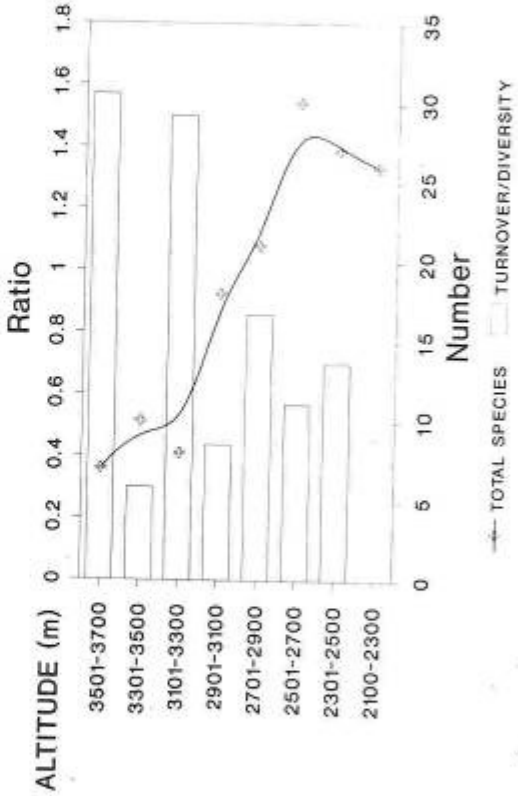

Fig. 7. Total species diversity (number) and species turn over / diversity ratio for different altitudinal zones along Sirkut-Opti thatch in Kanawar Wildlife Sanctuary.

Table 6. Distribution and status of species in alpine region of AWLS.

Taxa	Frequency (%)	Density (Ind/m^2)	RDB records
Endemic			
Aconitum falconerii	7.41	1.5	-
Athyrium duthiei	11.11	0.1-0.4	+
A. rubricaule	11.11	0.1-1.3	-
Kobresia duthiei	22.22	3.5-48.1	-
Lactuca macrorhiza	11.11	0.1-0.5	-
Pimpinella acuminata	3.70	1.2	-
Pleurospermum densiflorum	11.11	1.0-1.8	-
Scrophularia himalensis	11.11	0.1-0.5	-
Anthropogenic			
Aconitum balfourii	14.81	0.1-0.9	-
A. heterophyllum	3.70	1.0	-
Allium humile	3.70	0.9	-
A. wallichii	29.63	0.2-2.6	-
Dactylorhiza hatagirea	11.11	0.3-0.7	-
Jurinella macrocephala	3.70	0.7	-
Meconopsis aculeata	18.52	0.2-0.7	-
M. paniculata	3.70	0.4	-
Nardostachys grandiflora	29.63	0.2-4.9	+
Picrorhiza kurrooa	18.52	1.1-8.3	+
Saussurea obvallata	11.11	0.7-1.6	-

RDB = Red Data Book of Indian Plants

Table 7. Biomass (kg m^{-2}) and production (yeild, kg m^{-2}) of crops in the villages of AWLS

Crop species (varieties)	Baram (1000)		Chopta (1400)		Maitli (2000)	
	Total biomass	Yield	Total biomass	Yield	Total biomass	Yield
Triticum aestivum (Kalyan)	3.94	1.0	3.69	0.98	3.89	0.42
Hordeum vulgare	3.44	1.50	1.44	0.93	5.86	1.25
Lens esculenta	0.61	0.32	0.60	0.18	0.24	0.10
Pisum sativum	0.10	0.05	0.17	0.13	0.06	0.02
Zea mays	3.43	0.78	5.91	2.68	1.83	0.94
Eleusine coracana	0.31	0.10	0.75	0.25	0.17	0.08

2. Inventories on bioresources, their use pattern and traditional knowledge of management are being made. Species-wise, monthly fuel wood consumption pattern (1996-1997) is analyzed. Eight species for upper and twelve for the lower zone village had their major contribution to daily households' fuel wood consumption (totaling as 48.1 kg HH^{-1} day^{-1} and 30.1 kg HH^{-1} day^{-1}, respectively). For upper zone, the maximum consumption HH^{-1} day^{-1} is obtained for the months of November (60.0 kg) to February (62.0 kg), and the minimum during June (30.0 kg) and July (31.5 kg). Whereas, lower zone suggests the maximum values for December (47.8 kg), and the minimum for July (16.0 kg) and August (16.3 kg).

3. It is estimated that the *Pinus wallichiana* (43.0% and 22.6% for upper and lower zones, respectively), *Cedrus deodara* (25.1% and 0.9% for lower and upper zone, respectively), and *Pinus roxburghii* (19.8% for lower zone) are highly consumed fuel wood taxa.

4. The fodder consumption HH^{-1} day^{-1} is maximum during snow-bound months of December (56.3 kg) and January (62.7 kg), and the minimum during summer months of June (16.7 kg), July (14.2 kg) and August (12.9 kg) for lower zone villages.

5. The People's perception survey on the extraction of medicinal plants for upper zone reveal that the 50% households sell their material to local trade agents and 31.8% households directly sell in nearby towns. Nearly 12% households agreed the money received from medicinal plants is the main source of income, whereas 35% consider it as a fraction of their family income. Majority (85%) of households have consensus on making village level cooperative societies for trade in medicinal plants.

6. An experimental nursery (0.2 h) of medicinal plants has been established at Kasol through the authorities of Parvati Forest Division. Preliminary work has been initiated.

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 base line data for the Himalayan bioresources is not available. Therefore, preparation of inventory of bioresources (family wise, rare-endangered, ethnobiological, endemic, key stone species) has been initiated. The analysis of the data generated so far has proved useful.

Objectives

1. Develop a computerized data base of all species and their habitats.

2. Identify gaps therein.

3. Draw information about various attributes of specific habitats/species.

4. Prioritization of activities related to conservation.

Results and Achievements

1. Inventory of the family Caryophyllaceae in the Indian Himalaya prepared. It is

represented by 139 taxa in twenty two genera, ranging from sub tropical to alpine regions. Among the genera *Silene* (32), *Arenaria* (26), *Stellaria* (24), *Dianthus* (12) and *Lychnis* (8) are species rich.

2. The species representation in different biogeographical regions is as follows: trans/ north west Himalaya(69.8 %), west Himalaya (56.8%) and central and east Himalaya (46.8%). Among the genera, *Silene*, *Dianthus* and *Cerastium* showed maximum representation (>70%) in trans, north west Himalaya. *Holosteum* and *Herniaria* are restricted in trans, north west Himalaya. However, *Spergula*, *Thylacospermum* and *Vaccaria* are widely distributed in all the provinces. The species richness among dominant genera in different parts of Himalaya is presented (Fig. 8).

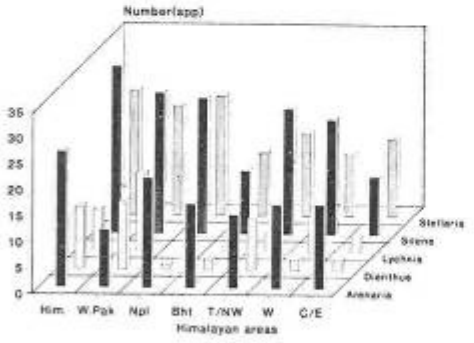

Fig. 8. Species richness among dominant genera in different parts of Himalaya (Him-Himalaya, W.Pak-West Pakistan, Npl-Nepal, Bht-Bhutan, T/NW-Trans/NorthWest, W-West, C/E-Central/Eastern)

3. The family is represented in all altitude zones of Indian Himalaya but relatively more in temperate (67.8%)and alpine zones (74.1%). Among the largely represented genera, *Arenaria* (88% and 60%) and *Minuartia* (100% each) are mostly confined in alpine and high alpine areas. Others, *Dianthus* (92%, 67%), *Lychnis* (88%, 63%), *Silene* (72%, 91%) and *Stellaria* (67%, 71%) are common in temperate and alpine areas respectively. However, *Silene*, *Stellaria* and to some extent *Dianthus* exhibit wide ecological amplitude. On the contrary, among monospecific genera *Thylacospermum* (high alpine), *Vaccaria* (alpine), *Spergula* (temperate), *Polycarpaea* (sub tropical) are restricted to specific altitude zones.

4. Indian Himalayan Caryophyllaceae revealed high proportion of native (61.9%) taxa. Most of the prominent genera (except *Dianthus* 50%) exhibited high nativity (>65%).

5. Of the representative native taxa, proportion of Himalayan endemic and near endemic is high (94.2%).Endemic are represented in four genera, i.e. *Arenaria* (4), *Lychnis* (1), *Silene* (5), *Stellaria* (2), and mostly concentrated in trans/northwest (8: 66.6%) and west Himalaya (6: 50.0%). Likewise the diversity of near endemic is maximum in trans/northwest (53: 38.1%) followed by west (47: 33.8%) and central/east Himalayan provinces (36: 25.8%). Along vertical range, representation of Himalayan endemic (endemic and near endemic) increases (sub tropical 18.5% to high alpine 68.4%) with increasing altitude. Considering the spatial extension of endemic ten taxa are restricted in one biogeographic province (narrow endemic). Also, high percentage (35.9%) of restricted near endemic taxa is interesting.

6. The extent of endemism (*sensu lato*) in Caryophyllaceae of the Indian Himalaya and neighbouring mountain areas is comparable. In general, Caryophyllaceae is rich in endemic in Soviet-Asia and Europe (>40% each).

7. On account of restricted distribution and/or depleting population some of the taxa in Caryophyllaceae of Indian Himalaya have been listed in Red Data Book of Indian plants. Among these *Arenaria curvifolia* Majumdar and *A. ferruginea* Duthiei ex Williams are endemic to west Himalaya, hence narrow endemic. Other reported taxa are restricted near endemic.

8. As in Brassicaceae, in view of the spatial pattern of near endemic distribution in Caryophyllaceae identification of trans border reserve is suggested.

Medicinal plants of Indian Himalaya

1. Inventory of 1743 species (representing 223 families and 915 genera) of medicinal plants of Indian Himalaya was prepared. These species are distributed within three taxonomic groups i.e. Angiosperms (96.4%), Gymnosperms (0.7%) and Pteridophytes (2.9%). Of the total species 62.9% are herbs, 19.2% shrubs, 14.9% trees and 2.9% Pteridophytes.

2. Considering the species richness within the families, Asteraceae (129 spp.) ranked first, followed by Fabaceae (107 spp.), Lamiaceae (67 spp.), Rubiaceae (55 spp.), Euphorbiaceae (51 spp.), Ranunculaceae (48 spp.), Rosaceae (42 spp.), Poaceae (40 spp.), Orchidaceae (38 spp.), and Polygonaceae (32 spp.) respectively. The remaining families showed < 30 species.

3. Among the genera, *Polygonum* (19 spp.), *Euphorbia* (16 spp.), *Piper* (14 spp.), *Ficus* (13 spp.), *Swertia (12* spp.), *Aconitum* (12 spp.), *Artemisia* (11 spp.), *Desmodium* (10 spp.) and *Solanum* (10 spp.) are the species rich genera. The remaining genera showed < 10 species.

4. Along the altitudinal gradient maximum diversity (81.2%) was found in the zone > 1800m. This may be due to maximum human habitations and knowledge of use of species as medicine. The diversity decreases with the increasing altitude, hence, minimum in the zone above 3800m.

5. The diversity of use of species as medicine in all the biogeographical provinces is >30% of the total medicinal plants. Central Himalaya (40.8%) and West Himalaya (40.7%) showed maximum use of species as medicine.

3.3.3. Establishment and Maintenance of a functional arboretum at Kosi-Katarmal, Almora.

Background

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

Objectives

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

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

3. Large scale multiplication of species and making the sapling available to local people and also for use in greening of degraded lands.

Results and Achievements

1. Infrastructural facilities such as development of polyhouse, extension of nursery and arboretum area for the plantation of Himalayan woody species was carried out.

2. Propagules of over 50 species were collected and sown in the arboretum nursery. Species were monitored for germination and growth performance. Among all the species, *Albizia julibrissin, Dalbergia sissoo, Erythrina arborescens* and *Alnus nepalensis* showed high (>90%) germination whereas *Kydia calycina, Maesa indica, Acer cappadocicum, Symplocos ramosissima* and *Ardisia solanacea* showed no germination. Also, the arboretum is enriched with the introduction of ferns (>15 spp.), orchids (>15 spp.) and medicinal plants (>20 spp.).

3. Over 5,000 seedlings were planted in arboretum sites and Institute campus. Survival percentage of the species in arboretum sites was about 55%.

4. About 1,000 seedlings of 20 species were distributed to schools/colleges for the development of conservation models.

5. The effect of frost on some of the established species in the arboretum site was monitored. *Albizia procera, Dalbergia sericea, Saurauia napaulensis, Bischoffia javanica, Ehretia laevis, Bauhinia variegata, B. racemosa, Ficus nemoralis* and *Ficus roxburghii* were frost prone species with >90% damage of aerial part. *Butea pellita* showed 100% shoot loss.

6. Growth performance of four species was monitored in different experimental conditions, i.e. nursery, glass house and net house (Table 8). *Albizia chinensis* and *Heynea trijuga* showed maximum shoot development in nursery, *Albizia lebbek* in net house while *Semecarpus anacardium* in nursery as well as glass house conditions. The pattern of root development in all the species was similar except *Semecarpus anacardium* in which maximum development of root system took place in nursery condition.

7. *Albizia chinensis* and *A. lebbek* attained maximum biomass in net house. However, *S. anacardium* and *H. trijuga* attained maximum biomass in glass house and nursery conditions, respectively (Table 8).

8. The development of root nodules in *A. chinensis* and *A. lebbek* in all the experimental conditions was observed, the nodule formation in *A. chinensis* was 2.2 times higher than *A. lebbeck*.

3.3.4. Initiating Biodiversity Conservation through People's Participation in Indian Himalaya.

Background

Biodiversity conservation programmes are being pursued across the Himalaya by both the Government and Non-Government agencies. Presently, such initiatives are restricted to identification of surveys, inventorisation of biological resources, strengthening the net work 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.

Table 8. Growth performance of different species in Glass house. Net house and Nursery conditions (after 8 months period). (ind = individuals)

Parameters	Species			
	Semecarpus anacardium	*Heynea trijuga*	*Albizia chinensis*	*Albizia lebbek*
Shoot				
Glass house				
Diameter (cm)	1.2 ± 0.04	1.6 ± 0.11	2.0 ± 0.15	1.7 ± 0.04
Height(cm)	7.1 ± 1.21	14.4 ± 1.16	44.3 ± 2.64	20.3 ± 2.14
Leaves (no)	7.0 ± 0.55	7.0 ± 0.63	8.4 ± 1.03	5.6 ± 0.81
Biomass (gm ind^{-1})	1.8 ± 0.36	3.4 ± 0.79	4.2 ± 0.87	2.9 ± 0.26
Net house				
Diameter (cm)	1.4 ± 0.12	1.1 ± 0.10	1.6 ± 0.28	2.8 ± 0.33
Height (cm)	3.1 ± 0.78	7.4 ± 0.10	20.7 ± 6.14	50.6 ± 11.4
Leaves (no)	5.3 ± 1.67	3.0 ± 0.0	5.5 ± 0.87	10.6 ± 1.47
Biomass (gm ind^{-1})	1.1 ± 0.21	1.6 ± 0.25	11.0 ± 3.30	3.0 ± 1.10
Nursery				
Diameter (cm)	1.5 ± 0.05	2.2 ± 0.15	1.9 ± 0.15	1.6 ± 0.11
Height (cm)	5.7 ± 0.56	15.6 ± 1.44	60.7 ± 1.58	23.0 ± 3.08
Leaves (no)	3.8 ± 0.37	5.2 ± 0.20	13.4 ± 0.98	6.0 ± 0.89
Biomass (gm ind^{-1})	1.2 ± 0.11	3.8 ± 1.89	3.0 ± 1.40	1.4 ± 1.0

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. IV training workshop on "People's participation in biodiversity conservation" with desired reorientation of programme features was held at L.W.S. Girls Inter College, Bhatkot, Pithoragarh (October 24-25, 1997).
2. The most important feature of the workshop was on site training featuring six capsules on biodiversity (1) Status, (2) Assessment, (3) Valuation, (4) Conservation, (5) Soil, water and biodiversity interdependence, (6) Participation and role of target groups.
3. Information packages were developed in easy (Hindi) language and disseminated to participants.
4. Participants reactions were obtained through standardized questionnaires and analyzed (Table 9).

5. Conservation models being developed at G.I.C. Lohaghat, G.I.C. Narayan Nagar and G.H.S. Pati through the participation of students and teachers were strengthened with plantation of Himalayan native species.
6. Survival performance was monitored in all the model sites. At G.I.C. Lohaghat and G.H.S. Pati species survival was nearly 45% whereas survival percentage was >60% in G.I.C., Narayan Nagar. Attempts are being made to enrich the models through introduction of locally important taxa.

Table 9. Responses of participants during IV Workshop

Particulars	Teachers (%) (n=26)	Students (%) (n=37)
Objective		
Agreed	93.3	100.0
Achieved	61.5	81.1
Interaction/Training		
Good	53.8	81.1
Satisfactory	38.5	13.5
Needs improvement	7.6	5.4
Future Participation		
Voluntary	(53.8)	54.1
Land/resource arrangement	26.9	5.4
Technical inputs	19.2	16.2
No reply	-	24.3
Mode of Future Training		
As such	34.6	29.7
More frequent	23.1	27.0
Training needs modification	38.5	-
No reply	3.8	32.4

3.3.5. Prioritization of Conservation sites in Timberline Zone of west Himalaya.

Background

Timberline represents a transition between high temperate and low alpine zone across the Himalaya. In the west Himalaya it is a cradle of high temperate and low alpine sensitive elements of tremendous biological value. The area is also subjected to anthropogenic disturbances of various types and magnitudes, reflected at different organizational levels. In view of the rich biological diversity it supports, it is important to assess the threats to the ecotone. The data available on realized and potential value of biodiversity elements and the nature and extent of pressure on the ecotone is not adequate.

Objectives

1. To develop an update inventory on biodiversity elements of timberline zone of west Himalaya.

2. To select sites for prioritization on the basis of biodiversity and socio-economic value.

3. To prioritize strategies for conservation of selected priority sites and stretches.

4. To develop participatory methodology for prioritizing sites and strategies.

Results and Achievements

1. Twenty clusters or sites were identified throughout the timberline zone of west Himalaya on the basis of species commonalties and drainage net work.

2. In order to identify priority clusters/sites, four levels of prioritization were followed: (i) identification and ranking of priority clusters on the basis of the proportional representation of cumulative features of biodiversity attributes of clusters with respect to those of timberline area of west Himalaya; (ii) identification of unique clusters on the basis of proportional representation of attributes with respect to an identified cluster; (iii) ranking of representative and unique clusters; (iv) identification of most representative grid with maximum species, natives, endemic and rarities was identified within each prioritized cluster of multiple grids.

3. The approach of prioritization has narrowed and sharpened the focus on representative grid unit of a prioritized site (cluster) for initiating appropriate conservation action. The top ranking priority sites/clusters in West Himalaya are given (Table 10). In the Himalayan context, secondary data has been, for the first time effectively utilized for setting conservation priorities. This is the hallmark of the present study.

4. Among others, the following are the major recommendations of this project: (a) the process of prioritization should be based on both primary and secondary data in view of gaps in knowledge, (b) the studies on TLZ should not be restricted to the present study area but must be extended all across the Himalaya, (c) efforts should be made to demarcate biogeographical boundaries of TLZ of Himalaya using GIS so that functional division / subdivisions are identified.

Table 10. Ranking of top priority clusters in TLZ of West Himalaya

Cluster (Valley)	Level I	Level II	Total	Priority rank
Pindari	1	3	4	I
Ralam	3	2	5	II
Tungnath	4	4	8	III
Panchhuli	9	1	10	IV
Bhyudar	2	8	10	IV
Nanda Devi	5	6	11	V

3.3.6. Biodiversity Studies using Remote Sensing in the Indian Himalaya

Background

It has been realized that the biological diversity in the Himalaya, particularly in Kumaun and Garhwal, is facing many pressures. However the intensity and impacts of these pressures are not well known. Remote sensing and GIS could help in identifying the areas of high pressure and also the gradients of the disturbances across different land use categories. In view of this, ICIMOD, Nepal and GBPIHED India have initiated a collaborative project, which envisages to coordinate remote sensing and ground truth data for studying different aspects of Biodiversity at Macro, Regional and Micro levels.

Objectives

1. Macro level : Using coarse resolution satellite data (IRS-1C, WIFS) for field work and vegetation assessment.

2. Regional level : Mapping the land use classes, habitat types and forests types using high resolution (LISS-III and LANDSAT-TM) digital/hard copy satellite data.

3. Micro level : Detailed mapping and classifying intensive sites (e.g. forests, land use and habitats) at level lower than the regional level.

Results and Achievements

1. The Chir pine (*Pinus roxburghii*) forest in Askot Wildlife Sanctuary (AWLS) was studied intensively for their compositional/ structural diversity patterns.

2. Diversity of various compositional features across altitudinal strata and in different forest zones was analyzed. *P. roxburghii* contributes >58% relative density and >76% relative basal area.

3. The forest tree basal area (TBA) shows no significant relationship with altitude. Across altitudinal strata sapling and seedling density shows decreasing trends (low altitude : sapling 147 ha^{-1}, seedling 11555 ha^{-1}; high altitude: sapling 99 ha^{-1}, seedling 10011 ha^{-1}). Across forest zones, the regeneration potential decreases considerably from edge to core zones.

4. The density of *P. roxburghii* does not vary considerably along altitudinal range (241-263 tree ha^{-1}). However, difference was apparent in *P. roxburghii* density in different zones (237-463 trees ha^{-1}). The core zone has maximum density. The total basal area of *P. roxburghii* was highest at low altitude (18.6 m^2 ha^{-1}) and decreases towards high altitude (13.3 m^2 ha^{-1}). Across forest zones the TBA values of *P. roxburghii* does not vary considerably (15.8-16.6 m^2 ha^{-1}).

5. *P. roxburghii* contributes >29% of total seedling and sapling density in the forest. The species has higher seedling and sapling density at lower altitudes and forest edges.

6. Chir-pine forest map was prepared for AWLS using visual interpretation techniques. To delineate chir-pine from other forest types and land use classes an interpretation key was developed. The total area (Planimetric) under chir-pine forest was estimated as 127.7 km^2 (representing 21% of the total sanctuary area).

7. Considering the difference in tone/ texture and the subsequent difference in species composition the Chir-pine forest was broadly categorized into two structural types, i.e. pure pine and mixed-pine.

8. Three crown density classes were recognized: (a) 40-60% - low; (b) 60-80% - mid and (c) >80% - high density class, for further investigation of structural properties. Maximum forest was estimated under low density class (46.5% Pure pine; 49.7% mixed-pine) and minimum under high density class(17.2% Pure pine; 14.8% Mixed-pine).

9. The changes occurred during 1988-1996 in Chir pine forest were estimated (Table 11). In general, during this period chir pine forest has increased at the rate of 0.8 sq. Km year^{-1}. The maximum conversion was observed from oak forest to mix pine (7.6 km^2).

Table 11. Changes under different forest types/landuse patterns during last 8 years at and around chir pine forest in AWLS.

Category	Location	Variation in size (km^2)		Total area (km^2)
		Minimum	Maximum	
Oak to pine	26	0.025	1.83	7.6
Pine to oak	15	0.025	0.80	3.5
Pine to habitation	25	0.050	0.38	2.8
Shrubland/agriculture to Pine	6	0.050	0.15	0.6
Miscellaneous to Pine	14	0.030	0.90	3.5
Pine to miscellaneous	7	0.050	0.40	1.3
Scrub land to chir pine	21	0.030	0.30	3.0
Pine to scrub land	9	0.250	0.30	1.5
Pine to *Macaranga*	3	0.130	0.17	0.5
Macaranga to Pine	4	0.050	0.60	0.9
Total	130			25.2

3.3.7. Wild Edible Plants of Food Value, Their Nutrient Status and Regeneration in Sikkim Himalaya (1995-98)

Background

Sikkim is a hill state and has a very rich plant diversity of over 6000 plants. The state has sub-tropical to temperate and alpine type of climatic conditions in an elevation range from 300-8500 m above sea level. Low lands are utilised for double crop production but most of the high lands have monocropping system. In the Sikkim Himalaya a large number of wild plant species are used as food, medicine beverages, fish poisoning, dyes, oil, timber, firewood, fodder and various other purposes. These plants have got little attention despite their various uses. There is need to do further survey to see more species of potential uses, their growth as well as nutritional status.

Objectives

1. To examine conservation status of various wild edible species.

2. To know viability, dormancy and germination of seeds of some selected wild edible species.

3. To find out calorific values of some selected wild edible species.

4. To know the micro and macro nutrient composition of some selected wild edible species.

Results and Achievements

Inventorisations of the wild edible species are continued and till date a total of 190 species have been screened for their food value. Six most potential wild edible species (*Spondias axillaris, Eriolobus indica, Machilus edulis, Bassia butyracea, Elaeagnus latifolia* and *Baccaurea sapida*) have been selected for detailed study.

1. The fresh fruit weight was highest for *Eriolobus indica* (15.15 g) followed by *Machilus edulis* (11.02 g), *Spondias axillaris* (9.21 g), *Elaeocarpus sikkimensis* (6.75 g), *Elaeagnus latifolia* (5.80 g) and *Bassia butyracea* (5.38 g).

2. Per tree fruit productivity for *Baccaurea sapida* varied from 5 kg (tree girth 25cm cbh) to 106 kg (cbh 186 cm), *Spondias axillaris* is from 1.43 to 185 kg per tree (cbh from 90 cm to 250 cm), *Eriolobus indica* from 6.19 to 56.64 kg per tree (cbh 62 to 130 cm), *Machilus edulis* from 5.16 kg per tree in 135 cm cbh class to 57 kg per tree in 410 cm cbh, and for *Bassia butyracea*, the fruit productivity per tree ranged from 3.08 kg in 80 cm to 155 kg per tree in 165 cm cbh size. *Elaeagnus latifolia*, a liana, showed fruit production, which varied from 20-200 kg per plant from 96 to 193 cm cbh size girth class plants.

3. Phenological investigations leading to leaf fall and flushing, flower bud formation and blooming, and fruiting and maturation was done for six selected species.

4. Seed germination of *Baccaurea sapida* started after 30 days of sowing and most of the seeds completed germination after 50 days of sowing (seed viability 22-35%). For seeds of *Machilus edulis*, 100% germination was recorded after two months of sowing. In case of *Elaeagnus latifolia* about 60% seeds germinated. Seeds of *Bassia butyracea* started germination after 12 days of sowing and the germination percentage was observed to be 82%.

5. Growth parameters are being recorded on seedlings raised in the nursery after 3, 6, 9, 12, 15... months interval for different species. *Machilus edulis* recorded a high growth rate with 26.7 cm height in first 3 months, and thereafter the growth was slow.

6. Collection of large quantities of these wild edible plants from natural habitat has seriously effected their survival. Fruit collection of a number of wild tree species has checked their regeneration in natural areas.

7. Interview with the villagers revealed that they are willing to raise a number of wild edible plants, particularly trees, in their farms, viz., *Spondias axillaris, Bassia butyracea, Elaeagnus latifolia, Baccaurea sapida*, etc. A few farmers are already growing some of these species but supply of seedlings/saplings is the real problem. For most of the species, fruits are available for a short period in the market and sold at a low price. This is due to low keeping quality of these species. Such species can be available for a long duration if their keeping

quality is increased and some value addition is done to them.

3.3.8. Sikkim Biodiversity and Ecotourism.

Background

The rich natural and cultural heritage of Sikkim makes this small Himalayan state in north-eastern India an attractive destination for international and domestic tourists. With over 90,000 domestic and 6,000 international tourists in 1995, tourism is rapidly becoming an important economic activity for Sikkimese people. Ecotourism, with its focus on environmentally sound practices and generating widespread economic incentives to conserve, offers an opportunity for Sikkim to improve mountain livelihoods and protect its unique heritage. The Sikkim Biodiversity and Ecotourism Project is a collaborative initiative designed to conserve the biological diversity of key destinations.

Objectives

Increasing community and private sector biodiversity conservation initiatives include

1. Community ecotourism plans covering site-enhancement, trail and site maintenance, natural resource management and monitoring and conservation education.

2. Supporting fuelwood reduction measures by trek operators and local lodges.

3. Supporting local NGOs working in ecotourism and conservation.

Results and Achievements

1. Project activities in this year included skill development through training (viz., Porters, Lodge Operators, Trek-Cooks', Transport Sectors and farmers for micro- enterprises like off-season vegetable production and vegetable seed production), exchange programme between travel/trekking agencies of Sikkim and Nepal, community plantation and trail clean-up drives, Khangchendzonga National Park (KNP) workshop for linking park management towards conservation and ecotourism, and study tours of the government officials, private sector and community to protected areas of tourism interest such as Buxa Tiger Reserve in West Bengal and Chitwan National Park in Nepal.

2. The project has emphasized to conserve the biological diversity of key destinations through increasing economic returns from ecotourism services and enterprises, which contribute to policies that meet ecotourism and conservation goals. Out of 346 households in Yuksam and Khecheopalri sites 57% are involved in tourism, and about 50% of them are porters, 4% own lodges, 7.5% are engaged in tourism related business, 25.6% are involved in household cottage industry and 12.6% reared pack animals. In Yuksam alone more than 50% of households are directly/indirectly getting economic benefits from tourism. In 1997, a total of 1112 domestic and 888 international tourists trekked in Yuksam-Dzongri trail, and local communities received more than Rs. 34 lakhs turn-over. A local NGO called Khangchendzonga Conservation Committee has taken up various conservation activities. More than 40% of the Travel Agents Association of Sikkim members have complied to the Code of Conduct by using fuel-wood alternatives, transporting back the non-biodegradable materials, discouraging camp fires and keeping the trail and camp sites clean.

3. The Khecheopalri lake situated in the west district is a closed basin with respect to silt transport and deposition processes. Land management in the watershed, erosion rates under different land uses, peat development in the boggy area, and physico-chemical and biological parameters of lake-water are assessed. About 48 plant species were recorded in the bog area dominated by *Sphagnum*, *Acorus* and *Cyperus*. The surrounding watershed forest has about 17 tree species dominated by *Castanopsis tribuloides*, *Machilus edulis* and *Beilschimedia* sp. with a net productivity of 16 t ha^{-1} $year^{-1}$.

4. In the 26 km Yuksam-Dzongri trekking corridor influences of grazing on vegetation structure, species richness species diversity are assessed. Grazing indicator species and carrying capacity assessment are also being done at temperate, sub alpine and alpine zones. In the study area a total number of 92 species of plants have been recorded in the alpine pasture showing biological spectrum as short forbs (32.6%), tall forbs (18.5%), cushion form (15.2%), spreading form (15.2%), shrub/undershrub (13.1%) and the graminoides (5.4%). In order to see the effect of grazing open grazed areas and protected enclosures were considered for estimation of species diversity, vegetation composition, dominance, species richness, palatable/unpalatable biomass and net primary productivity.

5. Fuelwood and fodder collections are the major threats for the area leading to depletion of forest and destruction of wildlife habitat. An assessment of habitat change and its impact on birds and butterflies are monitored. The forest stands in the area are diverse but shows poor regeneration and productivity specially in human interfered area. About 160 species of birds, 45 species of butterflies and 18 species of mammals including two endangered species, namely snow leopard and red panda use this area as their habitat. A number of indicator species of birds and butterflies are found inhabiting either only in pristine condition or in human stressed area. Bird species like, Nepal parrot bill, red tailed minla, hoary barwing etc. were found to be only in pristine condition and thrushes, bushchats, greenbacked tits are the dominating species of human stressed area. Likewise, moor's bushbrown, tigers, tortoiseshell are found in stressed condition and few species like swardtails, cerulain, yellow sailors are indicated to use pristine forest condition as their habitat. So far there is no marked differences in bird and butterfly species diversity of two forest types as well as in forest conditions.

3.3.9. Standardization of Hardening System for Transfer and Establishment of Planting Material of Selected Multipurpose Trees for the Waste and Marginal Land of Central Sub-Himalayan Hills.

Background

Hardening of *in-vitro* raised plants and their subsequent performance in the field condition is the most important factor which determines the success of *in-vitro* protocol. The proposal aims to optimize the hardening process of selected MPTs (*Sapium sebiferum*, *Diploknema butyracea* and *Bauhinia vahlii*) and also standardize their performance in field conditions. Scaling up the planting material and their plantation in demonstration plots will not only full fill the gulf between demand and supply but also help the mountain people to augment their day to day requirements of fuelwood and fodder. This will also help to explore the possibilities of income generation.

Objectives

1. To monitor the survival and growth performance of *in-vitro* raised plantlets during hardening process.

2. Establishing *in-vitro* raised high yielding superior plant material in the experimental plot, arboretum.

3. To scale up production of plant material (of selected species) developed through *in-vitro* and conventional means.

4. To establish demonstration plots in identified sites through active collaboration of NGO's.

5. To monitor the performance of plant material through active participation of local community group.

6. To organize training workshop on methods of propagation and monitoring, focusing on identified target groups.

Results and Achievements

1. Improvement in the efficiency of micropropagation protocols in *Sapium* and *Bauhinia* through intervention of different cytokinin type.

2. Optimization of time lag between explant establishment and *ex-vitro* survival in both the taxa.

3. Hardening procedures in *Sapium* and *Bauhinia* is in progress.

4. Monitoring *ex-vitro* growth performance of *Sapium*.

3.3.10. Seed setting, germination and seedling growth in 'nahor' (*Mesua ferrea*)

Background

Mesua ferrea, locally known as 'nahor', is an evergreen tree. The species is extensively used for avenue plantations in north-east India. The seed contains a non-edible oil which is used in soap industry. The seeds from avenue plantations have vast potential of exploitation for commercial extraction of oil. If germination is found satisfactory seed crop from natural populations can be harvested partly.

Objectives

1. To analyze patterns of seed setting within a fruit.

2. To examine their relation with the germination percentage and seedling growth.

Results and Achievements

1. The seeds from five marked trees were collected in October, 1997 from Nirjuli, Arunachal Pradesh. The source trees are about 11 years old and constitute an avenue plantation in the NERIST campus.

2. A total of 98 fruits were collected from tree-1, 107 fruits from tree-2, 105 fruits from tree-3, 101 fruits from tree-4, and 124 from tree-5. Thus a total of 535 fruits were collected.

3. The fruit of nahor contains 4 carpels, of which one, two, three or all four may develop into seeds. Thus a wide variation is observed in seed number per fruit. The frequency distribution of fruits in seed number per fruit class was observed (Fig. 9). Nearly 50% fruits were two-seeded.

4. The weight of the seeds varies greatly. Seeds from single seeded fruits were heaviest, and the seeds from four seeded fruits were lightest (Table 12).

5. The frequency distribution of seeds in weight classes shows a near-normal distribution.

6. The seeds were sown in polybags to study the effect of seed weight on germination and seedling growth. Further monitoring is in progress.

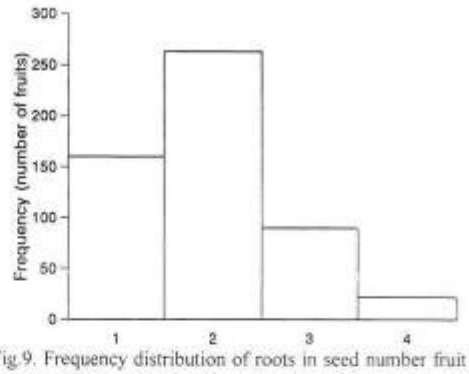

Fig.9. Frequency distribution of roots in seed number fruit classes.

Table 12. Variation in seed weight in 'nahor'.

Seed Number Fruit^{-1}	Minimum Weight (g)	Maximum Weight (g)
1	2.621	7.392
2	0.640	6.834
3	0.662	6.085
4	0.267	5.199

3.3.11. Exploration, Quantification and Use of Agricultural Diversity, and Folk Knowledge in a Remote Landscape of the Central Himalaya

Background

Conserving biodiversity of plant and animal species is essential to maintaining a productive and sustainable environment for agriculture and other human activities. There is a threshold of diversity below which most ecosystems can not function. Greater effort is also needed to conserve the genetic diversity that exists in crops worldwide. The existing diversity has proven extremely valuable in improving crop productivity through the development of high yielding, disease resistant and stress tolerant varieties.

Objectives

1. to explore the biodiversity and its management in a remotely located agricultural landscape
2. to identify species rich spots of agricultural diversity in village and their role in conservation,
3. to explore local land races of crops, their use, and to establish linkages between the use of agricultural biodiversity and functioning of village ecosystem,
4. documentation of folk and indigenous knowledge and dissemination of knowledge for wider use

Results & Achievements

1. Preliminary survey indicates that the diversity of food-grains and pulses is much greater in the mountains (Shiwalik and Lesser Himalayan belts) than in the crop fields of plains (*tarai* and *bhabar*).
2. The native traditional agricultural practices of hill farmers favour maintenance of high

crop diversity (in the form of various land races) and the use of these land races is generally associated with risk coverage.

3. The impact of remoteness was clearly visible in the number of land races still under cultivation; as the distance of a village from the motor road increased there was a greater abundance of land races.

4. The hill agriculture has proved to be a niche for rich variety of land races of paddy. The Lesser Himalayan belt harbours major proportion of recorded landraces.

5. Terrace risers act as a rich gene bank of natural vegetation. A total of 25 plant families have been recorded from the village landscape. It was greater in the lower elevation than in the mid and higher elevations. Thirteen plant families were common to all the three locations.

6. A proportional distributional of plant species in various plant families indicates that the Poaceae (an important group; most food-grains are from this family) and Asteraceae were among the dominant families in the three altitudes.

3.4. ECOLOGICAL ECONOMICS AND ENVIRONMENTAL IMPACT ANALYSIS

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 the inputs to tourism planning in the area. In the first phase, an assessment with respect to tourism accommodation was carried out at Kullu and Manali. Also the tourist flows and use of various modes of transport was documented. It was noted that Kullu Valley is facing various infrastructural constraints. Major ones being solid waste management and architectural and landuse control over hotel construction. During 1995-96, recommendations for Kullu Dussehra were finalized and submitted to District Administration. In Mohal, solid waste sampling and perception study surveys was carried out largely to access women's perception about their wastes and their willingness to participate in the process of management.

Objectives

1. To carry out survey with greater emphasis on the views of women to ascertain their perceptions on wastes and level of participation in its management at Mohal (Kullu).

2. To estimate quantity of solid wastes and its characteristics.

3. To initiate waste management activities in Manali.

Results and Achievements

1. 120 MT/annum SW is collected from Kullu municipality town and dumped in low lying river bed or close to river Beas due to inadequate land and lack of sustainable SWM options. Waste characterisation from point sources (11 municipal waste collection points and hotels) showed that readily biodegradable wastes (RBW) ranged in between ~42% (winter season=W) to 48% (monsoon season=M) in Kullu municipal town (Figure 10). 64% RBW out of total generation was identified from business

establishments such as hotels. Amongst the major compositions, food and vegetable waste is dominating in hotels. The RBW share from disposal sites occupied in between ~43% (W) to 56% (summer season=S). The major predominating components from point sources were vegetables, fruits and food showing the mixed fine organic matter ranged ~16% (M) to ~20% (S). Moreover, RBW constituents' order in non-point sources was almost similar to point sources.

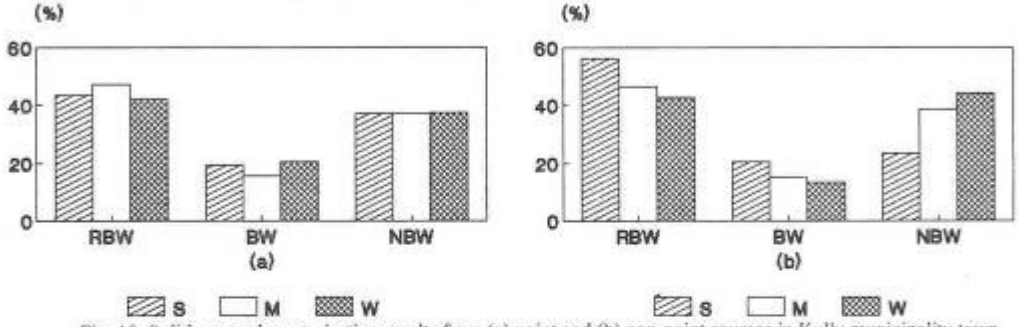

Fig. 10. Solid waste characterisation results from (a) point and (b) non-point sources in Kullu municipality town.

2. Biodegradable wastes (BW) varied from ~16% (M) to ~21% (W). Of the total BW, paper constituted in between ~11% (M) to 14% (W). Paper was followed by rags/cloths, wooden matter, hay and straw. But all were below ~4% during every three seasons. Based on average hotel waste results, paper was also found about 14% amongst other wastes. Further, paper waste was found in high quantity in star rather than in deluxe-cum-ordinary category of hotels. BW constituents from non-point sources also showed almost similar pattern. However, papers' relative share slightly decreased 6% (W) to 12% (S).

3. The non biodegradable wastes (NBW) have good potential for reuse and recycling. The NBW differed very slightly from 37% (S) to ~38% (W) from collection points. On contrary, ~15% glass in the form of drink bottles was identified from hotels followed by plastic (~4%). Non point sources depicted 23% (S) to 44% (W) where these occurrences slightly lessened at point sources. The worth mentioning NBWs from both of the sources were plastic including polythene and glass composing ~10% (M) to ~13% (W). Glass was in between 2 to ~3% during identified three seasons. From non-point sources, plastic varied from 2% (W) to 7% (M). Hospital waste characterisation results brought to light that maximum waste was non infectious (58%) whereas infectious and highly infectious was ~41.89% and 0.11%, respectively.

4. Bulk density ranged 184 to 245 kg/m^3 in W and M seasons and 205 to 226 kg/m3 in M & S seasons from point and non-point sources, respectively. Moisture in RBW cum BW wastes varied 48 (W) to 54% (S) in waste collection points and 58% in hotels; and ~52 (W) to 58% (M) in disposal sites. pH value of SW ranged 7.19 (S) to 0.86% (M) from collection points. In hotel waste, N constituted 1.15%, while at non-point sources it occurred 0.45 (S) to 0.90% (W). Phosphorus as P_2O_5 (P) nutrient was in between 0.79 (S) to 0.85% (W), 0.98% in hotel wastes and 0.45 (S) to 0.85% (W) at collection points and 0.75% in hotels. These values came down from 0.48 (S) to

0.82% (W) at non-point sources. Carbon/nitrogen ratio was found in between 17 (W) to ~32 (S) in collection points, ~45 in hotels and ~25 (W) to 37 (M) in disposal sites. Calorific value ranged 585 (S) to 1080 (W) K cal/kg as the lowest and highest at disposal sites amongst both point sources-hotels and collection points.

5. Regarding SWM options, due to high quantity of RBW and BW, organic wastes have potential for biocomposting or biogas generations. NBW has promising potential for reuse and recycling. Hospital wastes due to their more hazardous nature than that of other wastes need a separate treatment. Highly infectious hospital wastes could be treated to disinfection, grinding and landfilling; and infectious wastes by incineration. SWM options and technical know-how require integrated and participatory efforts from concerned municipality, local hotel associations, district administration and non-governmental organizations and local people.

3.4.2. Ambient Air Quality Monitoring in Kullu Valley

Background

Initially, a project on bio-geochemical cycles was conceptualized in collaboration with Indian Institute of Tropical Meteorology, Pune to study interaction in biochemical cycles in Himalayan ecosystem. As it comprises of ambient air quality monitoring, revised title is more representative of the work. The present area of study namely Kullu Valley is an important tourist destination in western Himalaya. It has experienced tremendous growth in tourism over past five years. The valley is a 100 km. long starting from Aut (south) near Pandoh dam upto Rohtang Pass (north).

Objectives

1. Assessment of background concentrations of air pollutants.

2. Atmospheric chemical transformations in the Himalayan Eco-systems.

Results and Achievements

1. Bi-monthly/monthly sampling of 8 hours duration in a day revealed that total suspended particulate matter (SPM) remained 56 and 124 $\mu g/m^3$ in November' 97 and January' 98, respectively at Mohal (lower Kullu valley; Figure 11). The SPM value, however, was found to be low at Manali (upper Kullu valley) showing 51 (August'97) and 118 (February'98). The SPM values were more governed by local weather conditions, seasonal tourists' influx, and increasing vehicular and domestic emissions during May, June and July months.

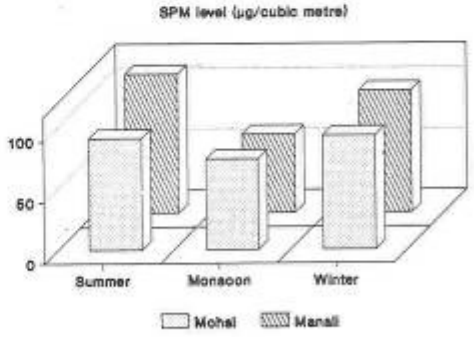

Fig. 11. SPM levels in Kullu-Manali towns.

2. Trace gases concentration of sulphur dioxide (SO_2) and nitrogen oxides (No_x) were within detection limits, i.e., 15-30 $\mu g/m^3$. SO_2 was found 6 to 9 at Mohal and 6 to 7 at Manali. No_x was measured in between 3 to 15 at Mohal and 4 to 14 at Manali. June and October months were the important months when tourists visited in large number Kullu-Manali complex.

3.4.3. An Empirical Study of Development of Tribal Communities from Eco-cultural Perspectives: A Study in the Central Himalayan Region of India

Background

Tribals constitute a very significant part of our heritage and the backward classes have been the focus of attention, particularly since independence. Though a number of development models have been suggested, a viable one interlinking ecology, economy and culture, and conductive to them is yet to evolve.

This project aims to evolve a model for development which is acceptable, through a study of two tribal communities, the Bhotiya and the Jaunsari in UP Hills. The study has so far been confined to 5 villages, predominantly inhabited by the Bhotiya tribe, in Kapkot block of Almora District in Central Himalaya. Bio-physical and eco-cultural diversities were accorded prior consideration while selecting the sample villages. The investigation is expected to identify markers of sustainability and constraints of peoples' participation in the development process.

Objectives

1. To study the integrated nature of tribal culture and its influences on resource use and management.
2. To understand the concept of development from tribals perception.
3. To study the interlinkages between ecology, economy and culture and their influence on development.
4. To identify markers responsible for sustainable development and nature of variation of these markers in different tribal communities.
5. To quantify the degree of diffusion of development interventions and their impact on social structure and community culture.

Results and Achievements

1. The ecology, economy, culture and developmental problems & prospects of two tribal communities, i.e., the Jaunsaries & the Bhotiyas, were studied covering 10 villages each and 3847 and 3266 population, respectively. In this issue, impacts of Integrated Rural Development Programme (IRDP) on the tribes are discussed. Integrated Rural Development Programme, in India, was first visualized in 1974 as a technical approach to rural development, taking the district as unit. The programme was first introduced in 1978 in 2300 pilot blocks, which was further extended to all development blocks of the entire country by Oct. 2, 1980. Since the inception of the programme in the blocks in habitted by the tribes, the yearwise physical achievement is shown in Table 13. This Table shows that, among the four sampled blocks, Kalsi recorded the highest number of families that have benefited so far, whereas the Munsiyari block of the Bhotiya region has the lowest position. A comparative look on both the regions reveals that in the Jaunsar region the number of families benefiting from the programme has increased from the year

1984-85 to 1987-88, but afterwards the figure has declined till the year 1994-95.

2. In the Bhotiya region the number of beneficiaries has increased gradually upto the year 1985-86, thereafter there have been fluctuations in terms of number of beneficiaries upto 1993-94. The regional variation in the number of beneficiaries could be a result of variations in the infrastructural facilities, geo-demographic features and a number of other factors.

3. A positive correlation between the number of beneficiaries and the availability of infrastructural facilities (i.e., road network, banks, etc.) were found. Table 14 presents the distribution of beneficiaries on the basis of communities and sex. Female participation in the programme, as found, in both the regions was higher for scheduled tribe categories than for others. Regionwise comparative data show that the total female participation is higher in the Bhotiya region than the Jaunsar region. This may be due to comparatively higher female literacy and sex ratio in the Bhotiya region.

4. A great deal of regional variation in sector-wise distribution of beneficiaries proves the appropriateness of different schemes made available under IRDP. The programmes created to the local needs have been very successful in terms of people's participation and their response to such initiatives. Comparatively greater emphasis has been given to primary sectors (agriculture) in the Jaunsar region and secondary sectors in the Bhotiya region. Most of the sampled population in the Bhotiya region are traditionally associated with trade, and due to the scarcity of agricultural land they deserve more financial assistance to establish cottage industry (particularly woolen) at household level. On the other hand, the Jaunsaris are agriculturists, and demands for assistance are much more under the primary sector. Thus, the programme really caters to their respective demands.

5. The distribution of beneficiaries of IRDP on the basis of sector and category as represented in Table 15 shows that the percentage of marginal farmers who got the benefit under primary sector was 63 and 29 for the Jaunsaris and Bhotiyas, respectively. The frequency of marginal farmers is the least in the secondary sector in the Jaunsar region as well as in the tertiary sector in the Bhotiya region.

6. Majority (77%) of rural artisans/agricultural labourers of Bhotiya villages got the benefit under the secondary sector whereas, most of them (83%) in the Jaunsar region got it under the primary sector. The tertiary sector has also recorded sufficient number of beneficiaries from different social categories in both the regions. In the same region, the percentage of beneficiaries on mule/horse was 89.9% of the tertiary sector and 29.3% of the total. In the Bhotiya region retail shops appears to be the most preferential project under the tertiary sector. These two projects under the tertiary sector indicate the higher per capita investment for the same as well as preference for subsidy oriented programmes. The rationale of different emphasis in the two regions makes sense in the light of existing socio-economic and geo-cultural perspectives.

Table 13. Yearwise Number of Beneficiaries at Block Level

Year	Jaunsar region		Bhotiya region	
	Chakrata	Kalsi	Munsyari	Dharchula
1981-82			324	219
1982-83	568		430	573
1983-84	468	1343	534	514
1984-85	322	578	702	617
1985-86	397	586	268	573
1986-87	685	694	101	402
1987-88	1015	755	247	605
1988-89	705	645	327	462
1989-90	645	638	463	488
1990-91	594	591	426	392
1991-92	521	519	312	395
1992-93	378	390	247	281
1993-94	386	427	234	365
1994-95	342	222	290	345
Total	6684	7166	5005	6231

Table 14. Social Category & Sex of the Beneficiaries

Social category	Studied Jaunsar villages			Studied Bhotiya villages		
	(M)	(F)	(P)	(M)	(F)	(P)
ST	189 (82.2)	24 (55.0)	213 (78.0)	205 (61.6)	81 (66.9)	286 (63.0)
SC	40 (17.40	19 (44.2)	59 (21.6)	96 (28.8)	35 (28.9)	131 (28.9)
Others	1 (0.4)	-	1 (0.4)	32 (9.6)	5 (4.2)	37 (8.1)
Total	230 (100)	43 (100)	273 (100)	333 (100)	121 (100)	454 (100)

Table 15. Category & Sector wise Distribution of Beneficiaries

SN.	Sector	Jaunsaris			Bhotiyas		
		MF	SF	RA/AL	MF	SF	RA/AL
1.	Primary	126 (63)	45 (51)	5 (83)	88 (29)	1 (33)	1 (2)
2.	Secondary	9 (5)	21 (24)	-	158 (51)	2 (67)	33 (77)
3.4	Tertiary	64 (32)	22 (25)	1 (18)	62 (20)	-	9 (21)
	Total	199 (100)	88 (100)	6 (100)	308 (100)	3 (100)	43 (100)

3.4.4. The Socio-economic and development problems and prospects of Raji (Van-Rawat) tribe of Central Himalaya

Background

The Rajis or (Van Rawats) are socially, educationally and economically, the most under-developed tribal community of Central Himalaya. They were recognized as a scheduled tribe in 1967 and as a primitive tribe in 1995 by Government of India.

The community is numerically small and are reported from 10 villages in total, i.e., 9 villages in Pithoragarh district and 1 village in Udham Singh Nagar district of state of Uttar Pradesh. Other than being primitive and forest dwellers, the tribe is a nomadic community. Probably, its nomadism has been the factor that prohibited a complete and true enumeration of its total population, as various studies carried out by various authors and agencies have reported difference in population for the tribe for a single period. Hardly little is know about the demographic behaviour, socio-economic and developmental issues of this tribe. Also, knowledge in quantified terms about the changes that must have occurred under developmental and technological interventions is totally lacking. With this background, a study has been undertaken to have some explanations and answers to the above issues.

Objectives

1. To have a true census of the total population and to understand the demographic behaviour of the tribe,
2. To find out socio-economic realities, and
3. To quantify the level of changes/impacts that have occurred under developmental and technological interventions.

Results and Achievements

1. The Rajis, a primitive tribe, numbering 531 are distributed in 10 settlements in the district Pithoragarh and 1 settlement in the district Udham Singh Nagar. Over 97 per cent of the total population reside in four sub-divisions (Tehsils), viz., Dharchula, Didihat, Kanalichina and Champawat of district Pithoragarh, which is strategically a very important district of India bordering Tibet and Nepal. The Rajis are the oldest race of Didihat and are described as Van Rawat (king of forest), Van Raji (royal people of forest) or Van Manush (wild man or man of forest) who claim themselves to be Rajputs and the original inhabitants of Central Himalaya, though anthropologically they belong to Tibeto-Burman family. They believe themselves to be the descendants of Kirata who ruled over these areas in prehistoric time. The Rajis are also considered as a living link between Kiratas of somewhat Tibetan physique and the Khasas of equally pronounced Aryan form and habits.

2. The Rajis were complete nomads about three to four decades back, lived under temporary huts or in caves and frequently moved from place to place amidst the forests of the border district Pithoragarh. About 25 per cent of population are still persuing nomadism. A part of its population resides in Nepal and there is a strong social and affilial relations between Rajis of India and Rajis of Nepal. The occupation and material culture of the tribe are changing under acculteration. From hunter-gatherers, they have moved to

agriculture but are highly dependent on forests and wage labour.

3. Few decades back, they used to avoid going to habitations of other communities, hide away in forests from people of the Kumaon and the only relationship it had with the other people was through barter of wooden implements and utensils. The Rajis were famous for the unique practice of invisible trading and were known as the traders of the night. During nights they disguised themselves under barks and skins of animals and go to nearby settlements of other communities carrying wooden implements and utensils, bamboo baskets and other forest produces. They used to keep these materials at the gate of the house or at door steps and disappear. These articles were collected and replaced by foodgrains, salt, sugar and other essential material by the household, which were collected by the Rajis in the next night again.

4. Also, like the African primitives, the Rajis usually kept the forest produces as well as wooden utensils at selected places and hide themselves at a distance in the forests or behind the bushes. The local traders or people, acquainted with this practice, would visit the place and replace these products with articles of this peoples' need, i.e., cloth, foodgrains, etc., which the Rajis collected afterwards. This trade of this nomadic people was completely based on mutual belief and trust. With the introduction of stringent forest laws restricting and often prohibiting use of forest wealth, the Rajis were compelled to change their economic pursuits and occupation. Through welfare schemes of both the state and union government of India, they have been allotted land for agriculture in addition to many other benefits. This has resulted in changing lifestyle and the community is gradually adopting to sedentary agriculture. About 52.35 per cent of the populace constituted the main workforce at the time of survey. Out of it, 44.60 per cent were agriculturists. But what was interesting to note that nearly 50.46 per cent of their total income was from wage labour, 27.78 per cent was from forests and only 12.55 per cent was from agriculture in contrast to the largest workforce in agriculture.

5. The effective literacy (population above age of 7) rate was 35.06, being 50.68 for males and 16.66 for females in 1997 (Table 16). The crude literacy (entire population) rate was 26.74 recording 38.01 and 12.97 for males and females, respectively. This achievement was enormous for a tribe which was complete nomad about 3-4 decades back and hardly had any knowledge of education. More than 85 per cent of the total literates were below the age 25 while all the female literates were below this age, i.e., 25 years.

6. The Rajis are multilingual. They speak a language, which belongs to the Himalayan group of the Tibeto-Burman family of languages. They also speak the Indo-Aryan language, Kumaoni, with others. Very few among them speak also Hindi.

7. The tribe is divided into a number of exogamous patrilineages like Pal, Chand, Byom, Sah, Bisht, Kunwar, etc. The tribe is monogamous and the modes of acquiring mates are elopement, intrusion, exchange and negotiations. Widow remarriage is prohibited while levirate, sororate and cross cousin marriages are practiced. Bride price is more prevalent than dowry. The rule of inheritance is male equigeniture.

8. Oldest male member of the family is the head of the household. The life cycle rituals of the community were extremely simple in the past, which are gradually becoming elaborate and complex under acculturation. The tribe

is becoming more Hinduised acculturating more cultural traits of the Caste Hindus, particularly of neighbouring Rajputs of the Kumaon. The tribe has its deities like Chuchurmal, Malayanath, Gananath, Kholiya, Khudai and Malkan Jan. However, they worship Hindu deities like Mahadev, Parvati, Ganga, etc., as well as spirits like Masan & Bhutas, goblins and defied persons, in addition to all aspects of nature. They celebrate the Hindu festival Nandadevi and also perform Jagara (spirit possession seance). Formerly they use to bury their dead, but at present they have taken to cremation.

9. From 1969 to 1981 the annual growth rate for the tribe was 3.88 which has declined to 3.31 during 1981-1991 and very disturbingly this has sharply declined to 1.24 from 1991-1996. Average number of pregnancies for an ever married female (EMF) was 4.28 and the number of children born for an EMF was 3.88. The general fertility rate (GFR) of the tribe was about 198 against India's 145.2 and the total fertility rate (TFR) was 6.6 against India's 4.0. The general fertility rate (GMFR) was as high as 226. The total fertility rate (TFR) was 6.595 against India's 4.0 and the total marital fertility rate (TMFR) was 7.52. The age specific fertility rate (ASFR) and the age specific marital fertility rate (ASMFR) were 1.319 & 1.504, respectively (Table 17).

Table 16. Literates in various Age-groups by Gender in the Raji Tribe

No.	Age-Groups	Percentage of literates in various age-groups by gender		
		Males	Females	Total
1.	0-6	2.70	3.22	2.82
2.	7-10	20.72	22.58	21.13
3.	11-15	23.42	41.93	27.47
4.	16-20	15.30	22.58	16.90
5.	21-25	18.02	9.68	16.20
6.	26-30	9.92	-	7.75
7.	31-35	5.40	-	4.23
8.	36-40	1.81	-	1.40
9.	41-45	0.90	-	0.70
10.	46+	1.81	-	1.40
	All Age-Groups	50.68	16.66	35.06

Table 17. Fertility among the Rajis

Age-groups	Children born in 1996	Total women in the age group (15-49)	Total married women of child bearing age	ASFR	ASMFR
15-19	4	27	14	0.140	0.285
20-24	6	23	20	0.260	0.300
25-29	8	21	21	0.380	0.380
30-34	3	15	15	0.200	0.200
35-39	3	16	16	0.187	0.187
40-44	1	10	10	0.100	0.100
45-49	1	19	19	0.052	0.052
All age	26	131	115	1.319	1.504

3.4.5. Preliminary study on Landslide disaster of June 1997 in the Gangtok area of Sikkim

Please see section on quick appraisal studies

3.5. ENVIRONMENTAL PHYSIOLOGY & BIOTECHNOLOGY

3.5.1. Rhizosphere Microbiology of Himalayan plants

Background

Plant growth promoting rhizobacteria improve plant growth by colonizing the root/ system. The beneficial effects on plant growth due to inoculation of these bacteria have been reported through various mechanisms viz. (1) biological nitrogen fixation (2) production of antibiotics and siderophores (3) secretion of growth promoting substances including phytohormones and (4) solubilization of rock phosphates. The bacteria and blue green algae are capable of xing nitrogen from the atmosphere and are therefore applied as source of fixed nitrogen. The mycorrhizae can solubilize the rock phosphate and thus make available to the plants usable phosphorus. Most studies on the rhizosphere, have been carried out on short duration plant species. The microbial community in an established tree rhizosphere should be more specific owing to the prolonged length of time occupied by the plant species, and due to the interaction amongst various microbial communities. Therefore, identification of existing microbial communities in soil, studying plant-microbe and microbe-microbe interactions, and isolation and selection of beneficial microbes would be highly relevant. The selected bneficial isolates can be developed as inoculants for better plant performance at higher elevations.

Objectives

1. Isolation and selection of plant growth promoting rhizobacteria.
2. Studies on rhizoflora associated with conifers.
3. Selection of phosphate solubilizing microorganisms and mycorrhizae in conifers.

4. Microbial interactions in tea rhizosphere.

5. Maintenance of useful microbial cultures of the Himalayan region.

Results and Achievements

1. Extensive studies are being carried out on isolation, characterisation and selection of beneficial microorganisms. Three groups of microorganisms, viz., bacteria, actinomycetes and fungi have been taken under consideration for characterising the properties like production of antimicrobial substances, nitrogenase activity, P-solubilising ability and their survival at various growth conditions. Various species of *Bacillus*, *Pseudomonas*, *Trichoderma*, *Aspergillus* and *Penicillum* have been characterised and are being developed as inoculants for improved plant growth.

2. Studies in relation to the rhizosphere microbial communities of three coniferous trees, namely *Pinus*, *Cedrus* and *Taxus* are in progress. Detailed studies have been carried out in case of P-solubilising fungi, isolated from *Cedrus* rhizosphere. *Penicillium pinophillum* was found to have strong P-solubilising activity at 10°C. Modifications in rhizosphere communities for better seed germination of *Taxus* has repeatedly given encouraging results. Pure cultures of mycorrhizae, *Trichoderma* and various rhizobacteria, isolated from soils of different high altitude locations are being used as inoculants in *Cedrus*. *Trichoderma* and bacterial inoculation resulted in control of *Fusarium* wilt. Data is recorded on the establishment of the microorganisms in rhizosphere after inoculation and growth promotion.

3. A number of bacteria, isolated from tea soils, are being developed for inoculation of tissue culture, seed and cutting raised tea plants. A large number of bacteria were initially screened for their antagonistic properties. Four of these isolates have been found to have the potential to be developed as promising inoculants. Two of the bacteria have repeatedly given 90 to 100% survival in case of tissue culture plants. These bacteria are taxonomically identified and are now being tried in various formulations. The bacteria are also found useful in seed raised plants in terms of better survival as well as growth promotion; these bacteria have been introduced in field (Haigad watershed) where fresh tea plantations through cuttings is being carried out.

4. All the isolated microorganisms (bacteria, actinomycetes and fungi) are being maintained using appropriate methods in our collection.

3.5.2. Large Scale Propagation of location specific elite plants using conventional and Biotechnological methods

Background

There has always been a need to undertake studies for development of methods for large scale propagation of location specific elite plants. One of the major constraints in undertaking large scale plantation work with regard to rehabilitation of degraded/waste land, afforestation programmes and introduction of high value plants is the lack of sufficient quantities of good quality planting material.

In view of the above, a study has been initiated to address the above question. For this, conventional methods of seed germination

(and overcoming the problems of poor viability, dormancy, etc.), vegetative/clonal propagation are equally important, and 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 applications.

2. Developing *in vitro* protocols for selected tree species.

3. Conservation of endangered/threatened species.

4. To understand the problem of seed germination in selected forest species.

Results and Achievements

1. *In vitro* protocol for mass scale propagation has been developed for *Thamnocalamus spathiflorus* (common names - Dev-ringal, Ringal, Tham), an evergreen temperate bamboo. By using germinating excised embryos, multiple shoot formation was optimized on MS medium supplemented with 5.0 uM BAP and 1.0 uM IBA. About 90% explants proliferated in this medium producing an average of about 30 shoots per explant in 8 weeks. Following 14 days culture on a medium containing 150 uM IBA, clumps of 3-4 microshoots could be subsequently rooted on plant growth regulator free medium. Almost 100% rooting was recorded with an average of 4-5 roots per plant. These well rooted plants have been successfully transferred to pots containing soil and are being hardened under net house conditions (50% shade).

2. Attempts are in progress to standardize micropropagation protocols for *Aconitum balfourii*, *A. heterophyllum* and *Taxus baccata* subsp. *wallichiana*. Multiple shoot formation was achieved in *A. balfourii* in MS medium supplemented with BAP; these shoots were subsequently rooted and transferred to pots. Efforts are continuing to obtain differentiation in callus cultures (obtained earlier) of *T. baccata* and *A. heterophyllum* by using various hormonal combinations.

3. The standardized vegetative (clonal) propagation of *T. baccata* subsp. *wallichiana* using 1st year's young shoots is being used for multiplying plants for experimental purposes. Use of *Agrobacterium rhizogenes* to induce root formation in stem cuttings of tea, poplar and *Grewia* is continuing.

3.5.3 Impact of Environmental Changes on Growth Performance of Plants

Background

Rapid depletion of tree resource, a major concern of today, has resulted in acute shortage of fodder, timber and other by products (oil, tannins, medicine etc.) directly affecting the Himalayan environment and its people. In order to ameliorate this problem, plantation of selected multipurpose trees remains a viable alternative. The project envisages the importance of initiating plantations of economically viable selected tree species of the region by developing simple nursery and invitro packages, which will be eventually made available to the local populace. This can serve the dual purpose of meeting the optimum demands for renewable energy resources and also to uplift the economic status of the local inhabitants.

Objectives

1. Identification and quantification of the resource availability.
2. Initiating in-vitro techniques and establishment of cultures.
3. Monitoring biological and edaphic adaptation of the seedlings raised through tissue culture.
4. Developing propagation packages both for nursery and in-vitro methods.

Results and Achievements

1. Standardization of techniques for determining carbon metabolic enzymes namely ribulose 1, 5-bisphosphate carboxylase (RUBP carboxylase) and phosphoenolpyruvate carboxylase (PEP carboxylase) using ^{14}C compounds.
2. Considerable differences in RUBP carboxylase and PEP carboxylase activities in leaf tissues of plants from different climatic zones, viz., tropical (*Boehmeria rugulosa, Celtis australis, Grewia optiva* and *Rumex dentus*), temperate (*Alnus nepalensis, Betula utilis and Quercus* spp.) and alpine (*Aconitum balfourii, Angelica glauca, Geum elatum, Nardostachys jatamansi, Picrorrhiza kurrooa, Podophyllum hexandrum, Potentilla* spp., *Rheum emodi* and *Rumex dentatus*) were recorded.
3. Quantification of protein and pigment contents in the above mentioned plants was also carried out.
4. Analysis of plant tissues was carried out to determine the mineral elements nitrogen, phosphorus and carbon (Table 18).
5. Data obtained on the photosynthetic response of plants to rising CO_2 concentration at varying temperature and light levels (using Compact Mini Cuvette system) were analysed.
6. Daily measurement of atmospheric CO_2 concentration showed a marked variation in atmospheric CO_2 level on monthly basis.

Table 18. Chlorophyll a, b, and a/b ratio, protein, nitrogen, phosphorus and carbon content in leaf tissues from tropical (*Boehmeria rugulosa*), temperate (*Betula utilis*) and alpine (*Podophyllum hexandrum*) plants.

	Plant Species		
	B.rugulosa	*B. utilis*	*P. hexandrum*
Chl. a (mg/g fr.wt)	1.00	1.61	1.72
Chl. b (mg/g fr.wt)	0.28	0.48	0.51
Chl. a/b ratio	3.65	3.35	3.37
Protein (mg/g fr.wt.)	94.36	89.94	67.25
N_2 (%)	2.51	1.94	1.58
Phosphorus (%)	0.21	0.22	0.16
Carbon (%)	45.00	44.64	44.37

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

Background

Due to dramatic differences in elevation (within a map distance of 100-200 km), climate, physiography and soil, the Himalaya harbours, perhaps, the premier vegetational gradient on the earth and is considered world's largest plant diversity centre. This plant diversity is critical to the survival of the human being and exists at the level of an individual, population, community and ecosystem. Increased biotic pressure (mainly in terms of logging, crown removal and root harvesting) has caused either threatening of the survival/existence or extinction of various plant species. 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, there is an urgent need to undertake studies on performance, ecology, canopy loss and interactions of various plant species in the Himalayan region.

Objectives

1. To study the role of rural biotechnology for sustainable use of various plant species.
2. To determine physiological processes and their effect on productivity at community level.
3. To study plant soil interactions and role of fire in ecosystem processes.
4. Recruitment and plant behaviour in nature and/or modified environment.
5. To explore the relationship between forests and agricultural productivity.

Results & Achievements

Amongst various high value medicinal plants of the Himalayan region, *Taxus baccata* L. subsp. *wallichiana* (Zucc.) Pilger (the only *Taxus* species in India) has gained considerable importance due to its uncontrolled harvesting from the Himalayan wilds for the extraction of anticancer drug taxol ® (paclitaxel). Therefore, a study has been carried out to determine the stand and canopy structure, microsite characteristics, extent of canopy removal, and regeneration in anthropogenically disturbed and undisturbed plots.

1. *Taxus baccata* in Jageshwar area grows under *Cedrus deodara* trees, forming small groups of 5-10 trees (generally along main water channels) largely on north-west and north-east aspects between 1770 and 1920 m altitude. The other associates of the species are *Neolitsea pallens, Lyonia ovalifolia, Rhododendron arboreum, Aesculus indica, Quercus leucotrichophora* and *Q. floribunda.*
2. In eight plots selected for the study of different parameters, stock density ranged from 31 to 143 trees/ha with basal area in the range of 0.69 to 4.67 m^2/ha.
3. Regeneration of the species was satisfactory in undisturbed plots as compared to disturbed plots.
4. The mean leaf area index (LAI) across all circumference at breast height (CBH) was 2.0. The girth was positively related ($P<0.01$) to LAI ($y= 1.35 + 0.0095 x$; $r^2 = 0.487$) and volume ($y = 55.655 + 2.9205 x$; $r^2 = 0.882$).

5. Mean canopy removal computed from the canopy profile co-ordinates using a Plant Canopy Analyzer and C-2000 programme (Licor , USA) was approximately 57%.

3.5.5. Network Programme for Mass propagation and Improvement of Tree Species of the Himalayan Region

Background

Based on the recommendations of a Brain Storming Session held in the Department of Biotechnology in December, 1992 a network programme for improvement and mass propagation of Himalayan tree species has been initiated, using a multidisciplinary approach. It is envisaged that core facilities will be developed making use of both conventional and biotechnological approaches.

Objectives

1. To develop practicable methods for mass propagation of selected tree species, using tissue culture and conventional methods.

2. Large scale propagation of selected plants for which tissue culture protocols have been developed.

3. Studies in tree seed biology in relation to seed maturation, viability/storage, seed germination and seedling establishment.

4. To impart training to interested persons from the Himalayan region.

Results and Achievements

1. High frequency and reproducible somatic embryogenesis achieved in tea and *Quercus*.

2. Complete protocol has been developed for *in vitro* propagation of mature and elite plants of 'maggar' bamboo (*Dendrocalamus hamiltonii*).

3. Encapsulation of somatic embryos into 'synthetic seeds' has been standardized for tea and 'maggar' bambpo; conditions being optimised for improving germination.

4. *In vitro* raised plants of tea, 'maggar' bamboo and oak have been transferred to field conditions with satisfactory survival.

5. Multiple shoots induced from cotyledonary leaves, hypocotyl and apical portions of mature embryos of *Pinus gerardiana*.

6. Bacterial isolates obtained from various types of soils have been used for improvement of seed germination, rooting and establishment of seedling/tissue culture raised plants. Microbial inoculation of *Cedrus deodara* seeds resulted in enhanced germination and better survival of seedlings.

7. Four bacterial isolates (two from tea rhizosphere and two from other soils), characterised for antagonistic properties, were selected for inoculation of tissue culture raised tea plants. Survival rate of nearly 100% has been recorded with two of the bacteria against 40-50% in control plants.

3.5.6. Seedling Development and Subsequent Growth in Relation to Cotydedonary Senescence in Two Alpine Rosettes

Background

Two herbaceous dicots, namely *Podophyllum hexandrum* Royle

(Podophyllaceae) and *Aconitum heterophyllum* Wall (Ranunculaceae) which grows in the Himalayan alpine and sub-alpines, are of tremendous medicinal and export value, and are presently endangered. Although these plants perennate through underground parts (containing active principles of medicinal value), the period of active growth is confined only to a few summer months. In view of the medicinal importance and commercial relevance of these plants, it would be appropriate to estimate the endogenous plant growth substances in seeds, cotyledons and to experimentally influence seed germination and stimulate seedling growth.

Objectives

1. To initiate growth of plumule in the 1st year itself by chemical means in order to hasten the growing cycle.

2. Comparisons to be made with another species of *Aconitum*, namely *A. balfourii* where inhibitory influence of the cotyledon is not present.

3. To influence seed germination by chemical means.

Results and Achievements

1. In order to examine the seed viability over a period of one year storage (0, 6, 12 months) at 4°C, the staining pattern in *Aconitum balfourii* and *A. heterophyllum* seeds were recorded; the results indicated that all parts of the seed took stain in about 73-77% of the seeds reflecting that majority of the seeds remain viable immediately following collection. The values were found to decrease with the duration of storage over a period of 12 months. In general, seed viability and staining pattern were quite similar in both these species.

2. The rate of seed germination in *A. balfourii* and *A. heterophyllum* was greatly enhanced by certain plant growth substances. GA_3 (250 uM) significantly enhanced 42.5% compared to 27.5% in control) germination in *A. balfourii* within 15 weeks while it did not have any effect in *A. heterophyllum*. On the other hand BAP (250 uM) enhanced germination (42.5% compared to 25.0% in control) in *A. heterophyllum* while there was no effect in *A. balfourii*. Thiourea and KNO_3 treatments were found to advance the time as well as the rate of germination in both the species. Treatment with 65 mM thiourea resulted in a germination rate as high as 75% (compared to 27.5% in control) in the 15th week in *A. balfourii* but such a treatment was ineffective in *A. heterophyllum*. Similarly treatment with 50 mM KNO_3 significantly enhanced germination (62.5% compared to 27.5% in control) within 15 weeks in *A. balfourii* only.

3. Seeds and cotyledons of *Podophyllum hexandrum* are being analysed for determining plant growth substance levels. Bioassay results indicate some activity; results of further analysis are awaited.

3.5.7. Biochemical aspects of Ammonium Assimilation in Mountain Plants

Background

Today major concern in the area of plant biochemistry, biotechnology and crop improvement is to understand the mechanisms that control the expression and developmental pattern of enzyme proteins involved in nitrogen metabolism and how they regulate the distribution of carbon and nitrogen in different plant parts. A clear understanding of these two

major pathways is necessary for the future plant biotechnology and crop improvement.

Objectives

1. To understand the biochemical and molecular mechanisms involved in the regulation of gene expression and enzyme synthesis associated with ammonium assimilation in plants.

2. To study the effect of various environmental stress conditions on the activity/synthesis of GS,GOGAT and GDH at protein and mRNA level.

(Summary of completed project)

In vitro protein synthesis using ^{35}S labelled L-methionine and immunodetection of glutamate dehydrogenase using GDH-antibodies were studied in soybean and *Selinum vaginatum*, an alpine perennial herb grown at three altitudes (550, 2100 and 3600 m). In addition, *in vitro* effect of various inhibitors such as cycloheximide, chloroamphenicol, streptomycin, methionine sulphoximine and azaserine were studied on soluble protein, ammonia accumulation and some important enzymes of nitrogen metabolism in suspension cultures of both the species. It was observed that ^{35}S incorporation increased in both the species as altitude increases but the increase is species specific. Although immunodetection of GDH in both the species confirmed our earlier findings of increasing enzyme activity with increasing altitude, quantitative changes in the enzyme has been observed. In both the species, many of the inhibitors produced contrasting trends in most of the parameters studied. The overall results indicate that some of the ammonia assimilatory properties in both the species are not similar.

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

Background

Mixture 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 N_2-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 will be tested in large cardamom (*Amomum subulatum*) 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.

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- cardamom plantations, and to correlate with phosphorus availability.

Results and Achievements

1. N_2-fixing Alnus accelerated nitrogen and phosphorus cycling in large cardamom based agroforestry. Acceleration of nitrogen cycling has resulted from nitrogen accretion through biological fixation. Mechanisms of malleability of phosphorus cycling were not clear and, therefore, investigated. Solubilization of secondarily fixed phosphorus in the soil was influenced by N_2-fixing Alnus in the rhizosphere.

2. In the Alnus-cardamom agroforestry, phosphorus pools in soil [viz., available-P, labile-P, stable organic-P (soil organic matter-P and microbial-P), and fractionated phosphorus as Ca-P, Fe-P and occluded Fe-P] were quantified in rhizosphere and bulk soils in young-, medium- and old-Alnus, cardamom-Alnus, and non-N_2-fixing mixed tree species.

3. Organic carbon was recorded maximum in non-N_2-fixing tree rhizosphere and minimum in the bulk soil. Available-P was highest in mixed tree rhizosphere followed by the bulk soil. Its concentration was relatively lower in different aged Alnus and cardamom rhizosphere but with higher microbial-P values (Fig 12). Low available-P in Alnus rhizosphere suggests higher rate of uptake that corroborates with faster cycling. The highest microbial biomass-P was recorded in the rhizosphere of youngest Alnus trees. Oxalates in rhizosphere soil of Alnus and Alnus-cardamom mixed situation are higher showing the exudation of oxalic acid and then solubilizing phosphorus by chelating with calcium and iron.

4. It has been realized that rhizospheric processes of both Alnus and cardamom solubilize unavailable inorganic-P and organic-P pools to available-P pool. Estimation of low molecular acids such as oxalic acid from Alnus rhizosphere indicated its chelating role and release of phosphorus from unavailable pool. The pH control on P-solubilization is also investigated. This has increased soil fertility in terms of phosphorus, and partly explain the acceleration in its cycling in the presence of N_2-fixing Alnus.

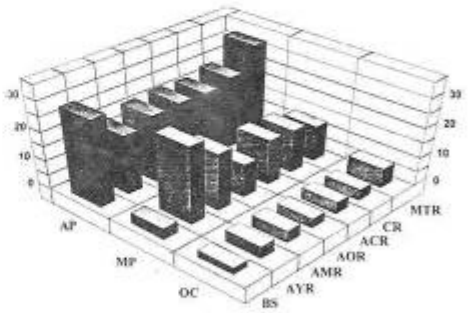

Fig. 12. Available-P (ug/100g soil), microbial-P (ug/100g soil) and organic-C(%soil) in the rhizosphere of *Alnus*-cardamom agroforestry in Sikkim. [AP=available-P; MP=microbial-P; OC=Organic carbon; BS=Bulk Soil; AYR=Young *Alnus* rhizosphere; AMR=medium *Alnus* rhizosphere; AOR=old *Alnus* rhizosphere; ACR=*Alnus*-cardamom mixed rhizosphere; CR=cardamom rhizosphere; and MTR=Mixed tree rhizosphere.

3.5.9. Asian Biotechnology and Biodiversity Subprogramme ; FARM project : A case study of Haigad Watershed.

Background

The Asian Biotechnology and Biodiversity subprogramme is one of the seven sub programmes of the FARM (Farmer Centered Agricultural Resource Management) programme initiated by UNDP?FAO?UNIDO. FAO is the executing agency and the Department of Biotechnology, Govt. of India is the main implementing agency, with the overall responsibility for Regional Co-ordination and Monitoring. The sub-programme specifically aims at providing information on new biotechnologies and assessing these to determine their potential to contribute to natural resource management.

Objectives

1. To establish an Asian Bioinformatics Network involving eight countries to enable exchange of information on biotechnology amongst member countries.

2. To undertake technology assessment on the potential of new biotechnologies to contribute to IPM, agroforestry and rainfed farming system.

Based on the topography, soil fertility status, crop production, demands of the local people, various alternate practices have been identified and efforts were made to implement these practices through the ABB sub-programme of FARM activity in the Indian mountain site (Haigad Watershed). The demonstrated technologies were simple, cheap and replicable. Out of the earlier identified and demonstrated practices, bio-composting, protected cultivation under polypits and polyhouses, development of agro-forestry and dry land horticulture and germplasm characterization and conservation have been replicated with active participation of local inhabitants in the Khulgad watershed of district Almora.

Results and Achievements

1. Two sets of bio-composting trails were demonstrated in the watershed. The ingredients in the first demonstration trial were (i) soaked waste paper, (ii) cattle dung, (iii) chopped farmyard weeds, and (iv) sieved soil. In the second demonstration, farmyard weeds were replaced by dried leaf litter of chir-pine (*Pinus roxburghii*), as it is the most prevalent material used as cattle bedding and in the traditional FYM. Now, bio-composting is being adopted by a good number of farmers (seven in village Jyoli and three each from each villages Dilkot, Kujrari and Kharkune) in the watershed.

2. A total of two polyhouses and two polypits were made and demonstrated on farmers' field at village Jyoli using locally available material (bamboo), except for polythene which was obtained from outside and provided to them. Additional farmers were trained for these simple technologies and polythene sheets were provided to them for making use of protected cultivation on their own lands.

3. A large number of saplings (grafted on suitable root stock) of different fruit trees (apricot, peach, pear, plum, peanut, almond, walnut, etc.), lifted from Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H.P.), have been planted on the terrace

risers of less productive rainfed agricultural fields, surrounding cultivable waste land and near the farm house of the villagers under a suitable agroforestry system.

4. Documentation of the existing germplasm of village Jyoli has been completed and a total of 98 plant species have been recorded.

5. A training programme entitled "Farmers' field school-cum-training programme" was organised in the village Jyoli on May 18-19, 1998. A total of 10 farmers from four village (Jyoli, Kujrari, Dilkot and Kharkuna) were selected on the basis of their economic status/work performance and their participation during the implementation of FARM activities. In addition, school teachers, children, village pradhans, other farmers of the surrounding village, etc., also participated and were given practical inputs. The following technologies were discussed and demonstrated and their value explained. a) Bio-composting technology, b) protected cultivation-polypit and polyhouse technology, c) development of agroforestry, d) water harvesting technology, e) cash crop production (mainly large cardamom), f) development of silvi-pastoral system, g) multi-purpose tree plantations, h) site improvement/green manuring, i) multiplication technology for bamboo, j) nursery technology, k) soil conservation measures and bio-fencing. In addition, practical training and demonstrations are being regularly given to farmers on their farms. Informal discussion are also held with the villagers from time to time, in groups or individually.

3.6. INSTITUTIONAL NETWORKING AND HUMAN INVESTMENT

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

Based on the recommendations of the Project Evaluation Committees (PECs), following nine projects (two to Universities, four to NGOs and three to Govt. Institutions/ Autonomous Organizations/Army regiments) were sanctioned and funded during the year.

1. *Parvatiya kshetra mein krishi vaniki ke liye paudh bank ka vikas evam prasar*. (Mr. A. Swami, Jai Bharat Sewa Samiti, Srinagar, Pauri Garhwal, U.P.).

2. Resource identification and technology transfer for water harvesting in Nayar watershed area of Garhwal Himalaya. (Dr. A.K.Agrawal, SEED, Kotdwara, Pauri Garhwal, U.P.).

3. *Garhwal kshetra ke sthai vikas hetu nakadi faslon evam chare ka utpadan*. (Mr. U. Sati, Shri Badri-kedar Srijnatmak Samiti (SBKSS), Nagnath Pokhari, Chamoli Garhwal, U.P.).

4. Scientific screening of under-exploited food plants used by Adi, Apatani and Nishing tribes of Arunachal Pradesh. (Dr. Y.P. Kohli, Department of Chemistry, Jawaharlal Nehru College, Hill Top, Pasighat, Arunachal Pradesh).

5. A detailed study on mass wasting and related processes: As a step towards reducing environmental hazards in parts of Kumaon and Garhwal Himalaya. (Mr. D.S. Tolia, Geotechnological Engineering Division, Central Road Research Institute, New Delhi).

6. GIS application in forest resource management. (Dr. S. Mahajan, GIS Cum Computer and Instrumentation Centre, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P.).

7. Establishment of *Rakshavan* at Mana in Badrinath Dham. (Col. Rajendra Singh, Garhwal Scouts, Joshimath, Chamoli Garhwal, U.P.).

8. Sustained utilization of Garhwal Himalayan rivulets for electricity generation by modifying Gharats. (Dr. B.S. Semwal, Department of Physics/USIC, HNB Garhwal University, Srinagar, Pauri Garhwal, U.P.).

9. Studies on mycorrhizal biotechnology of high altitude Himalayan conifer - *Taxus baccata*. (Dr. T.N. Lakhanpal, Himalayan Research Group C/O Mycology and Pathology Lab., Department of Biosciences, H.P. University, Shimla, H.P.).

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

1. Twelve (12) fresh project proposals, which were received for funding during the year, were screened carefully and subsequently processed/referred for preliminary evaluation to the subject experts. All these projects were also evaluated by the experts.

2. For the finalization of 28 pending revised/fresh project proposals during the year, VIII meeting of the PEC was organized at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P. on January 20, 1998. Six members including the Chairman and one special invitee attended the meeting. Follow-up action on the decisions of the VII/VIII PEC meeting was completed/initiated during the year.

3. Funds for forty seven (47) ongoing and other projects were released during the year after careful examination of the Utilization Certificates and Statement of Expenditures/project documents submitted by the respective PIs.

4. Annual Progress Report (APR) of twenty (20) on-going projects, submitted by the PIs during the year, were processed for evaluation and referred to the subject experts. Subsequently, the comments of the subject experts were communicated to the PIs for follow-up action.

5. On-spot evaluation of five (05) field-oriented on-going projects was initiated during the year by duly constituted Committee of the subject experts. The observations of the subject experts were communicated to the respective PIs for follow-up action.

6. Final Technical Report (FTR) of twenty (20) projects was received during the year. These were mailed to the concerned Deptts./Institutions/State Govt. etc. for follow-up action/ utilization of research findings. The FTRs were also referred to the subject experts for their comments.

7. Executive summaries of fourteen (14) completed projects were submitted to the SIC, ENVIS, GBPIHED for publication in ENVIS Bulletin of the Institute.

8. The executive summaries of six (06) completed projects were published during the year in the ENVIS Bulletin of the Institute and the bulletin was distributed to

the concerned user agencies etc.

9. Follow-up action on eight (8) concluded project files was completed in all respects during the year whereas in twelve (12) completed project files it was initiated during the year. Follow-up actions on other 71 project files (fresh/revised/on-going etc.) were also initiated during the year. In all, follow-up action in 91 project files was initiated/completed during the year.

3.6.2. Environmental Awareness Programmes

Environmental awareness on the aspects of nursery development, tree plantation techniques and natural resource conservation and management was created during the year among the people by organizing plantation ceremonies/on-site training programmes/ plant distribution ceremonies as well as by attending various meetings with the people/organizations etc. In all, environmental awareness was created among more than 370 persons during the year by the scientists of the INHI Core of the Institute.

3.6.3. On-site Training Programme

Three day on-site training programme (sixth of its kind) on nursery development, tree plantation techniques and natural resource conservation and management was organized by the INHI Core of the Institute from February 11 to 13, 1998 at Chessa village (Districts - Pupum Para) of Arunachal Pradesh. The target groups included local body elected representatives, volunteers, farmers and rural women. In all, 57 participants from Assam and Arunachal Pradesh attended this short term on-site training programme. The participants were trained by the staff of INHI Core and North East Unit of the Institute as well as by the identified resource persons of SFRI and NERIST, Arunachal Pradesh. The participants welcomed this activity and the response was quite encouraging for active furtherance of the programme particularly in the remote areas of Indian Himalaya.

Fig. 13. On-site training programme at Chessa village.

3.6.4. Dissemination of Information through Networking

Through in-house publications INHI Core is actively involved in the dissemination of knowledge. Hima-Paryavaran (a newsletter of the Institute) and Annual Report of the Institute were distributed during the year to almost 226 NGOs, 121 Academic/Scientific/Govt. Deptts. and 396 subject experts working on various aspects of Himalayan environment and development.

R&D inputs on various aspects of Himalayan environment and development were also provided by the scientists of the Core to the representatives of 28 academic/ scientific/Govt. Deptts. and 28 NGOs, and also to the more than 300 persons (i.e. villagers/farmers/rural women/ex-service army personnel/ pilgrims/ in-service persons etc.) during the year. Scientific and technical inputs to the officials of Garhwal Scouts, Joshimath for the strengthening of Manavan at Badrinath Dham and also to the officials of Parmarthlok, Badrinath for the expansion of Parmarthlokvan at Badrinath Dham were also provided by the scientists of the Core from time to time during

the year.

3.6.5. Strengthening of Central Nursery at the Headquarters

Central nursery activities at the Kosi campus of the headquarters were strengthened and monitored successfully during the year. Seeds of twenty five (25) promising mountain trees were collected in large quantities during the year from time to time and sown in the nursery beds/polybags/seedlings trays at the nursery. Cuttings of ten (10) promising mountain trees were also collected in large quantities during the year and planted in the beds at the Central nursery. Twenty five thousand (25,000) seedlings/saplings/cuttings of various trees were raised in the nursery during the year. Five thousand and ten (5,010) seedlings of various trees were distributed, free of cost, to the villagers/farmers, school children and NGOs for plantation purpose whereas four thousand (4,000) seedlings/saplings of different trees were distributed to various scientists/institutions during the year for R&D purpose. Five thousand (5,000) seedlings/saplings of different trees were also used for plantation in the premises of the Institute. The central nursery of plants at Kosi (Almora) was also remained in-come generating during the year.

QUICK APPRAISAL STUDIES

Preliminary study on Landslide disaster of June 1997 in the Gangtok area of Sikkim

Background

A disastrous series of landslides took place in June 1997 at different spots within Gangtok city and its suburbs leading to heavy casualties and other losses. Following this, a preliminary assessment was undertaken in the immediate aftermath of the disaster by G.B. Pant Institute of Himalayan Environment and Development in collaboration with International Centre for Integrated Mountain Development (ICIMOD). The broad objectives of the study were to assess and provide (1) brief history of landslide disasters, (2) causative factors, (3) consequences and (4) lessons for future and recommendations for further study.

Over recent years, there is a rising trend of high intensity rainfall triggered landslides and consequent loss of lives in Gangtok (Fig. 14). June'97 landslide events were preceded by rainfall of approx. 220 mm during the event. There were nearly fifty lives lost besides devastating or affecting large number of houses and other properties. Another landslide disaster within city was in September 1995 at Deorali area with a rainfall of 95 mm during the event which swept downslide many dwelling units with casualty figure of about thirty. Similar calamitous landslides took place in Syari and Deorali areas of Gangtok in September 1990 with 85 mm of rainfall during the event. There were nearly twenty five human lives lost.

The fragile host terrain, steep topography and excessive loading of the slopes lead to increase in the shear stress (driving force/unit area) at relatively constant shear strength (resisting force/unit area) resulting into physiographically more sensitive zones with slope instabilities. The Gangtok area shows occurrence of soft phyllite and schist along with gneiss and some mixed rock categories of brittle nature. The predominant occurrence is that of schist and gneiss. During field observations, the intense weathering leading to reduced cohesion particularly of schistose and other allied rocks were observed which require special attention. The soil genetic and physiographic conditions suggest the landslide susceptibility of different geomorphic terrain

units depending on their soil association and the parent rock properties.

Observations and recommendations

1. The high rainfall recorded on a single day during all the recent landslides of Gangtok proves its important triggering role. The north-eastern earthquake tremors in the recent past may also have affected these areas beforehand as an indirect cause. This city is already overburdened with building and other constructions. Tourism is also growing very fast leading to economic growth and at the same time, putting much pressure on the existing city infrastructure. There are plenty of associated developmental activities. Thus, suitable building sites are scarce and even less suitable sites are not spared from construction activities. Thick overburden soil cover is also significant within heavily constructed areas with less possibility of the foundation piles of houses resting on stable rock strata or slope plane in considerable number of cases. The pattern of city settlements seems to be inadequate coupled with poor drainage system of old times aggravating the intensity of recent hazardous calamity. Numerous drainage channels were found to be clogged with water supply pipes, telecommunication cables and non-biodegradable plastic wastes during June'97 disaster.

2. Different localities of Gangtok and its suburbs experienced landslides within a short duration of high intensity rainfall on the night of 8th June. The severely affected areas in terms of loss of human lives, properties and livestock were assessed for observing the geological conditions which might have contributed to these events. These localities are - Zero Point near Sikkim Raj Bhawan, Development Area, Tathangchen, Chanmari (Fig. 14) and, Rongey Basti (Dokan Dara) and Chongey Tar Basti (Fig. 14) on Gangtok-Rongey-Bhusuk-Assam (GRBA) road (suburban sites).

3. Based on field investigation and assessments, it is recommended to carry out extensive work incorporating the following: A comprehensive study for (a) multilevel zonation of landslide hazard on different scales using remote sensing data and maps as well as ground surveys (b) documentation of engineering-geological, meteorological and other geo-environmental variables as suitable Geographical Information System (GIS) overlays. A terrain classification approach should supplement these at all the levels in terms of sloping land facets for creating database for the city and its suburbs around a GIS platform. This shall allow ready access to the administrators and planners, and shall also serve as a model for other mountain cities.

Fig. 14. Important landslide affected localities.

4. MISCELLANEOUS ITEMS

4.1. Addition to Library

One Thousand two hundred and sixteen (1216) books were added in the library during the year. The total number of books available in the Library is 8085. A total of 132 international and nationals periodicals are being subscribed in the library including 15 periodical subscribed by the ENVIS Centre on Himalayan Ecology at the Institute. Databases of library have been updated, and Computerised Current Awareness Service (CAS) and Selective Dissemination of Information (SDI) Services are being provided. New arrivals and Articles Alert Services are being provided regularly. Library is also receiving some books from some national and international organizations as complimentary copy.

4.2. Membership of Professional Societies /Committees

Member, Research Advisory Committee of Wadia Institute of Himalayan Geology, Dehradun (**L.M.S. Palni**)

Member, Board of Governors, Central Himalayan Environment Association, Nainital (**L.M.S. Palni**)

Member, Expert Committee set up by the Government of India for establishing the Institute of Biodiversity in Arunachal Pradesh (**L.M.S. Palni**)

Member, Ecological Society of America, USA (**Subrat Sharma**)

Member, International Association for Landscape Ecology, USA (**Subrat Sharma**)

Member, Sikkim Science Society, Sikkim (**Subrat Sharma**)

Member, Institute of Landscape, Ecology and EKISTICS (**D.S. Rawat**)

Member, Indian Association of Hydrologists, Roorkee (**Kireet Kumar**).

Member, Indian Society of Tree Scientists (**S.K. Nandi**)

Member, National Geographic Society, USA (**R.K. Maikhuri** and **G.C.S. Negi**)

Member , New York Academy of Sciences, USA (**G.C.S. Negi**)

Member, The Mountain Forum, USA (**V. Joshi** and **A. P. Krishna**)

Member, The International Association of Hydrological Sciences, Canada (**V. Joshi**)

Member, National Institute of Ecology (**P.K. Samal**)

4.3. Awards and Honours

Elected Fellow of the National Academy of Sciences, India (**L.M.S. Palni**)

Prof. K.K. Nanda Memorial Young Scientist National Award (1996) awarded by the Indian Society of Tree Scientists in recognition of work in the area of tree ecology and conservation (**H.C. Rikhari**).

Prasasti Patra for book "*Pan Ki Kheti*" EBIS, CSIR (1996) from DG, CSIR and Secretary, Department of Scientific and Industrial Research, awarded in 1977 (**K.K. Singh**)

Visiting fellow of Jawahar Lal Nehru Centre

for Advance Scientific Research, Bangalore (**G.C.S. Negi**).

4.4. Publications of the Faculty

4.4.1. Scientific Papers

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4.4.2. Popular Articles by Faculty

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Singh, G.S., K.K. Sen, **J.C. Kuniyal & S.C.R. Vishvakarma** (1997). Cloudbrust calamities in high altitude regions of Himachal Pradesh: prevention or cure. *Himalayan Paryavaran*, 5: 72-74.

Uma Shankar (1997). Unusual banana in the east. *Hima Paryavaran*, 9(2): 10.

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Vishvakarma, S.C.R., (1997). *Kullu ka vikas*. *Sadprayas*, 1(3) : 9-12.

4.5. Participation in Seminar/ Symposium/ Workshop/Training

Consultation Meeting on Prioritization of conservation sites in timberline zone of west Himalaya (Sponsored by WWF-India), GBPIHED, Kosi- Katarmal, Almora, April 12-13, 1997 (**U. Dhar, S.S. Samant, R.S. Rawal, J. Upreti, S. Airi, A. Tewari, E.A. Siril, I.D. Bhatt, K.S. Rao, K. Kumar & L.M.S. Palni**)

Developmental Biology & Commercialisation of Orchids and Orchid Show, organised by the Orchid Society of India in Gangtok, April 12-13, 1997 (**Sentikemba Jamir**)

The XXII General Assembly of the European Geophysical Society meeting, Session BAHC 03: Mini-symposium on Mountain Eco-hydrology, Vienna, Austria, April 21-25, 1997 (**S.C. Rai**)

Members of a delegation of 10 experts from India for Mountain Risk Engineering (MRE) exposure visit to China, April 26 - May 8, 1997 (**V. Joshi, A.P. Krishna & L.M.S. Palni**)

UNESCO Sub-regional Seminar on Culture, Environment and Indigenous Knowledge, Jomson (Mustang), Nepal, May 14-18, 1997 (**P.P. Dhyani**)

National Workshop on Climatic Changes and Communities in the Glacial Margins organised by Indian Network Etifice of Climatic Changes, Joshimath (Garhwal), May 16-17, 1997 (**G.S. Satyal**)

Participated in Training Course on Environmental Scenario, Policies & Strategies from World Environment Day at Paryavaran Parisar organised by Environmental Planning & Coordination Organisation, Bhopal; co-sponsored by Ministry of Environment & Forests, Govt. of India, New Delhi, June 5-8, 1997 (**J.C. Kuniyal**)

FREE-GHNP Research Workshop, organized by Wildlife Institute of India, Dehradun and DFFC, Himachal Pradesh, Mohal-Kullu, June 11, 1997 (**H.K. Badola**)

National Workshop-cum-Training programme on Biosphere reserve organised by the Garhwal Unit of GBPIHED at Joshimath, June 11-15, 1997 (**R.K. Maikhuri, K.S. Rao, S.C. Joshi, V. Joshi, G.C.S. Negi, S.S. Samant & L.M.S. Palni**)

The 1997 Open Meeting of the Human Dimensions of Global Environment Change Research Community, Laxenburge, Austria, June 12-14, 1997 (**S.C. Rai**)

Orientation Workshop for Summer Students from Canada, held at Almora, sponsored by SICI, New Delhi, June 16-17, 1997 (**P.K. Samal, D.S. Rawat, N.A. Farooquee, Pushpa Pant, S.K. Nandi, K. Kumar, U. Dhar, S.S. Samant, Y.S. Topal, B.P. Kothyari & L.M.S. Palni**)

Delivered a talk on Biodiversity, to the participants of Indian Youth Hostel Association trekking group, camped at village Grahan in KWLS-Kullu, June 16, 1997 (**H.K. Badola**)

UNESCO Review Meeting on Conservation and Management of Sacred Grove organized by Jawaharlal Nehru University New Delhi, June 19-20, 1997 (**R.K. Maikhuri**)

Regional Workshop on Indigenous Strategies for Intensification of Shifting Cultivation in

Southeast Asia, , ICRAF, Bogor, Indonesia. Poster paper presented on *Alnus*-cardamom agroforestry system : potential for stabilizing upland shifting cultivation in the eastern Himalaya, June 23-27, 1997 (**Rita Sharma**)

Meeting on *Integrated Watershed Management* organised by, Uttarakhand Development Department, Govt. of Uttar Pradesh at Lucknow on June 26, 1997 (**D.K. Agrawal**)

Attended and presented the progress of R&D activities in a task force meeting of DBT, New Delhi, June 1997 (**U. Dhar & L.M.S. Palni**)

Workshop on Biodiversity and Ecotourism Management Issues in the Khangchendzonga National Park, Yuksom, Sikkim, July 7-8,1997 (**Sikkim staff**)

Environmental Regulations, organized by Environmental Planning and Coordination Organization, Bhopal sponsored by Ministry of Environment and Forests, Govt. of India, July 08-11, 1997 (**S.C.R. Vishvakarma**)

Participated Workshop on Managing Hazardous Wastes organised by Indian Environmental Society & Central Pollution Control Board, Shima, July 15-18, 1997 (**A.S. Shannigrahi**)

National Workshop on Hydrological Instrumentation, Data Collection, Storage and Processing organised by National Institute of Hydrology, Roorkee, Aug. 6-8, 1997 (**G.S. Satyal**)

Integrated Development of Himalayan Region at Himachal Secretariat, Shimla, organised by Govt. of Himachal Pradesh, August 7, 1997 (**S.C.R. Vishvakarma & J.C. Kuniyal**)

Participated in seminar on Rural Development organized by Society for Agriculture and Rural Development at Manipur (Chamoli), August 8, 1997 (**R.K. Maikhuri**)

Remote Sensing and Geographic Information System (GIS) with Special Emphasis on Arunachal Pradesh, organised by the State Remote Sensing Application Centre (APRSAC), Itanagar, September 4, 1997. (**Uma Shankar**)

Meeting on Women & Technology organised by HESCO, Dehradun, September 6, 1997 (**L.M.S. Palni**)

Delivered a lecture on Conservation of Biodiversity in Himalayan Context, to the officers and men of the SSB Group Centre, Shamshi-Kullu, September 12, 1997 (**H.K. Badola**)

Regional Training-cum-Workshop on Application of Biotechnologies to Rainfed Farming System, including Bioindexing Emphasizing Participatory Approach at Community Level, Dr M.S. Swaminathan Research Foundation, Chennai, September 15-20, 1997 (**L.M.S. Palni & D.S. Rawat**)

Presented a paper in National Seminar on Valuation of and Accounting for Natural Resources at Institute of Economic Growth, Delhi, September 18-19, 1997 (**Kireet Kumar, G.S. Satyal & L.M.S. Palni**)

International Symposium on Emerging Trends in Hydrology, Roorkee University, September 25-27, 1997 (**G.C.S. Negi**)

Participated in the Anterrastriya Ozone Parat Sanraksan Diwas, organised by Paryavaran Nidesalaya, Utter Pradesh, Regional Office, Srinagar, September 16, 1997 (**S.C. Joshi & V. Joshi**)

Attended and presented an outlook on Institute activities in a workshop on DOS-DBT sponsored project at National Remote Sensing Agency, Hyderabad, September 25, 1997 (**L.M.S. Palni**)

Eco-development Meeting for KWLS, organized by Wildlife Division, DFC, Kullu, Kasol-Kullu, September 27, 1997 (**H.K. Badola**)

Attended a sub committee meeting on Environment and Forest convened by Planning Commission, Govt. of India, Lucknow, September 1997 (**U. Dhar**)

International Training Course on Management and Utilization of Fodder Trees and Shrubs in sub-tropical and Temperate Himalaya, Sponsored by FAO, Rome and organised by IGFRI, Jhansi, September 22-30, 1997 (**S.S. Samant & H.C. Rikhari**)

Joint Forest Management, organised by the Department of Environment & Forests, Arunachal Pradesh and Regional Centre NAEB, Shillong, October 3-4, 1997 (**Uma Shankar**)

Workshop on Perspectives of Mountain Risk Engineering in the Himalayan Region, jointly organised by GBPIHED and ICIMOD at Kosi-katarmal, Almora, October 8-10, 1997 (**A.P. Krishna, H.C. Rikhari, D.K. Agarwal, P.K. Samal, D.S. Rawat, K. Kumar, V. Joshi, G.S. Satyal & L.M.S. Palni**)

Seminar on Rejuvenation of Water Resources, jointly organized by H.P. Agriculture University, Palampur and INTACH, October 13, 1997 (**S.C.R. Vishvakarma**)

Consultative Committee Meeting on FARM Programme of FAO/UNDP in Bagor & Jakarta, Indonesia, 13-17 October 1997 and participation in an Exhibition organised to celebrate World Food Day, October 16, 1997 (**L.M.S. Palni**)

Research and Extension Advisory meeting of G.B. Pant University of Agriculture and Technology, Ranichauri, Tehri-Garhwal, Oct. 15, 1997 (**G.C.S. Negi**)

Workshop on National Concern for Management, Conservation and Use of Agro-biodiversity, ICAR, Shimla, October 15-16, 1997 (**K.S. Rao**)

Inter Institutional Linkages & Collaboration Meeting, VPKAS, Almora, October 21 & 22, 1997 (**L.M.S. Palni**)

Training Workshop on *Jav Vividhata Sanrakshan Mei Janata Ki Bhagidari*, organized by GBPIHED at L.W.S. Girls Inter College, Bhatkot, Pithoragarh, October 24-25, 1997 (**U. Dhar, S.S. Samant, R.S. Rawal, S. Airi, J. Upreti, V. Naithani, A.K. Singh, I.D. Bhatt, B.C. Pandey, D.S. Mehta, N. Bag & L.M.S. Palni**)

PG Diploma Course (9 months) on Remote Sensing & GIS, Centre for Space Science Education in Asia & Pacific (affiliated to United Nations), Dehra Dun, from October 1997 (**S. Sharma**)

International Hands-on-Training Course on DNA Fingerprinting held at Centre for DNA Fingerprinting & Daignostics, and Centre for Cellular and Molecular Biology, Hyderabad, November 6-19, 1997 (**Anil Kumar**)

Participated in a meeting to finalise the recommendations of workshop on *Paryatan: Vikas ka ek marg (Tourism: A model of development* (in Hindi) organised by Sadprayash, Kullu, November 9, 1997 (**S.C.R. Vishvakarma & J.C. Kuniyal**)

Attended and chaired Steering Committee Meeting of Integrated Training for Mountain Risk Engineering (MRE) in the Himalayas, ICIMOD, Kathmandu, November 11-13, 1997 (**L.M.S. Palni**)

Seminar on Environmental Situations in Sikkim - Reflections Over the Last 50 Years and Planning for the Next Century organised by World Wide Fund for Nature India (WWF) at Gangtok, November 20, 1997 (**E. Sharma & A.P. Krishna**)

IUFRO Symposium on Innovations in Forest tree, Seed Science & Technology, Raipur, November 22-25, 1997 (**M.S. Bisht & P. Vyas**)

Regional training course on Application of GIS and Remote Sensing in Planning for Basic Infrastructure and Services at ICIMOD, Kathmandu (Nepal), November 24 - December 19, 1997 (**Kireet Kumar**)

International Conference on Frontiers in Biotechnology, Trivandrum, November 26 - 29, 1997 (**A. Pandey**)

Consultation Meeting on Prioritization of conservation sites in timberline zone of West himalaya (Sponsored by WWF-India), DSB Campus, Kumaun University, Nainital, November 29, 1997 (**U. Dhar, S.S. Samant, R.S. Rawal, J. Upreti, A. Tewari, L.M.S. Palni**)

Acted as State Level Judge in National Children Science Congress, organised by the State Council for Science & Technology, Arunachal Pradesh, Itanagar, December 5, 1997 (**R. C. Sundriyal**)

Final Dissemination Workshop - CIDA-SICI CSP-I Patnership Programme, organized by Shastri Indo-Canadian Institute at Montreal, Canada, December 06-10, 1997 (**P.K. Samal**)

Participated in Regional Workshop on Ganga Water Pollution organised by Friends of Trees (NGO) at Srinagar (Garhwal), December 15, 1997 (**R.K. Maikhuri**)

European Conference on Environmental and Societal Change in Mountain Regions held at Oxford University London, December 18-20, 1997 (**S.C. Rai**)

Participated and presented a paper entitled, Tourism and Environment in Seminar on *Paryatan: Vikas Ka Ek Marg* (Tourism: A Model of Development) organised by *Sadprayaas, Kullu* (H.P.), January 11-13, 1997 (**J.C. Kuniyal & S.C.R. Vishvakarma**)

Second Meeting of the Task Force on Plant Biotechnology, DBT, New Delhi, January 13, 1998 (**U. Dhar & S.K. Nandi**)

A study tour of government officials, private sectors and community to Buxa Tiger Reserve in West Bengal and Royal Chitwan National Park in Nepal for protected area management, organised by Sikkim Biodiversity and Ecotourism Project, January 24-31, 1998 (**E. Sharma, Renzino Lepcha & Nakul Chettri**)

International Conference on Asian Wetlands organised by Indian Environmental Society, Delhi, January 29-31, 1998 (**Alka Jain**)

National Symposium on Current Trends in Plant Physiology and Plant Biochemistry, University by Hyderabad, Hyderabad, January 29-31, 1998 (**P. Vyas & Anil Kumar**)

Ninth Conference of Indian Institute of Geomorphologist (IGI) on Geomorphology and Environmental Management organised by Department of Geography, Dehli School of Economics, University of Delhi, January 30 - February 1, 1998 (**Iyatta Maharana**)

UNDP-WWF Sponsored Meeting, Kathmandu, Nepal and presented an invited paper on Agroecosystems, February 16-19, 1998 (**L.M.S. Palni;** coauthored with **R.K. Maikhuri & K.S. Rao**)

Delivered a lecture, Garbage management in Rewalsar town on the eve of location specific training on eco-restoration and afforestation needs for preventing pollution of Rewalsar lake and other lakes of the area organised by SERVE INDIA, Rewalsar, Mandi (H.P.), February 12, 1998 (**J.C. Kuniyal**)

International Conference on Medicinal Plants, organised by the Foundation for Revitalization of local Health Traditions (FRLHT), Bangalore, February 16-19, 1998 (**Uma Shankar**)

Seminar on Earth Observation System for Sustainable Development organised by the International Society for Photogrammetry and Remote Sensing, Indian Space Research Organisation, Bangalore, February 25-27, 1998 (**S. Sharma**)

Seminar on Fifty Years of Botany Research in India organised by Department of Botany, Banaras Hindu University, Varanasi, February 27-28, 1998 (**L.M.S. Palni, U. Dhar & E. Sharma**)

National Symposium on Commercial aspects of Plant Tissue Culture, Molecular Biology and Plant Biotechnology, Jamia Hamdard University, New Delhi, February 25-27, 1998 (**M.S. Bisht, P. Vyas & N. Bag**)

Attended meeting on Ravi Crop Diversification organized by District Administration, Almora, February 1998 (**S.S. Samant**)

Prioritization of conservation sites in timberline zone of west Himalaya in BCPP Partners Workshop held at WWF India, New Delhi February, 1998 (**U.Dhar, J. Upreti**)

Acted as Judge for evaluating State Level Essay Competition on Role of Science & Technology for Development of Arunachal Pradesh, organised by the State Council for Science & Technology, Arunachal Pradesh on the Occasion of National Science Day, February 28, 1998. (**R. C. Sundriyal**)

National Conference on Role of Plant Growth Regulators in Agriculture, Horticulture & Forestry, Gujarat University, Ahmedabad, March 5-7, 1998 (**S.K. Nandi**)

Invited by FAO, Rome for Third Regional Meeting/Workshop organized by Temperate Asia Pasture and Fodder Working Group and sponsored by FAO, Rome in Pokhara, Nepal, March 9-13, 1998 (**S. S. Samant**)

Delivered a lecture on *Paryavaran Evem Swachchata* in a regional training of NGOs on Panchayat Raj, at Regional Village Development Institute, Hawalbag (Almora), March 9, 1998 (**Kireet Kumar**)

National Conference on Conservation of Sacred Groves and Ecological Heritage Site. CPR Environmental Education Centre, Chennai, March 18 & 19, 1998 **(S. Sharma)**

Winter Workshop on Sources of Conflict in South Asia : Ethnicity, Refugees, Environment, held at Hikkadua, Srilanka and organised by Regional Centre for Strategic Studies, Colombo, Srilanka, March 12-22, 1998 **(Nehal A. Farooquee)**

Delivered a lecture on environmental protection on the eve of Youth Leadership Training Camp organized by District Youth Services and Sports Officer, Mandi, District-Mandi at Bajaura, March 20, 1998 **(J.C. Kuniyal)**

Delivered a lecture on Solid waste - one of the burning environmental problems, on the even of World Forestry Day, organised by Dr. Y.S. Parmar Horticulture and Forestry University, Regional Horticultural Research Centre, Bajaura, March 21, 1998 **(J.C. Kuniyal)**

Fifth West Bengal State Science Congress organised by North Bengal University, and sponsored by Science and Technology, Govt. of West Bengal, March 21 -23, 1998 **(Nabarun Panda)**

Ninth Manipur Science Congress organised by Minipur University & sponsored by Science and Technology, Govt. of Manipur, March 25-27, 1998 **(H. Birkumar Singh)**

Presented a paper in National Scientific Conference at Institute of Himalayan Bioresource Technology, Palampur, March 26 - 27, 1998 **(R.S. Rawal)**

I.C. Sanghal, B.Com. (Hons). L.L.B., F.C.A.
A.K. Jain, B.Com. F.C.A.

I. C. Sanghal & Co.
Chartered Accountants

17, Rajpur Road, Dehradun - 248 001
Phone (0135) 654607, 653402 Fax : (0135) 723831

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

Dear Sir,

We have examined the Balance Sheet of GB PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT, Almora, as on 31.3.98 which are in agreement with the books of accounts, maintained by the said Institution.

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 said Head Office and the Units of the above named Institute so far as appears from our examination of the books. Proper returns adequate for the purpose of audit have been received from Units not visited by us. Subject to the comments given below :-

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

1) In the case of Balance Sheet of the State of Affairs of the above named Institution as on 31.3.98.
2) In the case of Income & Expenditure Account of the INCOME of its accounting year ending on 31.3.98.

For I.C. Sanghal & Co.
Chartered Accountants

-Seal-

17-Rajpur Road, Dehradun
Dated : 15.9.1998

-sd-
(A.K. Jain)
Partner

I.C. Sanghal, B.Com. (Hons), L.L.B., F.C.A.
A.K. Jain, B.Com. F.C.A.

I. C. Sanghal & Co.
Chartered Accountants

17, Rajpur Road, Dehradun - 248 001
Phone (0135) 654607, 653402 Fax : (0135) 723831

NOTES FORMING PART OF THE REPORT ON THE STATEMENT OF ACCOUNTS OF *G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT, KATARMAL, KOSI, ALMORA*, FOR THE YEAR ENDING 31.3.1998 AND ANNEXED TO AND BALANCE SHEET OF EVEN DATE.

1. Books of Accounts have been maintained in cash basis, subject to Para 4 below.
2. Depreciation has not been provided on Fixed Assets in the accounts and value has been shown at cost.
3. All purchases of consumables, laboratory expenses, chemicals, glass-wares, stores and stationery etc. have been charged to the Income & Expenditure A/c at the time of purchase.
4. Interest on Fixed Deposits has been provided on accruals basis.
5. Stock registers of assets have been maintained by the institution for movement of assets, stores, vehicles, which have been physically verified at regular intervals.
6. Provident Fund liabilities and investments of the institute has been incorporated in the statement of accounts.
7. Fixed Assets except vehicles and Electric Sub-station have no insurance cover to provide security against any loss, considering the accumulated value of assets, appropriate insurance cover be obtained.
8. Outstanding entries pending adjustments in the bank Reconciliation Statement needs to be adjusted.
9. Deposits of Rs. 15,00,23,967/- for Construction, with CCU (MOE &F), New Delhi, needs to be adjusted for the work which has already been completed.
10. Annexure '1' to '39' are integral part of the Statement of Accounts prepared for the year.

For I.C. Sanghal & Co.
Chartered Accountants

-Seal-

17-Rajpur Road, Dehradun
Dated : 15.9.1998

-sd-
(A.K. Jain)
Partner

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
BALANCE SHEET AS ON 31 MARCH, 1998

PARTICULARS	ANN	AMOUNT	AMOUNT
SOURCE OF FUNDS :			
General Fund :			
Last Balance		2442290.14	
Additions for the year :		1171967.19	
		3614257.33	
Less : Tfd. To Endowment fund		1482756.34	2131500.99
Endowment Fund :			
Last Balance :		2173703.81	
Add : Addition during the year		1482756.34	
Interest Earned		163152.00	3819612.15
Fixed Assets Fund :			
Last Balance :	70427662.31		
Additions for the year :	14277114.00	84704776.31	
Less : Sale during the year :		107397.70	**84597378.61**
Construction Fund :			
Last Balance :		123919000.00	
Addition for the year :		26104964.00	150023964.00
Provident Fund :			
Last Balance :	2649797.00		
Additions for the year :	2461842.00	5111639.40	
Less Payment during the year :		0.00	5111639.40
Project Funds :	1		
Research & Development Fund :		640267.79	
Construction Fund (GH/NH)		48583.00	
NEC Shillong Fund :		(6981.00)	
IERP Project Fund :		47.39	
ENVIS Project Fund :		(39450.00)	
DST (SKB) Project Fund :		222.00	
DST (RSR) Project Fund :		1032.00	
DST (RKM) Project Fund :		5869.00	
CSIR (HCR/GCSN) Project Fund :		4761.00	
BIOTECH (I) Project Fund :		668.00	
BIOTECH (II) Project Fund :		269544.00	
BIOTECH (III) Project Fund :		3177067.00	
IEG Project Fund :		39019.00	
UNDP (HAIGAD) Project Fund :		(28035.00)	
Balance Carried Forward :		**4112614.18**	**245684095.15**

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)

BALANCE SHEET AS ON 31ST MARCH 1998

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward :		4112614.18	245684095.15
Project Funds			
(Brought Forward)			
CSIR (RCS) Project fund :		34374.00	
DST (SKN) Project Fund :		(66087.00)	
ICIMOD Project Fund :		43151.05	
TSBF Project Fund :		(188002.00)	
INDO CANADIAN Project Fund :		76906.00	
INDO CANADIAN SUMMER PROGRAMME		39337.00	
ICIMOD SALT Project Fund :		71816.21	
ICIMOD ISSMA Project Fund :		(66353.00)	
MACARTHER UNESCO Project Fund :		230900.00	
ECO TOURISM Project Fund :		496335.00	
AGRICULTURE BIO DIV. Fund :		4148.00	
LAND USE Project Fund :		60.00	
WWF (CBD) Project Fund :		(25950.00)	
ICIMOD (CBD) Project Fund :		189409.00	
ICIMOD (PARDYP) Project Fund :		608806.00	
ICIMOD (FIBRE) Project Fund :		209515.00	
ICIMOD LAND SLIDE Project Fund :		19521.00	
ICIMOD GIS EQUIPMENT :		148800.00	
SALT FARMERS TRAINING		19995.00	
MRE WORKSHOP FUND		28272.00	
INHI BADRIVAN Project Fund :		159885.00	
MRE PROJECT FUND		132721.00	
ICAR (ES)		360635.00	
NDBR WORKSHOP		(70049.00)	
NDBR (RKM)		25764.00	
INSA/DST (FOR TOUR)		12422.00	
BIOTECH IV Project Fund		259473.00	
FAO BIO-DIVERSITY		171480.00	
HAIGAD II (FARM Project)		60647.00	
BIO-TECH V Project Fund		90581.00	
MOE & F (SSS)		90000.00	
CSIR (RS)		20670.00	**7301796.44**
Balance Carried Over			**252985891.59**

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
BALANCE SHEET AS ON 31ST MARCH 1998

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward			252985891.59
Other Liabilities :			
Group Saving Link Insurance :		3080.10	
CPF Payable		1364.00	
Salary Payable		9616.70	
ST Payable		671.00	
Medical Claim Payable		230.00	
Security Payable		7000.00	
E.M.D. Payable		72500.00	
Advance (K.S. RAO)		1990.00	
Advance (R.K. Maikhuri)		43.00	
Advance SUBRAT SHARMA		50.00	
ADVANCE (SALT)		10530.39	107075.19
TOTAL RS.			253092966.78
APPLICATION OF FUNDS :			
Fixed Assets :	38		**84597378.61**
Deposits with CCU for Construction		150023964.00	
SP. LAO for Land :		80000.00	**150103964.00**
Security Deposits :			**45343.00**
Closing Balances :	39		**18346281.17**
TOTAL RS.			**253092966.78**

-sd-
(Finance Officer)

As per our separate report of even date

-sd-
(D.D. Officer)

-Seal-

-sd-
(A.K. JAIN)
Partner
I.C. Sanghal & Co.
Chartered Accountants
17, Rajpur Road, Dehradun
Dated : 15.09.98

-sd-
(Director)

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH, 1998

PARTICULARS	ANN	AMOUNT	AMOUNT
INCOME			
Grant-in-aid:			
Designated Project Grant For :			
RESEARCH & DEVELOPMENT			
AND OTHER EXPENSES :		29800000.00	
CONSTRUCTION WORK		26104964.00	
IERP Project :		4203819.88	
ENVIS Project		320000.00	
DST (SKB) Project :		300000.00	
ICAR (ES) Project :		384560.00	
BIOTECH (I) Project :		63000.00	
BIOTECH (II) Project :		990000.00	
BIOTECH (III) Project :		294000.00	
NDBR (RKM) Project :		85000.00	
NDBR (WORKSHOP) :		200000.00	
IEG Project :		105000.00	
UNDP (HAIGAD) Project)		47925.00	
CSIR (RCS) Project :		137379.00	
INSA/DST (For T.A.) :		12422.00	
TSBF Project :		75198.00	
ICIMOD (SALT) Project :		213155.00	
MACARTHER UNESCO Project		775570.00	
ECO TOURISM Project :		1605733.00	
ICIMOD (FIBRE) Project :		112203.00	
ICIMOD (PARDYP) Project :		1195337.00	
LAND USE Project :		49000.00	
WWF (CBD) Project :		111000.00	
CSIR (RS)		48203.00	
BIOTECH IV Project :		386000.00	
HAIGAD II (Farm Project):		191500.00	
BIOTECH V Project		107000.00	
MOE & F (SSS) Project :		90000.00	
ICIMOD LAND SLIDE Project :		19521.00	
ICIMOD GIS EQUIPMENT :		148800.00	
ICIMOD SALT FARMER'S TRAINING		107370.00	
MRE WORKSHOP		195335.00	
MRE Project :		192848.00	
INHI BADRIVAN Project :		159885.00	
FAO BIODIVERSITY Project :		171480.00	
INDO CANADIAN Project :		396772.0	
INDO CANADIAN SUMMER PROG.		200000.00	69599979.88
Balance Carried Over			**69599979.88**

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH, 1998

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward			69599979.88
Less : tfd. To Designated Funds For :			
RESEARCH & DEVELOPMENT			
AND OTHER EXPENSES :		29800000.00	
CONSTRUCTION WORK :		26104964.00	
IERP Project :		4203819.88	
ENVIS Project		320000.00	
DST (SKB) Project :		300000.00	
ICAR (ES) Project :		384560.00	
BIOTECH (I) Project :		63000.00	
BIOTECH (II) Project :		990000.00	
BIOTECH (III) Project :		294000.00	
NDBR (RKM) Project :		85000.00	
NDBR (WORKSHOP)		200000.00	
IEG Project:		105000.00	
UNDP (HAIGAD) Project :		47925.00	
CSIR (RCS) Project :		137379.00	
INSA/DST (For T.A.) :		12422.00	
TSBF Project :		75198.00	
ICIMOD (SALT) Project :		213155.00	
MACARTHER UNESCO Project :		775570.00	
ECO TOURISM Project :		1605733.00	
ICIMOD (FIBRE) Project :		112203.00	
ICIMOD (PARDYP) Project :		1195337.00	
LAND USE Project :		49000.00	
WWF (CBD) Project :		111000.00	
CSIR (RS)		48203.00	
BIOTECH.IV Project :		386000.00	
HAIGAD II (Farm project):		191500.00	
BIOTECH V Project :		107000.00	
MOF & F (SSS) Project :		90000.00	
ICIMOD LAND SLIDE Project :		19521.00	
ICIMOD GIS EQUIPMENT :		148800.00	
ICIMOD SALT FARMER'S TRAINING		107370.00	
MRE WORKSHOP :		195335.00	
MRE Project :		192848.00	
INHI BADRIVAN Project :		159885.00	
FAO BIODIVERSITY Project :		171480.00	
INDO CANADIAN Project :		396772.00	
INDO CANADIAN SUMMER PROG.		200000.00	69599979.88

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH, 1998

PARTICULARS	ANN.	AMOUNT	AMOUNT
Interest From Banks :			351954.19
Other Income :			
Sale of Scrap :		9440.00	
Sale of vehicle :		107397.00	
Licence Fee :		65315.00	
Water Testing Fee :		5350.00	
Nursery :		2000.00	
Institutional Charges :		348552.00	
Guest House/Hostel Charges :		16653.00	
Soil Testing Charges :		720.00	
Royalty :		39500.00	
Miscellaneous :		308843.00	
Sale of Tender Forms :		6645.00	910415.70
Designated Grant Utilised For :			
RESEARCH & DEVELOPMENT AND OTHER EXPENSES :		32119915.55	
CONSTRUCTION WORK (GH/NH) :		7736.00	
CONSTRUCTION FUND (CCU) :		26104964.00	
IERP Project :		4203778.00	
ENVIS Project :		245758.00	
DST (SKB) Project :		300700.00	
ICAR (ES) Project :		23925.00	
BIOTECH (I) Project :		47379.00	
BIOTECH (II) Project :		306559.00	
BIOTECH (III) Project :		554671.00	
NDBR (RKM) Project :		59236.00	
NDBR (WORKSHOP)		270049.00	
IEG Project:		96776.00	
UNDP (HAIGAD) Project :		21111.00	
CSIR (RCS) Project :		103442.00	
DST/SKN Project :		144995.00	
TSBF Project :		327505.00	
ICIMOD (SALT) Project :		78348.00	
MACARTHER UNESCO Project :		496156.00	
ECO TOURISM Project :		1316804.00	
ICIMOD (FIBRE) Project :		6733.00	
ICIMOD (PARDYP) Project :		1308612.00	
LAND USE Project :		81264.00	
WWF (CBD) Project :		202559.00	
CSIR (RS)		27533.00	
AGRICULTURE BIO DIV. Project:		135852.00	
ICIMOD (ISSMA) Project :		320328.00	
ICIMOD (CBD) Project :		320857.00	
BIOTECH IV Project :		126527.00	
HAIGAD II (Farm project):		130853.00	
BIOTECH V Project :		16419.00	
ICIMOD SALT FARMER'S TRAINING		87375.00	
MRE WORKSHOP :		167063.00	
MRE Project :		60127.00	
INDO CANADIAN Project :		19500.00	
INDO CANADIAN SUMMER PROG.		160663.00	69912072.55
TOTAL INCOME (A)			**71174442.44**

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH, 1998

PARTICULARS	ANN	AMOUNT	AMOUNT
EXPENDITURE :			
Project Expenditure :			
RESEARCH & DEVELOPMENT			
AND OTHER EXPENSES :	2	18093696.55	
CONSTRUCTION WORK (GH/NH) :	3	7736.00	
IERP :	4	4203778.00	
ENVIS :	5	245758.00	
DST (SKB) Project :	6	300700.00	
ICAR (ES) Project :	7	23925.00	
AGRICULTURE BIO DIV. Project:	8	135852.00	
BIOTECH (I) Project :	9	47379.00	
BIOTECH (II) Project :	10	292623.00	
BIOTECH (III) Project :	11	506163.00	
NDBR (RKM) Project :	12	59236.00	
IEG Project:	13	96776.00	
UNDP (HAIGAD) Project :	14	13551.00	
CSIR (RCS) Project :	15	103442.00	
DST/SKN Project :	16	144995.00	
CSIR (RS):	17	27533.00	
WWF (CBD) Project :	18	194859.00	
LAND USE Project :	19	81264.00	
NDBR WORKSHOP :	20	270049.00	
BIOTECH IV Project :	21	126527.00	
HAIGAD II FARM Project :	22	15415.00	
BIOTECH V Project :	23	16419.00	
SALT FARMER'S TRAINING :	24	87375.00	
TSBF Project :	25	237505.00	
INDO CANADIAN Project :	26	19500.00	
INDO CANADIAN SUMMER PROG.	27	160663.00	
ICIMOD (SALT) Project :	28	78348.00	
ICIMOD (ISSMA) Project :	29	320328.00	
MACARTHER UNESCO Project :	30	446206.00	
ECO TOURISM Project :	31	1309001.00	
ICIMOD (PARDYP) Project :	32	1308612.00	
ICIMOD (CBD) Project :	33	320857.00	
ICIMOD (FIBRE) Project :	34	6733.00	
MRE WORKSHOP :	35	167063.00	
MRE Project :	36	60127.00	29529994.55
Balance Carried Over			29529994.55

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH, 1998

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward			**29529994.55**
Tfd. To CCU for Capital Expenditure			
Capital Expenditure :			**26104964.00**
RESEARCH & DEVELOPMENT :			
Library :	5196747.00		
Scientific Equipments :	5181631.00		
Office Equipments :	566554.00		
Furnitures :	2398679.00		
Vehicles :	682608.00	14026219.00	
Scientific Equipments :			
HAIGAD II Project :	115438.00		
ECO TOURISM Project :	7803.00		
BIOTECH II Project :	13936.00		
BIOTECH III Project :	48508.00		
UNDP HAIGAD Project :	7560.00		
MACARTHER UNESCO Project :	49950.00		
WWF (CBD) Project :	7700.00	250895.00	**14277114.00**
Loss on sale of Assets			90402.70
TOTAL EXPENDITURE RS. .(B)			**70002475.25**
SURPLUS (A - B)			
EXCESS OF INCOME OVER EXPDT.			
(TFD. TO GENERAL FUND A/C)			1171967.19
TOTAL RS...			**71174442.44**

-sd-
(Finance Officer)

As per our separate report
of even date

-sd-
(D.D. Officer)

-Seal-

-sd-
(A.K. JAIN)
Partner
I.C. Sanghal & Co.
Chartered Accountants
17, Rajpur Road, Dehradun
Dated : 15.09.98

-sd-
(Director)

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31ST MARCH, 1998

PARTICULARS	ANN	AMOUNT	AMOUNT
RECEIPT			
Opening Balance	37		13377262.05
Grant in aid For :			
Research & Development			
and Other Expenses :		29800000.00	
Construction Work :		26104964.00	
IERP :		4203819.88	
ENVIS :		320000.00	
DST (SKB) :		300000.00	
ICAR (ES) :		384560.00	
BIOTECH (I) :		63000.00	
BIOTECH (II) :		990000.00	
BIOTECH (III) :		294000.00	
UNDP (HAIGAD) :		47925.00	
CSIR (RCS) :		137379.00	
LAND USE :		49000.00	
WWF (CBD) :		111000.00	
CSIR (RS) :		48203.00	
NDBR (WORKSHOP) :		200000.00	
NDBR (RKM) :		85000.00	
INSA/DST (T.A.) :		12422.00	
BIOTECH IV :		386000.00	
FAO BIO-DIVERSITY :		171480.00	
HAIGAD II :		191500.00	
BIOTECH V :		107000.00	
MOE & F (SSS) :		90000.00	
IEG :		105000.00	64202252.88
Interest From Bank :			
Institute :		285386.19	
Endowment Fund :		163152.00	448538.19
Security Received			1000.00
E.M.D. Received			72500.00
ADVANCE N.E. UNIT			10530.39
ADVANCE SUBRAT SHARMA			50.00
G.S.L.I.			2879.95
C.P.F.			1271.00
PROVIDENT FUND CONTRIBUTION	**RECEIVED**		2461842.00
Other Income :			
Sale of Scrap :		9440.00	
Sale of Vehicle :		16995.00	
Licence Fee :		65315.00	
Water Testing Fee :		5350.00	
Nursery :		2000.00	
Institutional Charges :		348552.00	
Guest House/Hostel Charges :		16653.00	
Soil Testing Charges :		720.00	
Royalty :		39500.00	
Miscellaneous :		308843.00	
Sale of tender Forms :		6645.00	820013.00
TOTAL RECEIPT RS..			81398139.46

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31ST MARCH, 1998

PARTICULARS	ANN	AMOUNT	AMOUNT
PAYMENT			
Project Payment For :			
Research & Development			
and Other Expenses :	2	18093696.55	
Construction Work :	3	7736.00	
IERP :	4	4203778.00	
ENVIS :	5	245758.00	
DST (SKB) :	6	300700.00	
ICAR (ES) :	7	23925.o	
AGRICULTURE DIVERSITY :	8	135852.00	
BIOTECH (I) Project :	9	47379.00	
BIOTECH (II) Project :	10	292623.00	
BIOTECH (III) Project :	11	506163.00	
NDBR (RKM) :	12	59236.00	
IEG :	13	96776.00	
UNDP HAIGAD :	14	13551.00	
CSIR (RCS) :	15	103442.00	
DST (SKN) :	16	144995.00	
CSIR (RS) :	17	27533.00	
WWF (CBD) :	18	194859.00	
LAND USE Project :	19	81264.00	
NDBR (WORKSHOP) :	20	270049.00	
BIOTECH IV :	21	126527.00	
HAIGAD II :	22	15415.00	
BIOTECH V :	23	16419.00	**25007676.55**
Tfd. To C.C.U. For Capital Expenditure			**26104964.00**
SECURITY REFUNDED			**2000.00**
SECURITY DEPOSITED			**12622.00**
Capital Expenditure :			
Research & Development:			
Library :	5196747.00		
Scientific Equipments :	5181631.00		
Office Equipments :	566554.00		
Furniture :	2398679.00		
Vehicle :	682608.00	14026219.00	
Scientific Equipments :			
HAIGAD II :	115438.00		
BIOTECH (II) Project :	13936.00		
BIOTECH (III) Project :	48508.00		
UNDP HAIGAD :	7560.00		
WWF (CBD) :	7700.00	193142.00	**14219361.00**
Balance Carried Forward :			65346623.55

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31ST MARCH, 1998

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward :			65346623.55
Closing Balance :			
Cash & Bank Balance :			
Cash in Hand (IC A/C)			
Almora :		632.55	
Srinagar :		97.64	
Sikkim :		136.31	
Kullu :		1393.17	2259.67
Cash at Bank (IC A/C)			
CBI Kosi A/C No.CD-14 :		600603.75	
SBI Almora A/C No. 22752 :		2191336.35	
SBI Almora A/C No. 23884 :		1495712.15	
SBI Tadong A/c No. CA/4/65 :		395059.71	
SBI Kullu A/c No. 50201/7		16260.81	
SBI Srinagar A/C No. 3/615 :		37119.57	
SBI Almora P.F. a/c No. 22021 :		22686.40	4758778.74
Advances :			
House Building Advance :		510524.00	
Motor Cycle/Car Advance		476000.00	
Festival Advance :		12440.00	
Provident Fund Advance :		122905.00	
Units of Institute :			
Srinagar		11015.00	
Sikkim :		12422.00	1145306.00
Fixed Deposit :			
With SBI-Endowment Fund :		2323900.00	
SBI- Provident Fund :		3175000.00	
CBI- Provident Fund :		1200000.00	
Intt. Acc. On FDR (P.F. A/C)		591119.00	7290019.00
Due-Staff/Others (IC A/C)			
Klenzaids Con. Controls (P) Ltd., (BIOTECH I)		36880.00	
Director - IARI		26.50	
G.C.S. Negi (CSIR) :		2000.00	
A.S. Parihar :		389.00	
B.P. Kothyari :		6000.00	
J.M.S. Rawat :		4382.00	
S.P. Maikhuri (TTA) :		7400.00	
R.K. Nanda & Sons :		28517.00	
Pertech Computers :		2000.00	
Employment News :		14150.00	
Sigma Aldrich Chemicals :		10590.00	
Saltap Chemicals Ltd. (Biotech-III) :		16320.00	
Employment News (DST-SKN) :		900.00	
N.R.S.A. Hyderabad :		74800.00	
Shivalik Agro Products :		677.00	
Klenzaids Con. Controls Pvt. Ltd., :		57175.00	
M.P.C.B. :		16382.00	
Airport Handling Services :		35000.00	
Foss tecator :		35528.00	
NAT Steel Pvt. Ltd., Bombay :		225172.00	
Saveer Gewachshaws		1640630.00	
Saveer Biotech Ltd.		509893.00	
Research Software Design Portland :		4841.00	
H.K. Pandey :		3000.00	
Electric Sub Station (CCU)		100000.00	2852652.50
F.C. Inter Account :			2500.00
TOTAL PAYMENTS			81398139.46

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
SCHEDULE OF FIXED ASSETS AS ON 31st MARCH 1998

ANNEXURE '38'

PARTICULARS	COST AS ON 01/04/97	ADDITIONS DURING THE YEAR	COST OF SALES/ TFD. DURING THE YEAR	TOTAL
LAND :	0.00	0.00	0.00	**0.00**
Building :	2713848.00	0.00	0.00	**2713848.00**
Furniture :	4301225.40	2398679.00	0.00	**6699904.40**
(Details)				
INSTITUTE :	(4283618.40)	(2398679.00)	0.00	(6682297.40)
ICIMOD SALT :	(11000.00)	0.00	0.00	(11000.00)
ICIMOD ISMA :	(6607)	0.00	0.00	(6607.00)
Scientific Equipments :	43156427.11	5432526.00	0.00	**48588953.11**
(Details)				
Institute :	(32720621.19)	(5181631.00)	0.00	(37902252.19)
NORAD :	(1921158.00)	0.00	0.00	(1921158.00)
DST (RSR) :	(7415.00)	0.00	0.00	(7415.00)
BIOTECH-I :	(1840346.00)	0.00	0.00	(1840346.00)
BIOTECH-II :	(3851224.00)	(13936.00)	0.00	(3865160.00)
BIOTECH-III :	(787627.00)	(48508.00)	0.00	(836135.00)
UNDP (Haigad) :	(63400.00)	(7560.00)	0.00	(70960.00)
CSIR (RCS) :	(119758.00)	0.00	0.00	(119758.00)
DST (SKB) :	(808564.00)	0.00	0.00	(808564.00)
ICIMOD SALT :	(71866.92)	0.00	0.00	(71866.92)
INDO CANADIAN :	(180076.00)	0.00	0.00	(180076.00)
ICIMOD ISSMA :	(67161.00)	0.00	0.00	(67161.00)
ENVIS :	(242380.00)	0.00	0.00	(242380.00)
NWDPRA :	(64858.00)	0.00	0.00	(64858.00)
IEG Project :	(18865.00)	0.00	0.00	(18865.00)
DST (SKN) :	(323172.00)	0.00	0.00	(323172.00)
ECO TOURISM :	(67935.00)	(7803.00)	0.00	(75738.00)
MACARTHER UNESCO :	0.00	(49950.00)	0.00	(49950.00)
WWF (CBD) :	0.00	(7700.00)	0.00	(7700.00)
HAIGAD II :	0.00	(115438.00)	0.00	(115438.00)
Office Equipments :	1913838.35	566554.00	0.00	**2480392.35**
Fire Fighting Equipments :	60962.00	0.00	0.00	**60962.00**
Library :	13403018.50	5196747.00	0.00	**18599765.50**
Vehicles :	3360549.95	682608.00	107397.70	**3935760.25**
(Details)				
Institute :	(2276886.00)	(682608.00)	(107397.70)	(2852096.30)
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)
ICIMOD SALT :	(279224.00)	0.00	0.00	(279224.00)
Glass/Net House :	1517793.00	0.00	0.00	**1517793.00**
TOTAL RS...	70427662.31	14277114.00	107397.70	**84597378.61**

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)

CLOSING BALANCE **ANNEXURE '39'**

PARTICULARS	AMOUNT	AMOUNT
Closing Balance : (FC)		
Cash & Bank Balance :		
Cash in Hand :	24712.00	
Cash at Bank (SBI A/C No. 20910)	2191394.26	**2216106.26**
Advances :		
N.R.S.A. Hydr. (ICIMOD CBD) :	25950.00	
ADVANCE N.R.S.A. Hydr. (PARDYP) :	14500.00	
SILTAP CHEMICAL :	23012.00	
P.K. SAMAL :	4.00	
ADVANCE N.E. UNIT (SALT A/C)	13746.00	
ADVANCE S.K. UNIT (ECO TOURISM)	1447.00	**78659.00**
Closing Balance : (IC)		
Cash & Bank Balance :		
Cash in Hand (IC A/C)		
Almora :	632.55	
Srinagar :	97.64	
Sikkim :	136.31	
Kullu :	1393.17	**2259.67**
Cash at Bank (IC A/C)		
CBI Kosi A/C No. CD-14 :	600603.75	
SBI Almora A/C No. 22752 :	2191336.35	
SBI Almora A/C No. 23884 :	1495712.15	
SBI Tadong A/C No. CA/4/65	395059.71	
SBI Kullu A/C No. 50201/7 :	16260.81	
SBI Srinagar A/C No. 3/615 :	37119.57	
SBI Almora P.F. A/C No. 22021	22686.40	**4758778.74**
Advances :		
House Building Advance :	510524.00	
Motor Cycle/Car Advance	476000.00	
Festival Advance :	12440.00	
Providend Fund Advance :	122908.00	
Units of Institute :		
Srinagar :	11015.00	
Sikkim :	12422.00	**1145306.00**
Fixed Deposit :		
With SBI-Endowment Fund :	2323900.00	
SBI-Provident Fund :	3175000.00	
CBI-Provident Fund :	1200000.00	
Intt. Acc. On FDR (P.F. A/C)	591119.00	**7290019.00**
Balance Carried Forward :	TOTAL	**15491128.67**

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)

CLOSING BALANCE — **ANNEXURE '39' Contd..**

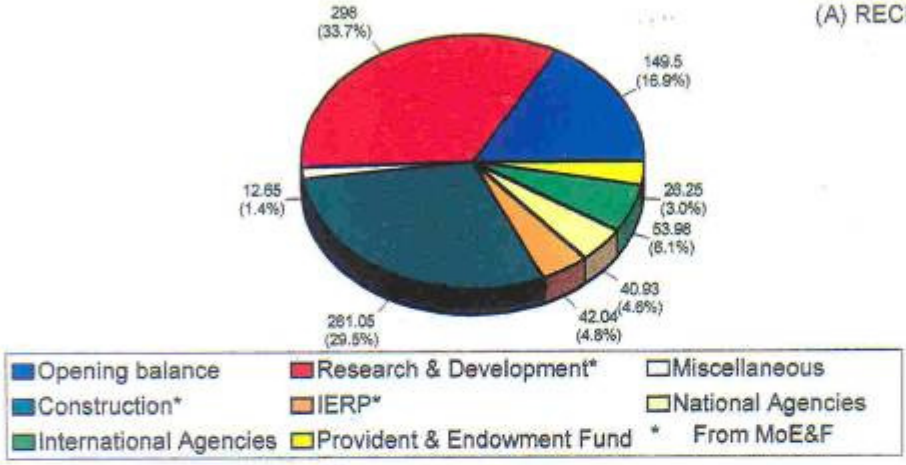
PARTICULARS	AMOUNT	AMOUNT
		15491128.67
Balance Brought Forward		
Due-Staff/Others (IC A/C)		
Klenzaids Con. Controls (P) Ltd., (BIOTECH I)	56880.00	
Director IARI	26.50	
G.C.S. Negi (CSIR)	2000.00	
A.S. Parihar	389.00	
B.P. Kothyari	6000.00	
J.M.S. Rawat	4382.00	
S.P. Maikhuri (TTA)	7400.00	
R.K. Nanda & Sons :	28517.00	
Pertech Computers :	2000.00	
Employment News :	14150.00	
Sigma Aldrich Chemicals :	10590.00	
Siltap Chemicals Ltd., (BIOTECH-III) :	16320.00	
Employment News (DST- SKN) :	900.00	
N.R.S.A. Hyderabad :	74800.00	
Shivalik Agro Products :	677.00	
Klenzaids Con. Controls Pvt. Ltd., :	57175.00	
M.P.C.B. :	16382.00	
Airport Handling Services :	35000.00	
Foss Tecator :	35528.00	
NAT Steel Pvt. Ltd., Bombay	225172.00	
Saveer Gewachshaws	1640630.00	
Saveer Biotech Ltd.	509893.00	
Research Software Design Portland :	4841.00	
H.K. Pandey	3000.00	
Electric Sub Station (CCU)	100000.00	2852652.50
F.C. Inter Account :		2500.00
TOTAL RS...		**18346281.17**

ABBREVIATIONS USED

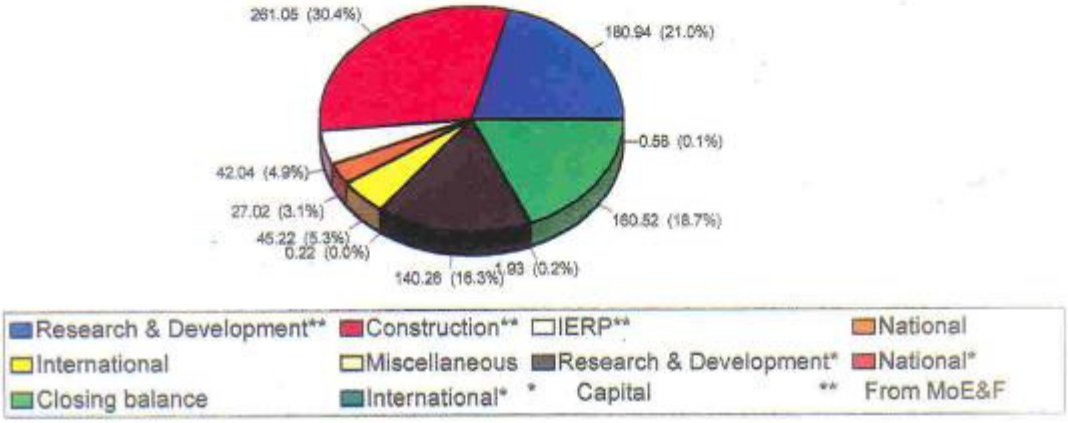
ICIMOD	:	International Centre for Integrated Mountain Development
TSBF	:	Tropical Soil Biology Fertility
IERP	:	Integrated Eco Research Program
ENVIS	:	Environmental Information system
DST	:	Department of Science & Technology
CSIR	:	Council of Scientific & Industrial Research
BIOTECH	:	Department of Bio-technology
NEC	:	North Eastern Council
NWDPRA	:	National Watershed Development Project for Rainfed Areas
UNDP	:	United Nations Development Programme
UNESCO	:	United Nations Educational Scientific and Cultural Organisation
UNICEF	:	United Nations Children Fund
IEG	:	Institute of Economic Growth
WWF	:	World Wide Fund for Nature
SALT	:	Sloping Agriculture Land Technology
ISSMA	:	Institutional Strengthening for Sustainable Mountain Agriculture
MRE	:	Mountain Risk Engineering
INHI	:	Institutional Networking and Human Investment
ICAR	:	Indian Council of Agricultural Research
NDBR	:	Nanda Devi Biosphere Reserve
INSA	:	Indian National Science Academy
FAO	:	Food and Agricultural Organization
FARM	:	Farmer, Centered Agricultural Resource Management

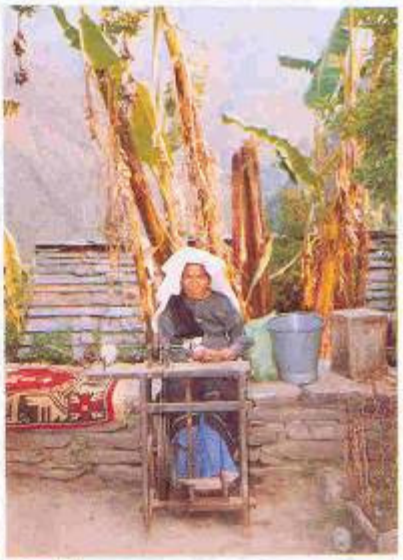
SUMMARY OF FUNDS RECEIVED AND EXPENDITURE FOR 1997-98 (Rs. in Lakhs)

(A) RECEIPTS

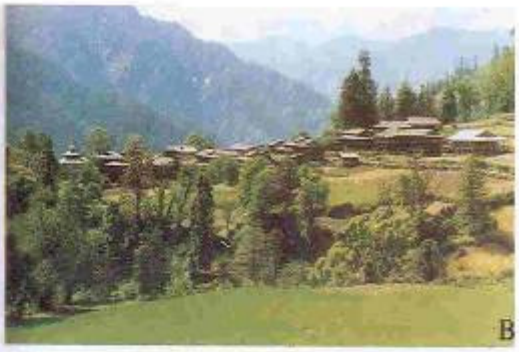


(B) EXPENDITURE






Penicillium raistrickii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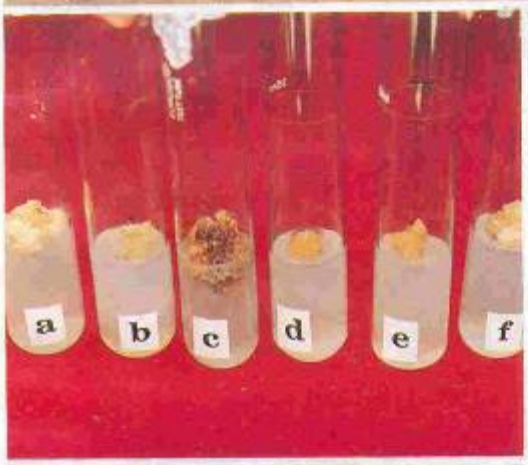
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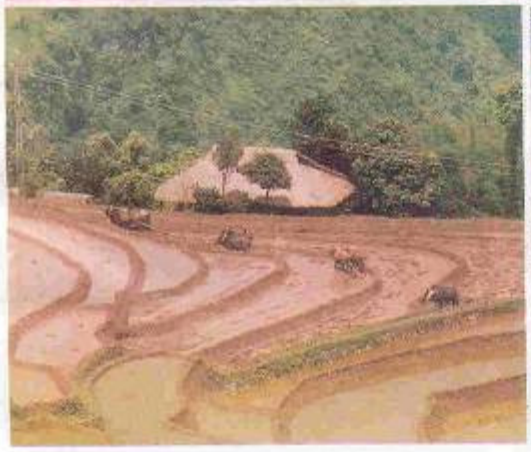

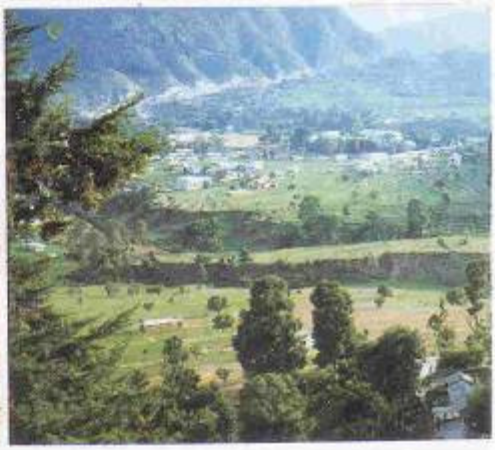








INSTITUTIONAL PUBLICATIONS

1991

- Agriculture Economy of Himalayan Region, Vol I Kumaon

1992

- Himalayan Environment & Development : Problems and Perspective
- Integrated Watershed Management : A Case Study of Sikkim Himalaya
- Action Plan for Himalaya

1993

- Agriculture Economy of Himalayan Region, Vol II Garhwal
- Himalayan Biodiversity : Conservation Strategies
- Tropical Soil Biology and Fertility Research : South Asian Context

1994

- Environmental Friendly Hill Development : An Approach for District Chamoli
- Sustainable Rural Development : Opportunity and Constraints
- *Myrica esculenta* Box Myrtle (Kaiphal) : A Promising underexploited tree crop of the Himalaya
- Hydropower management for Sustainable Rural Development in Remote Unelectrified Zones of Himalaya
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- Medicinal Plants of the Sikkim Himalaya : Status, Uses and Potential

1995

- Fodder trees and Shrubs of Central Himalaya
- Cultivation of Medicinal Plants and Orchids of Sikkim Himalaya

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- Water Management in Himalayan Ecosystem : A Study of Natural Springs of Almora

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- Himalayan Biodiversity – Action Plan
- Development Dilemma, Indian Scenario and Rural Himalaya : A Central Himalayan Perspective
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