ANNUAL REPORT

2000-2001

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

SOCIETY

President

Minister-in-Charge
Union Cabinet
Ministry of Environment & Forests
Government of India
New Delhi

Vice President

Minister of State-in-charge
Union Cabinet
Ministry of Environment & Forests
Government of India
New Delhi

Members

Two Member of Parliament
Nominated by Government of India
New Delhi

Minister-in-charge, Environment
Government of Arunachal Pradesh,
Assam, Himachal Pradesh,
Jammu & Kashmir, Manipur, Meghalaya,
Mizoram, Nagaland, Sikkim, Tripura, Uttar
Pradesh, West Bengal

Two Member of U.P.
Legislature nominated by Government of
India

Secretaries of Government of India:
Ministry of Environment & Forests,
Ministry of Finance (Expenditure),
Department of Biotechnology,
Department of Mines,
Department of Science & Technology,
Department of Water Resources,
Planning Commission,
Department of Non Conventional Energy
Sources,
Ministry of Rural Development,
Department of Urban Development,
Department of Agricultural Research
Ministry of Human Resource Development,

Chief Secretary,
Government of Uttar Pradesh,
Annexe Bhawan, Uttar Pradesh Secretariat,
Lucknow

Director General
Council of Scientific & Industrial Research
Anusandhan Bhawan, Rafi Marg
New Delhi-110 001

Inspector General (Forests)
Ministry of Environment & Forests,
Paryavaran Bhawan, CGO Complex
Lodi Road, New Delhi 110 003

Director General
Indian Council of Forestry Research &
Education

Chairman,
Indian Council of Social Science Research
35, Ferozshah Road, New Delhi

Director of
Indian Institute of Forest Management,
Botanical Survey of India,
Wildlife Institute of India

Nominated Members

Shri Harish Rawat
Akhil Bharatiya Congress Sewa Dal,
Jawahar Bhawan, Dr Rajendra Prasad Marg
New Delhi-110 001

Shri D.P. Joshi
Chairman
Central Himalayan Environment Association
Jubilee Villa, Nainital Cantt.
Tallital, Nainital, Uttaranchal

Dr (Ms) Vandana Shiva
Research Foundation of Science
Technology and Ecology
A-60, Hauz Khas
New Delhi - 110016

Vice Chancellor
H.N.B. Garhwal University
Srinagar-246 174, Garhwal, U.A.

Member Secretary

Director
Govind Ballabh Pant Himalaya
Paryavaran Evam Vikas Sansthan
Kosi-Katarmal, Almora 263 643, U.A.

GOVERNING BODY

Chairman

Shri V. Anand, IAS/ Shri P.V. Jayakrishnan, IAS
Secretary , Ministry of Environment & Forests
Paryavaran Bhawan, CGO Complex,
Lodi Road, New Delhi-110 003 /

Members

Prof. K.S. Valdiya
Jawaharlal Nehru Centre for
Advanced Scientific Research
Jakkur Campus, Jakkur P.O.

Bangalore-560 064
Prof. C.R. Babu
Department of Botany
University of Delhi, Delhi-110 007

Prof. H. Tombi Singh
Vice Chancellor, Manipur University
Chanchipur, Imphal-795 003

Prof. K.C. Malhotra
Director, Indian Institute of Statistics
Barrackpore Trunk Road
Calcutta-700 035

Shri P.K. Brahma / J. S. Maini
Joint Secretary & Financial Adviser
Ministry of Environment & Forests
Paryavaran Bhawan, CGO Complex
Lodi Road, New Delhi-110 003

Dr (Mrs) Manju Sharma
Secretary, Department of Biotechnology
Block II, 7-8th Floor, CGO Complex, Lodi
Road
New Delhi-110 003

Chief Secretary
Govt. of Uttar Pradesh
State Secretariat, Lucknow

Shri C.P. Oberoi, IFS
Inspector General (Forests) and
Special Secretary,
Ministry of Environment & Forests
Paryavaran Bhawan, CGO Complex
Lodi Road, New Delhi-110 003

Shri D.P. Joshi
Chairman
Central Himalayan Environment Association
Jubilee Villa, Nainital Cantt.
Tallital, Nainital, Uttaranchal

Dr (Ms) Vandana Shiva
Research Foundation of Science
Technology and Ecology
A-60, Hauz Khas
New Delhi - 110016

Member Secretary

Director

Govind Ballabh Pant Himalaya
Paryavaran Evam Vikas Sansthan
Kosi-Katarmal, Almora 263 643, U.A.

SCIENCE ADVISORY COMMITTEE

Chairman

Prof. J.S. Singh
Ecosystems
Analysis Laboratory
Department of Botany
Banaras Hindu University
Varanasi 221 005

Members

Prof. T.N. Lakhanpal
Himalayan Research Group
Umesh Bhawan
Chotta Shimla-171 002, H.P.

Dr. J.S. Samra
Director
Central Soil Water Conservation
Research and Training Institute
218 Kaulagarh Road
Dehradun-248 195, U.A.

Dr. V.C. Thakur
Director
Wadia Institute of Himalayan Geology
33 General Mahadeo Singh Road
Dehradun, U.A.

Er D.S. Tolia
393-C, Pocket II
Mayur Vihar (Phase I)
Delhi-110 091

Prof. A.C. Bhagbati
Department of Anthropology
Gauhati University
Guwahati, Assam

Prof. G.K. Kadekodi
Centre for Multidisciplinary Development
Research Centre
D.B. Rodda Road, Jubilee Circle
Dharwar-580 001, Karnataka

Dr C.J. Johny
Director and Head
Science and Society Division
Department of Science & Technology
Technology Bhawan, New Mahrauli Road
New Delhi-110 016

Dr M.N. Jha
Scientist-SG
Indian Council of Forest Research
And Education
P.O. New Forest, Dehradun, U.A.

Mr. A.K. Mehta, IAS
Deputy Secretary (CS)
Ministry of Environment & Forests
Paryavaran Bhawan, CGO Complex
Lodi Road, New Delhi-110 003

Member Secretary

Director
Govind Ballabh Pant Himalaya
Paryavaran Evam Vikas Sansthan
Kosi-Katarmal, Almora 263 643, U.A.

PROJECT EVALUATION COMMITTEE

Chairman

Dr. K.K. Dwivedi
Vice - Chancellor,
Arunachal University,
Rono Hills,
ITANAGAR – 791 111,
Arunachal Pradesh

Members

Professor R.S. Tripathi, *FNA*
Department of Botany,
North Eastern Hill University (NEHU),
SHILLONG – 793 022,
Meghalaya

Dr. G.S. Rawat, *IFS*
Director
Forest Research Institute (FRI)
[Indian Council of Forestry Research &
Education (ICFRE)],
P.O. – New Forest,
DEHRADUN – 248 006,
Uttaranchal

Dr. B.K. Chakraborty
(Retired Professor)
Milon Nagar,
VIP Road,
GUWAHATI AIRPORT –781 015, Assam

Dr. N.P. Singh
Director,
Botanical Survey of India (BSI),
P-8, Brabourne Road,
CALCUTTA – 700 001, West Bengal

Sri A. Chakraborty
President/Founder,
Kalyan Samity,
Gangail Road, Melarmath,
AGARTALA – 799 001,
Tripura (West), Tripura

Dr. I.A. Hamal
Department of Botany,
University of Jammu,
Baba Saheb Ambedkar Road,
JAMMU – 180 006, J&K

Professor D.S. Rawat
Department of Geography,
Himachal Pradesh University,
Summer Hill,
SHIMLA – 171 005, H.P.

Shri A.K. Mehta, *IAS*
Deputy Secretary,
Ministry of Environment & Forests, Govt. of
India,
Paryavaran Bhawan, CGO Complex, Lodi
Road,
NEW DELHI - 110 003.
(Representative of MoE&F)

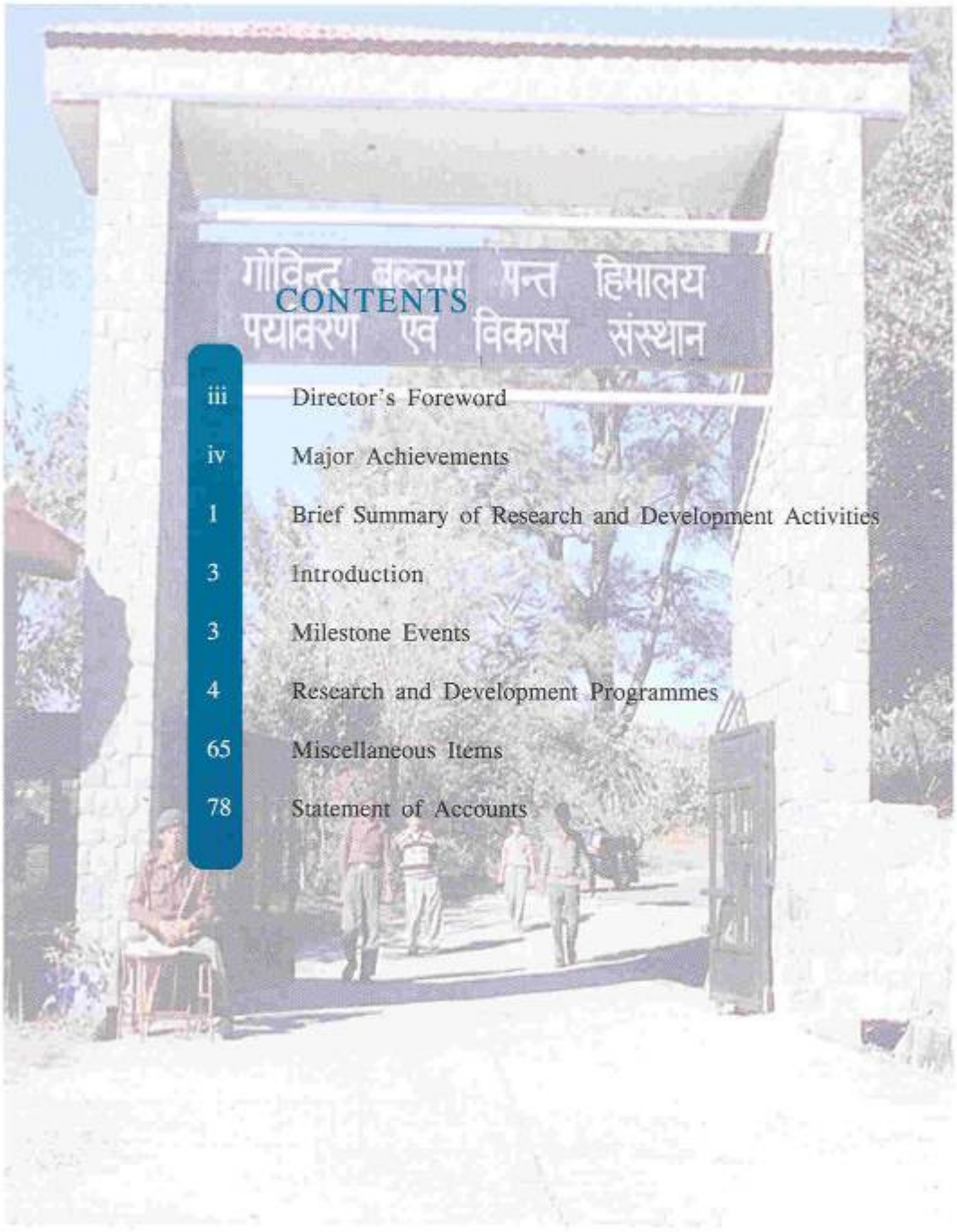
Member Secretary

Dr. P.P. Dhyani
Scientist D & Scientist Incharge – IERP & INH,
G.B. Pant Institute of Himalayan Environment
& Development (GBPIHED),
Kosi-Katarmal,
ALMORA - 263 643, U.A.
(Nominee of Director, GBPIHED).

ANNUAL REPORT

2000-2001

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



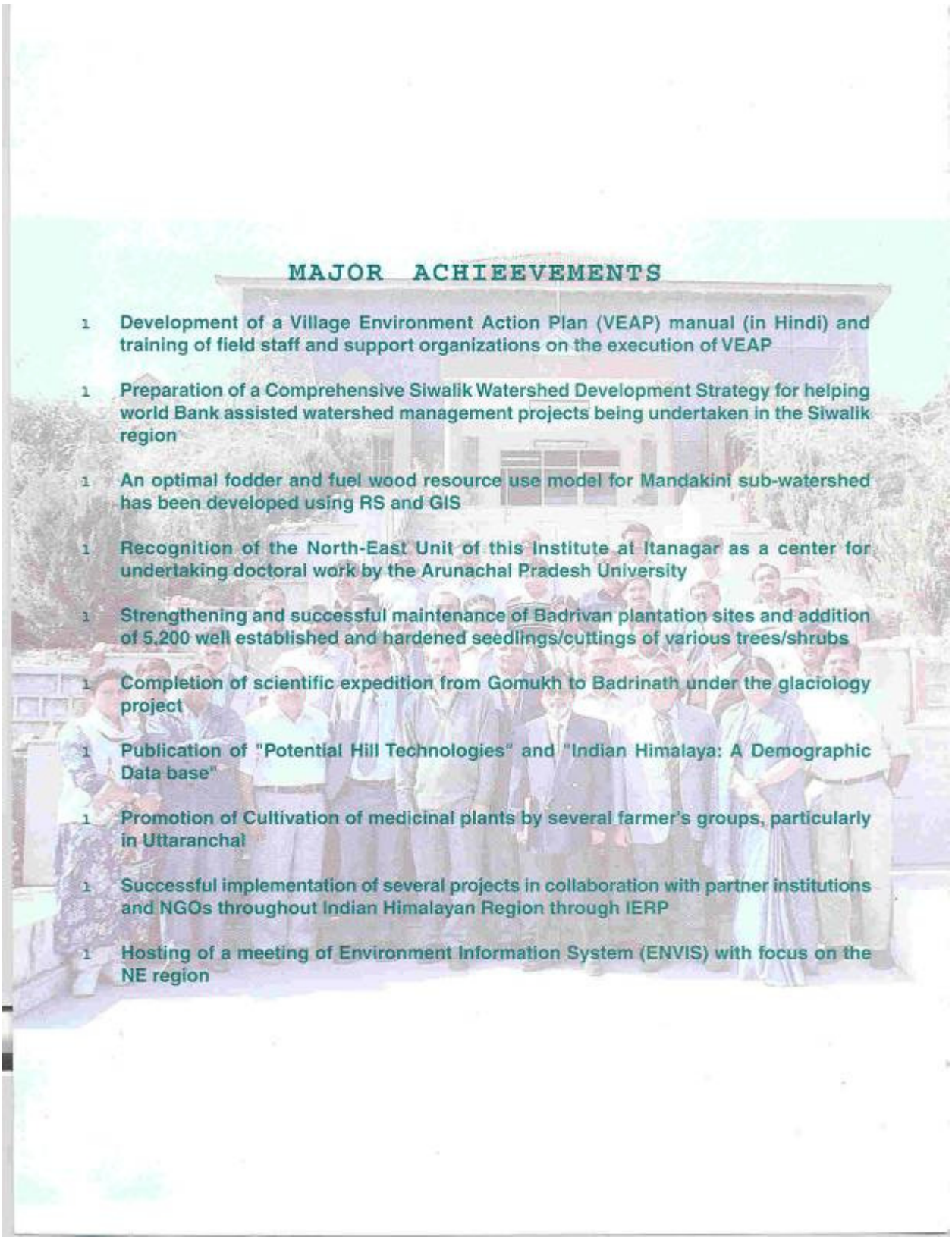
CONTENTS

Director's Foreword

Dr. L.M.S. Palni

The reporting year 2000-01 has been an important year for a variety of reasons. Since its inception in 1988, the Institute has continued to foster, carefully nurture, improve and develop various research and development programmes based on its mandate, under the supportive guidance of the Science Advisory Committee, members of the Board of Governors and the society. Over the years we have moved from descriptions to prescriptions and demonstrations. Initiation of a core group on "Indigenous Knowledge Systems" in the last reporting year has helped focus efforts on documentation of this time tested knowledge base. One of the significant developments during the year has been the establishment of a rural technology park for capacity building and economic upliftment with particular reference to women of the Indian Himalayan Region. Under this, training is provided through field demonstrations on a number of hill specific technologies, which can help provide solutions to many problems and give a much-desired boost to the income of the rural populace. Another important assignment undertaken during the year, was Compilation of a Comprehensive Siwalik Watershed Development Strategy, under the World Bank aided Watershed Development Projects being undertaken in five states, namely Jammu and Kashmir, Punjab, Himachal Pradesh, Harayana and Uttaranchal. It is envisaged that this strategy document will provide basic guidelines for effective implementation of Watershed Development Projects in the Siwalik Region. The Institute has also published a demographic data base for the Indian Himalayan region, and a complementary compilation on the social infrastructure is nearing completion.

The milestone events, mentioned in subsequent pages in this report, indicate that a number of noteworthy achievements were made. The Institute strengthened its ties with a number of National and International partners, and also established links with some more organizations committed to the welfare of the Himalayan region. The Institute has accordingly initiated new projects, in close association with the villagers and grass root NGOs to both learn from them and also to provide them with better options for economic development. The Institute also hosted a seminar on the "Role of Science and Technology in the Integrated Development of Uttarakhand" in cooperation with the Department of Science and Technology, Government of India. A National Workshop on "Himalayan Biodiversity 2000: Options for Development" was also organized by the Institute. Any comments and critique on the work presented in this report would be gratefully received.



MAJOR ACHIEEVEMENTS

- Development of a Village Environment Action Plan (VEAP) manual (in Hindi) and training of field staff and support organizations on the execution of VEAP
- Preparation of a Comprehensive Siwalik Watershed Development Strategy for helping world Bank assisted watershed management projects being undertaken in the Siwalik region
- An optimal fodder and fuel wood resource use model for Mandakini sub-watershed has been developed using RS and GIS
- Recognition of the North-East Unit of this Institute at Itanagar as a center for undertaking doctoral work by the Arunachal Pradesh University
- Strengthening and successful maintenance of Badrivan plantation sites and addition of 5,200 well established and hardened seedlings/cuttings of various trees/shrubs
- Completion of scientific expedition from Gomukh to Badrinath under the glaciology project
- Publication of "Potential Hill Technologies" and "Indian Himalaya: A Demographic Data base"
- Promotion of Cultivation of medicinal plants by several farmer's groups, particularly in Uttaranchal
- Successful implementation of several projects in collaboration with partner institutions and NGOs throughout Indian Himalayan Region through IERP
- Hosting of a meeting of Environment Information System (ENVIS) with focus on the NE region

Executive Summary
Research and Development Activities

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 has been placed on the preservation of fragile mountain ecosystems, indigenous knowledge and customs. A conscious effort is being made to ensure participation of local population for long-term acceptance and success of various programmes. The R & D activities of the Institute are centred around seven core programmes.

Land and Water Resource Management

The core activities have been focused on few selected themes during the year, namely, integrated watershed management (Sikkim and Garhwal Himalaya), water management through irrigation systems and rural water supply (Kumaun Himalaya), soil and water conservation and slope stabilisation (Kumaun and Garhwal Himalaya), and land restoration through participatory programme of Badrivan restoration. The main thrust of all these programmes has been on extensive use of biological measures through land restoration techniques (SWEET), use of agroforestry models, mountain risk engineering techniques, bioengineering for spring recharge and propagation of multi purpose tree species. In-situ water harvesting is demonstrated using low cost polylined tanks at all sites. Study of traditional system of irrigation water management was continued and studies of soil and water conservation practices have been initiated during this year. To involve local people and pilgrims in stabilization and restoration of Badrivan, the nursery at Hanumanchatti was further strengthened and a plant distribution ceremony was organized at Badrinath. Use of latest technique of Global Positioning System (GPS) has been continued for quantification of tectonic deformation fields in Kumaun Himalaya and a continuous reference GPS station has been set up at the Institute campus for future studies. A hydro-meteorological station has been installed at Gomukh, Gangotri glacier (4000m msl).

Sustainable Development of Rural Ecosystem

During the year studies on the natural resource management strategies of various indigenous societies of Himalaya were undertaken. The studied communities are Tangsa (Lunchangs and Jugli) tribe in Changlang area; Adi (Abor-Minyang) tribe in Pasighat area; Nyishis (Daflas) in Papum Pare area; Apatanis of Ziro area of Arunachal Pradesh, and Tolchhas of Joshimath area in Garhwal. Except the Tolchhas all other traditional communities are from northeastern India and the studies have concentrated on the natural resource utilization for sustainable livelihood options. The agrobiodiversity management strategies of Tolchha community were studied in detail over the last few years and the activity is in its concluding stage. The natural resource inventories in Hawalbagh block and Nanda Devi Biosphere Reserve were continued for effective development/ management planning and recommending sustainable livelihood options. These activities are still in resource inventory stages and the analysis of information will start in the next year or so. Demonstration of alternatives to shifting agriculture in north east India and restoration of degraded community lands and abandoned agricultural lands, and medicinal plant cultivation are out reach activities of the core programme on which farmers/local officials were provided information kits and hands on field training during the year.

Conservation of Biological Diversity

In view of the importance of primary data for biodiversity studies, database on protected areas (Askot and Kanawar Wildlife Sanctuary), subtropical/temperate and timberline zone were strengthened. Inventory of Himalayan Rutaceae was prepared and analysed for species richness, nativity and endemism. Development of propagation packages for important species (Multipurpose and Medicinal plants) strengthened the establishment of *ex situ* genebanks. The participatory biodiversity conservation programme was further strengthened through VII training workshop (March 2001). Responses of participants from three workshops were analysed for impact assessment of such programmes. The national workshop "Himalayan Biodiversity 2000: Options for Development" organized by the core group helped in putting the various issues of Himalayan Biodiversity

together for the formulation of an approach paper. As lead co-ordinating Institutions for R&D activities in selected Himalayan Biosphere Reserves the Institute has expanded its outreach in biodiversity related aspects.

Ecological Economics and Environmental Impact Analysis

The work on vehicular pollution and solid wastes, on account of increased tourism in the Himalayan region has been extended, to generate sound database, hence, the monitoring of air quality and characterisation of solid waste in Kullu-Manali region in Himachal Pradesh is under progress. Vegetable cultivation on commercial scale in the Khairna valley of Kumaon Himalaya has brought about rapid changes in land use, cropping pattern, socio-economics and environment. Hence a study has been initiated to carry out overall impact analysis of the situation in order to quantify the positive and negative changes. The impact of education and awareness on fertility behaviour of rural and urban Himalayan communities has been initiated in the Kumaoun region. The concept of Bioengineering and MRE has received attention for sustainable hill development. However, it is noteworthy that in spite of significant advancement in the field application of such mitigative measures, comparatively little development has taken place as far as their performance evaluation is concerned. The core, therefore, undertook evaluation activities in Kumaun and Sikkim Himalaya.

Environmental Physiology and Biotechnology

Concerted efforts are being made to understand the factors, which govern the productivity, functioning and regeneration of plant life, in the light of harsh climatic conditions prevailing in the Himalayan region. Over the years, the core activities have been largely based on use of conventional methods alongwith the blend of recent biotechnological techniques to meet the various R & D objectives. In view of these, studies of plant responses to environment, mass multiplication using conventional and tissue culture methods, (and increasing) and maintenance of soil fertility are underway. Plant microbe interaction studies with particular reference to the species of the Himalayan region are in progress. These include, isolation, screening and characterization of soil microbes of colder regions including rhizosphere communities. Microbial inoculants are being developed for biocontrol and better plant productivity. In addition, introduction of high value crops, fuel, fodder and biomass species has helped the local populace. Moreover, use of simple rural technologies has helped to improve the living standard of rural village communities.

Institutional Networking and Human Investment

Under the Integrated Eco-development Research Programme (IERP), seven projects (four to NGOs, two to Universities and one to Govt. Institution/Autonomous Organization) were sanctioned and funded during the year. Besides, funds for thirty (30) ongoing/-completed projects were also released. Twelve (12) projects were completed successfully during the year and 56 R&D projects were on-going in 10 Indian Himalayan states of the Country. Follow-up action on almost one hundred and seven (107) project files (old/fresh/on-going, etc.) was initiated/ completed during the year. Central plant nursery at Kosi (1,120m amsl) was maintained successfully during the year and strengthened by the addition of 17,095 trees/shrubs of various promising species. Furthermore, seeds of various multipurpose trees/shrubs were also collected during the year and subsequently sown in the seedling trays beds in the nursery. A three day on-site training programme (eighth of its kind) on nursery development, tree plantation techniques and natural resource conservation and management was also organized during the year at Shama village in Bageshwar district and fifty two (52) participants (including farmers, rural women, students, ex-service/army personnel and NGOs) were trained during the occasion. Three volumes of Hima-Paryavaran and the Annual Report of the Institute were also distributed by the Core to almost 597 individuals/ subject experts working on various aspects of mountain environment and development.

Indigenous Knowledge Systems

Recognizing the importance of indigenous knowledge and management practices of those high altitude societies, which still continue and preserve some of their traditional knowledge systems, it was decided to document their indigenous practices of natural resource management. The traditional practice of wool dyeing with natural colours made from various plant sources, and the indigenous method of making woollen garments have been documented, keeping in view the fast eradication of these practices. Similarly, the analysis of indigenous agricultural practices in the light of its efficiency and sustainability is also being analysed scientifically. The documentation of various landraces of traditional crops and their role in the agricultural systems is also

being analysed before they get phased out. These activities are still in their resource inventory stage and the analysis of information will start next year or onwards.

1. INTRODUCTION

The reporting year 2000-2001is twelfth financial year of research and development activities being carried out by the Institute at various locations in the Himalaya, in tune with regional issues, and is endeavoring to seek practical and workable solutions to specific problems. These activities include programmes supported through core funds provided by the Ministry of Environment and Forests, Govt. of India to the Institute and projects financed by external agencies (National and International). The Institute is also supporting activities of various partner Institutions in various Himalayan states through Integrated Eco-development Research Programme (IERP). The Science Advisory Committee of the Institute reviews the progress of existing projects and provides guidance and help to new programmes.

At present, the activities of the Institute are centered around seven designated core programmes. Several projects were successfully concluded during the year. Summaries of these are placed at appropriate places in the text. In due course detailed documents will be published and made available to the public. The progress made during the year 2000-2001 on various ongoing and newly initiated projects and a brief account of the academic and other activities, along with the statement of accounts, have been presented in this report. We would be most grateful for critical comments, suggestions for improvement and for indication of our shortcomings by anyone interested in the well being of the Himalayan society.

2. MILESTONE EVENTS

Hon'ble Union Minister of Human Resource Development, Prof. M.M. Joshi inaugurated a three day workshop from April 21-23, 2000 on the "Role of Science and Technology in the Integrated Development of Uttarakhand" at the premises of the G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora. Hon'ble State Minister of Science and Technology, Shri B.S. Rawat presided over the function. Shri M.S. Kandari and Shri Narayan Ram Das, Ministers in the Uttar Pradesh Government also graced the occasion. The workshop was organized by the Department of Science & Technology, Government of India, New Delhi and hosted by GBPIHED. The workshop was attended by around 300 participants including a number of Secretaries and senior officials from various Ministries and Departments of the Government of India, the State Government of Uttar Pradesh, renowned academics and scientists from all over India, NGOs and the representatives of the general public from Uttarakhand region. Some of the distinguished participants included Shri B.D. Pande, Former Governor of Punjab & West Bengal, Prof. V.S. Rammurthy, Secretary, Department of Science & Technology; Dr. (Smt) Manju Sharma, Secretary, Department of Biotechnology; Dr. D.N. Tewari, Member, Planning Commission; Shri N. Mookerjee, Secretary, MNES; Shri P.V. Jayakrishnan, Secretary, MNIT; Dr. Y.S. Rajan, Scientific Advisor to Govt. of India; Shri R.H. Khwaja, Jt. Secretary, Ministary of Environment & Forests; Shri S.N. Shukla, Principal Secretary, Uttarakhand Vikas Vibhag, Government of Uttar Pradesh; Dr. R.A. Mashelkar, Director General, CSIR; Dr. R.S. Tolia, Director, UP Academy of Administration; Dr. R.K. Pachauri, Director, Tata Energy Research Institute; Dr. B.S. Rajput, Vice Chancellor, Kumaon University; Prof. P.S. Saklani, Vice Chancellor, H.N.B. Garhwal University; Prof. H. Chowdhury, Vice Chancellor, G.B. Pant University of Agriculture & Technology; Prof. K.S. Valdiya, JNCASR; Dr. Sushil Kumar, Director, CIMAP and many others. Prof. M.M. Joshi while addressing the audience reiterated that the Himalaya is our country's pride and is a symbol of its value system, which cannot be segregated and is one entity. He questioned whether one should opt for technologies in toto from developed countries like Japan and the US, or go for technologies that are more relevant for the region. He was very pleased to announce that the Department of Biotechnology, Government of India will establish Resource Anushandan Kendra in the region for Kumaon and Garhwal, where G.B. Pant Institute of Himalayan Environment and Development will be involved as a nodal agency.

The Institute hosted a two-day meet (June 17-18, 2000) on Environment Information Systems (ENVIS) at its Sikkim unit, organized by the Ministry of Environment and Forests, Government of India. Shri Pawan Chamling, Hon'ble Chief Minister of Sikkim, was the Chief Guest and Dr. A.K. Kundra, Special Secretary, Ministry of Environment and Forests, Govt. of India presided over the meet. Over 100 participants from the entire northeast region, representing Universities, R&D institutions, NGOs and District Information Officers attended the meet. The presentations in the technical session by representatives of ENVIS centers provided a brief overview of database available at different centers and possibilities for accessing the data.

A three day National Workshop on "Himalayan Biodiversity 2000: Options for Development" was organized by the Institute at the

Headquarters from November 2-4, 2000. In all 51 experts belonging to 43 different Institutions of the country attended the workshop. The workshop included nine technical sessions and five working group discussions. The group discussions, which followed technical sessions, identified key issues under various themes to be taken up on priority. The participants agreed that the Action Points identified during the final round of group discussion should form the basis for preparation of an Approach Paper on Himalayan Biodiversity.

An automatic meteorological station (Weather Master Mark 4), has been installed by the Institute in the premises of Garhwal Scouts at Mana (3,133m amsl) in Badrinath on November 16, 2000. The annual meteorological data for Badrinath valley are not available till date because the valley remains closed from the middle of November to the middle of April due to heavy snow fall during the winter season. In due course of time, the meteorological data would be of great significance to planners and policy makers and also for proposing future strategies for R & D activities.

3. RESEARCH AND DEVELOPMENT PRO-GRAMMES

In order to achieve the sustainable development of the Indian Himalaya, research and development programmes of the Institute are 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 centred around seven 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, Institutional Networking and Human Investment and Indigenous Knowledge Systems. The achievement of goals and the progress made in various projects during the year have been placed under appropriate core programmes in the text. The project implementation sites have carefully been selected keeping in view the heterogeneous heritage of the Himalaya along with specific needs and aspirations of the local inhabitants. All activities are need based, target oriented and time bound; efforts are made to provide practicable solutions rather than theoretical prescriptions. To meet the targets, and to accomplish the objectives well equipped laboratories and computer facilities have been established. Rigorous data collection, development modification and demonstration of science and technology inputs, including technology packages of the Institute, are underlying elements of all project activities. While a number of projects were completed during the year, a few new projects were also initiated; most projects are now in their third or fourth year of operation. Highlights of the progress made during the year 2000-2001, along with a brief, conceptual background, specific objectives and major achievements are summarized for individual projects.

3.1. LAND AND WATER RESOURCE MANAGEMENT

Land and water are two basic resources on which the survival of mankind depends. In the Himalaya management of these two important natural resources is a difficult and complex problem. Sparse population, undulating terrain, tiny and scattered land holdings and inclement weather conditions characterize this region. Crops are cultivated on slopes with porous and gravely soil, scanty or no irrigation, and people depend upon surrounding forests for subsistence mode of livelihood. Major problems of land and water resources of the Himalayan region are: soil erosion, low irrigation opportunities, poor agricultural production, vanishing fuelwood and fodder resources and shortages of water for household consumption. Therefore there is a need to conduct R&D studies focused on sustainable use of land and water resources.

Theme leader

Kireet Kumar

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

Background

Irrigation development in most part of the Himalaya is very difficult due to rugged topography and the agriculture is mostly rainfed. In suitable locations seasonal small-scale irrigation systems form the integral part of traditional farming. Such small channels (locally called Gools) were traditionally built, operated and maintained by the farmer communities or individuals through various types of institutional arrangements. Some of these institutional arrangements are working successfully in the Central Himalaya. An attempt is made to document such traditional irrigation systems and study their performance in terms of irrigation efficiencies. This study proposes to analyze both successful and unsuccessful experiences in traditional as well as modern Government managed hill irrigation systems.

Objectives

1. Identification and study of operational and institutional aspects of different irrigation systems and the performance study for their comparative assessment under different environmental conditions.
2. Study of springs with particular reference to water availability, growing water demand and changing people's perception about rural water management.
3. To develop guidelines for integrated water management based on economic use of available water for irrigation and rural water supply.

Results and Achievements

1. Several traditional irrigation systems exist in the Kumaun region, which have command area ranging from 1-50 ha. These schemes do not conform to the norms of the state irrigation department, however such schemes are functional for more than 100 years. One such network of small canals was selected for the study in Pithoragarh district. Catchments of Tharigad, Viliagad and Kaphalgad (all tributaries of east Ramganga) are irrigated using a single source. Farmers have developed their own water distribution schedule of 20 and 15 days for different seasons. Equitable distribution of water and adhering to their water scheduling has been the reason behind the success of this scheme.
2. The water application efficiency ranges from 83.92 per cent to 95.65 per cent in these schemes, which is comparable with other community schemes in the region. The conveyance efficiency of canals in this scheme is about 85-92 per cent, which is higher than the conveyance efficiencies of other community canals in the region.
3. Water discharge of a drying spring treated with bio-engineering measures (spring sanctuary development) at Dugar Gad watershed in Pauri-Garhwal has recorded 37 per cent increase in water yield during summer 1999-2000, compared to the control year (Table 1). Most of this discharge was found relative to rainfall. In this WS about 56 per cent households collect roof top water (95 L/D), which is about one-third of the water consumed by them daily for different household activities.

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

Background

In the recent decades traditional knowledge has been recognized as an important starting point to bring out effective technology packages for natural resource conservation and management. Traditional soil and water conservation (SWC) in the Himalayan mountains is an important area in this regard. The predominant agri-sylvi-pastoral mode of livelihood in the mountains offer a wide range of SWC practices, which is almost difficult to understand and document.

Table 1. Rainfall and discharge relationship of spring

Water year (July-June)	Rainfall (mm)		Spring discharge (l/d) April –June	Water retention (% of annual rainfall)
	(April-June)	Total Annual		
1994-95	110	956	1055	7.0
1995-96	201	1567	1271	5.7
1996-97	428	1259	2311	6.8
1997-98	208	1260	4093	3.9
1998-99	233	1689	1360	9.2
1999-00	535	1942	2153	9.6

These practices have complex linkages with the social and environmental setting and they are cost effective too. The modern SWC technologies emerged from the concerned institutions have been felt inappropriate by the natives and warrant a fresh look on the whole approach of SWC, valuing traditional knowledge. Further, the evaluation of traditional SWC knowledge vis-a-vis modern technology also needs benefit-cost analysis and socio-economic feasibility of adoption of these technologies.

Objectives

1. To identify and document traditional soil and water conservation (SWC) practices in Himalaya.

2. Quantification of soil loss in different land use practices with or without SWC measures.

3. Assessment of performance of selected low cost bioengineering measures and evaluation of its techno-economic suitability.

Results and Achievements

In two micro-watersheds of Garhwal Himalaya hydrometerological studies were undertaken since 1994, and Dugar Gad WS was treated with some SWC measures under an in-house core project. Seven-year data reveal that stream flow peak in Srikot Gad, which has a high proportion of forests and low proportion of wasteland, was delayed by about one month.

In the Himalaya, crop fields are either slope modified or created on alluvial deposits along riverbeds. They are exposed to different SWC challenges. The stone and mud built terrace risers are generally 1-2 m high in slope modified terraces and < 1 m high in alluvial terraces. They have a fine masonry work to withstand the irrigation water overflows and avoid wall collapse. With the increase of slope the height of terrace riser and length of terrace is increased and width is reduced. The crop field bunds of slope modified terraces are usually > 0.3 m high, and kept low (< 0.3 m) for the irrigated crop fields on alluvial terraces to avoid the chances of water stagnation and likelihood of wall collapse.

In Garhwal, three traditional methods are in practice to raise nursery for paddy rice. In one practice, seed is broadcasted uniformly on the seedbeds. This practice requires more water for extraction of seedlings and chances of root damage are high. In other practice, about 15 cm deep channels are dug out on seedbeds and seed is sown on ridges. Irrigation water moves from one furrow to another connected at the end. This practice is water conserving and seedling extraction is easier. The third practice is rather simple, which involves ploughing in a circular fashion starting from center of the field and the seed is sown on the furrows created after ploughing (Fig. 1). Irrigation water is allowed to enter from the periphery, which moves gradually to the centre through the furrow. This practice is less labour intensive and water conserving.

In the Himachal Himalaya two types (narrow and wider) of terraces are found. The narrow terraces are fragile and sensitive to erosion. Width of the wider terraces on gentle slopes up to 35° range from 30 to 50 m. These terraces are quite stable and have fodder, fuelwood and fruit trees along their margins, which act as soil binder. Wider terraces are common up to 1500 m altitude in the entire Kullu valley. During rains overflow from these terraces is channelized for safe disposal.

Indigenous knowledge of SWC is quite rich in Sikkim Himalaya. A questionnaire survey showed that crop rotation, mixed cropping, minimum tillage, agroforestry, seasonal fallowing of crop fields is considered to be helpful in SWC by the local inhabitants.

3.1.3. Badrivan Restoration Programme

Background

The mythological/cultural, historical and scientific evidences indicate that Badrinath Dham (3,133m amsl) had dense vegetation/forest

Fig. 1. Nursery raising of paddy in some parts of Garhwal

around it in the past. However, at present there is hardly any trace of forest around this shrine. In recent past, some government and non-government organizations have attempted tree plantations around the shrine and other adjoining areas. However, there has been hardly any success. The probable reason for the failure may be incorrect selection of tree/shrub species and the lower age of the seedlings/saplings at the time of plantation. Furthermore, no attempts were made (before the closure of the site) for the protection of seedlings during winter months (when the valley remained closed). In view of the above, it was considered to initiate mass scale afforestation programme (based on scientific, cultural and spiritual/religious values) for the revival of Badrivan (the ancient sacred forest of Badrinath) in and around Badrinath shrine.

Objectives

1. To involve pilgrims and local people in environmental conservation and promote environmental awareness.

2. To prevent soil erosion and stabilize soil in and around Badrinath area.

3. To revive Badrivan at Badrinath in Chamoli Garhwal.

Results and Achievements

1. High altitude plant nursery at Hanumanchatti (2,500 m amsl) in Chamoli Garhwal was maintained and strengthened successfully during the year (i.e. from 10th May 2000 to 16th November 2000). Five thousand and two hundred (5,200) well-established and hardened seedlings/cuttings of various trees/shrubs were planted at different project sites (including Hanumanvan) during the year whereas eight thousand and six hundred eighty (8,680) seedlings/cuttings of 28 trees/shrubs were distributed, free of cost, to various NGOs/Govt. organisations/Army regiments, villagers and local people for plantation purpose. During the year, Hanumanchatti nursery was enriched by ten thousand and eight hundred fifty (10,850) seedlings/cuttings of 8 high altitude trees/shrubs. In all, twelve thousand and five hundred eleven (12,511) seedlings/cuttings of 28 high altitude trees/shrubs were available at the nursery in Hanumanchatti before the closure of the site (i.e. November 16, 2000).

2. All the Badrivan project sites (including Hanumanvan) were maintained and strengthened successfully during the year. In Hanumanchatti, three thousand and one hundred ninety two (3,192) well established and hardened seedlings/cuttings of twenty eight (28) high altitude trees/shrubs were planted at Hanumanvan project site. However, two thousand and eight (2,008) seedlings/cuttings of five (5) high altitude trees/shrubs were planted at different project sites in Badrinath valley. Almost 79% plants were observed well survived at Hanumanvan project site whereas 54% plants were found survived at different Badrivan project sites in Badrinath valley.

3. Seed germination potential of 10 promising high altitude trees/shrubs were recorded carefully during the year at two different locations [i.e. at Hanumanchatti nursery (2,500m) in Hanumanchatti and Rakshavan nursery (3,133m) in Badrinath]. The seeds of Akhrot (*Juglans regia*) exhibited highest rate of germination at both the locations/altitudes.

4. A Plant Distribution Ceremony (fourth of its kind) was organized on 25th August 2000 at Badrinath. A large number of well-established and hardened seedlings of Akhrot (*Juglans regia*) were distributed (free of cost) among the local inhabitants, villagers, priests (purohits) and saints for plantation in and around their habitations in Badrinath valley (Fig. 2).

Fig. 2. Plant distribution ceremony at Badrinath

5. Meteorological data (air temperature, relative humidity and soil temperature) at the intervals of 30 days were recorded during the year (i.e., w.e.f. May 2000 to November 2000) at the nursery in Hanumanchatti. On 16th November 2000, an automatic meteorological station (Weather Master Mark 4) was also installed successfully in the premises of Garhwal Scouts at Mana (3,133m amsl) in Badrinath.

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

Background

People and Resource Dynamics Project (PARDYP) is a regional collaborative programme involving local, national and international (Univ. of Berne, Univ. of British Columbia,

Chinese Academy of Sciences, Pakistan Forest Institute, HMG of Nepal and GBPIHED) partners, each contributing to the project objectives in their respective areas of comparative advantage. Considering a success of PARDYP Phase-I, extension was given for another three years (till Sep, 2002) begun on 1.10.99 with the recommendations / remarks of the review mission that " In view of its (Phase-I) many successes and unrealised potential, PARDYP should proceed to a second phase". The real challenges for phase II is to synthesize the data and pass on the relevant information to the different stakeholders. Increased aspirations of the watershed peoples are being partially fulfilled through small scale on farm activities, demonstrations, community based natural resource management programmes etc., on the basis of priorities fixed by the villagers during PRA exercise. Efforts are being made to approach the "research for development" philosophy by ensuring active participation of the community and stakeholders at different level.

Objectives

1. To build on and generate knowledge and facilitate the exchange and dissemination of information and skills in the middle mountains of HKH region.

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

3. To enhance the capacities and options of families and communities, especially marginalized people, in the use and management of natural resources in mountain watersheds and thereby to increase household and community benefits.

Results and Achievements

1. Watershed received 179.7 cm precipitation during 2000, which was significantly higher than that of 1999 (99.52 cm) and slightly higher than that of 1998 (169.49 cm). Out of the total precipitation, 139.8 cm was recorded during monsoon. Maximum soil loss is recorded from grazed pine forest (4.353 t/ha/year) followed by degraded land (2.477 t/ha/year), Tea-plantation area (1.511 t/ha/year) and agricultural land (0.125 t/ha/year).

2. Comparative study of two major crops showed a net profit of Rs. 66,627=00 /ha by growing Colocacia against traditional crops during monsoon and Rs. 11,183=00 by growing Pea against traditional crops during winter.

3. Lack of employment opportunities, insufficient cultivable land, poor farm production etc. are some of the main push factors leading to out migration, whereas support by kin and kith, access to modernity and better quality of life are some of the pull factors. Briefly, it was found that push and pull factors have impacted 72.09 % and 27.91%, respectively.

4. After 4th year, villagers have started harvesting leaves for winter fodder from *Grewia optiva* and *Bauhinia retusa* at Arah rehabilitation site. A villager's society had been formally formed in 1999 for managing the site. During the year villagers have harvested approximately 9 tonnes of grass worth Rs. 20,000, which they used to buy from outside sources till some time back. At Khaderia (new rehabilitation site), local community is properly managing all the species planted and survival rate of 92% has been recorded in 2000. From the same site, individual households (total households associated with the site are 67) have taken 4 head loads of green grass each during the year, which has never been the practice earlier due to open grazing. At another rehabilitation site (village Doba), over 90% survival rate of planted species has been recorded during the year. Water harvesting activities at both the rehabilitation sites are fully functional and are fulfilling the requirement.

5. Major areas of livelihood i.e. agriculture, horticulture, livestock, pisciculture, bee keeping, poultry, minor forest produces have been identified through PRA and initiatives to strengthen these activities have already been started with peoples' participation.

3.1.5. Hydrometry and Estimation of Sediment Load of Gangotri Glacier in Garhwal Himalaya

Background

The Gangotri glacier as well as its tributaries is all valley glaciers. The main Gangotri glacier drains in northwesterly direction from Badrinath group of peaks. The Bhagirathi river originates at the snout of glacier located at Gomukh in the northern most end of the glacier. Huge amount of sediment is transported through this glacier to lower valleys where several medium and large dam projects are being constructed. Study of sediment yield rates and its correlation with melt water discharge is of immense importance for the life of these projects. This study was initiated in year 1999 with financial support from Department of Science and Technology to study the discharge and suspended sediment of melt water stream.

Objectives

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

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

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

Results and Achievements

1. Melt water discharge from Gangotri glacier was measured for the ablation season (May to October 2000). Total melt water yield from the Gangotri glacier catchment was estimated as 547.47×10^6 cum during this ablation season. The discharge in 2000 was lower than the discharge in 1999 for the same period.

2. During the 2000-ablation season, monthly-suspended sediment load was highest in July (Fig. 3) as 48.23×10^4t and it was minimum in the month of October 0.02×10^4 t Total suspended sediment yield from the glacier during the observation period was 104.99 x 10^4 t, which is lower than the sediment yield of year 1999. Reduction in discharge was responsible for this decrease in this year.

Fig. 3. Sediment sources of Gangotri Glacier

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

Background

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

Objectives

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

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

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

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

5. Quantification of ecological and hydrological inter-linkages using mathematical models.

Results and Achievements

(a) All the streams attain significant sizes during the rainy season. The highest discharge of 6610 l/s was recorded in the month of August and the lowest of 467 l/s in the month of February in the Rinzikhola, the outlet of the watershed. Soluble organic carbon in the streams varied with season. The soluble organic carbon ranged from 43.5 ± 1.10 to 46.8 ± 0.62 mg/l in winter season, from 33.2 ± 0.91 to 34.2 ± 0.57 mg/l in summer and from 29.9 ± 1.12 to 38.3 ± 0.78 mg/l in the rainy season.

(b) Effect of change in land-use/cover on soil organic matter was studied along the altitudinal gradients in the watershed. The total organic carbon values for the soils ranged from 0.964 to 4.216% in the surface layer (0-15cm), slightly decreased to 0.62 to 2.55% in 15-60cm and then drastically decreased to 0.04% at 1m depth. It was recorded highest in dense mixed temperate natural forest and ranged from 4.22% at 0-15cm to 1.14% at 1m depth.

(c) Microbial biomass carbon was estimated on seasonal basis from the soils of different land-use/covers. The microbial biomass carbon varied with season (Fig. 4). The microbial biomass carbon was recorded highest in the dry winter season followed by summer and lowest in the rainy season in all the land-use/covers. The highest value was recorded in dense mixed temperate natural forest and lowest in subtropical open cropped area. On seasonal basis the microbial biomass carbon ranged from 416 µg/g to 1133 µg/g in winter; from 356 µg/g to 947 µg/g in summer and 219 µg/g to 921 µg /g in rainy season on dry weight basis when compared between soils of different land-use/covers.

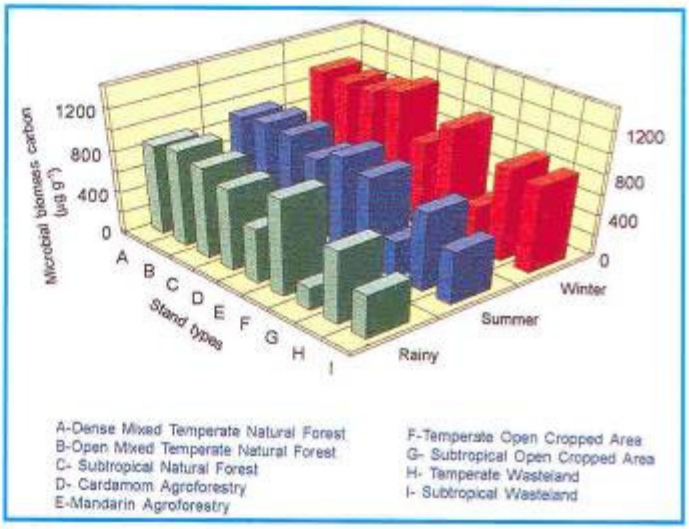


Fig. 4. Seasonal variation in microbial biomass carbon (µg/g) between soils of different land use/cover types

3.1.7. A Continuous Reference GPS Station at GBPIHED, Kosi-Katarmal, Almora

Background

Effective measures to enhance our resilience to inevitable natural hazards and thereby mitigate their disastrous impacts can, however, be designed by creating illuminating knowledge bases about the rates and style of ground deforming processes. The knowledge of landform changes in landslide prone areas could be used to design remedial measures and develop advance-warning systems. The above issues can be scientifically addressed using the modern tools of Global Positioning System (GPS), which essentially allows one to determine the location of any point on the globe with an accuracy of a few millimetres. Repeat measurements of the coordinates of some fixed points in a deforming region, thus yield changes in their position with time and thereby knowledge of their velocities with respect to some fixed reference points. A high precision Global Positioning System (GPS) installed in the campus of the GBPIHED, at Katarmal, has recorded data continuously since October 1997.

Objectives

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

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

3. To test models of continental deformation in the Himalaya through repeat determinations of south to north strain rate gradients from the northern edge of the rocky Indian Shield (Delhi/Jhansi) through the Kumaun Tethys Himalaya unto the Indo-Tibetan border (Untadhura, Kingribingri/ Lipulekh).

Results and Achievements

1. The field campaign continued during this year and GPS data was generated for determining the south-north gradient of strain accumulation rates right through and across the great Himalaya (from Almora to Milam). The GPS station at Katarmal was developed as one of the permanent station under the DST program of GPS surveys network.

2. Data generation and archiving was done for permanent station along with other field campaign sites.

3.1.8. Ecology of Reduced Tillage and Mulching in Central Himalayan Cropfields

Background

In the Central Himalaya most of the cultivation is rainfed and the sloppy terraces are prone to runoff and soil loss under the influence of monsoon rainfall. These cropfields are tilled twice (2T) and a large amount of FYM is applied every season. This conventional practice (CT) incurs a lot of human labour and forest biomass. The project aimed at whether the tilling could be reduced to once (1T) or to even zero tilling (NT), and whether the FYM could be replaced with Oak, Pine and Lantana leaf litter mulch without reduction in crop yield to find tilling and mulching practices favourable for soil fertility and SWC.

Objectives

1. To monitor soil moisture, soil temperature, soil nutrients (total N, NO_3-N, NH_4-N, organic C, available P and K) under different tillage and mulch materials.

2. Quantification of crop yield, runoff, soil loss and nutrient leaching under different treatments of tillage and mulching as compared with traditional practices of crop cultivation in rainfed farming.

Results and Achievements

1. Across the tilling treatments (NT, 1T and 2T) mean annual soil temperature was uniform (21 °C), the maximum value was recorded for CT (28.4 °C). Mean annual soil moisture was highest for 2T (16%) and lowest for CT (12%). Mean annual available soil N (NO_3-N and NH_4-N) was found highest for 2T (11.3 and 19.5 μg/g, respectively) and lowest for NT (9.8 and 16.8 μg/g, respectively). Under the CT soil NH_4-N (12.6 μg/g) and NO_3-N (16.4 μg/g) was found maximum. NH_4-N under Pine (8.3 μg/g) and NO_3-N under Oak mulch soils (15.1μg/g) were found minimum.

2. Annual soil loss was recorded maximum under 2T (16.1 g/m²). When considered across mulch materials, this value was lowest for Pine (8.6 g/m²) and highest for CT (70.1 g/m²). Under both 1T and 2T runoff was low compared to NT. Grain yield for both wheat (102 g/ m²) and paddy (72 g/m²) was recorded under 2T and Lantana mulched plots. The crop residue yield for 2T was also maximum for wheat (280 g/m²) and paddy (256 g/m²). Both grain and crop residue yield were found minimum under CT.

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

Background

A variety of environmental hazards such as landslides, floods, etc. are inherent in the Himalayan domain. However, the magnitude of these hazards varies both spatially and temporally. It is of special significance to understand the severity of these hazards with land use/land cover and resource use practices. The optimal limit of resource available and sustainable harvests should also be worked out. The use of RS and GIS techniques is extremely useful to monitor these changes and extrapolate the results on a larger scale.

Objectives

1. Productivity estimation of different land use and land cover in Alaknanda valley and development of a management model for optimal resource use (fuelwood and fodder) for Mandakini sub watershed using RS and GIS.

2. Model study of landslide hazard zonation along Chamoli-Tapoban-Joshimath road section.

Results and Achievements

1. An optimal resource use model for Mandakini sub-watershed in the Alaknanda valley of Garhwal

Himalaya revealed that 69667 t/yr fodder is available at optimal level of production, which is 11.96×10^4 t/yr short of the total consumption. Out of the total 450 villages in this sub-watershed only 39 villages show surplus fodder availability at optimal level of production and 102 villages fall in deficit category even when total production is considered. Similarly, optimal fuelwood production was computed 26.23×10^4 t/yr and 176 villages show surplus fuelwood availability. At optimal level of fuelwood production 286 villages fall in deficit category.

2. Land use/cover map (LISS III) shows that Mandakini sub-watershed has about 1632 km^2 area, out of which forests occupy 50.5%, agriculture (16.2%), grasslands (7%) and the remaining 26.3 per cent area is represented by snow cover, mountain scrubs, barren rocks, old and active landslides and river/streams. The forests were further divided into eight classes (Fig. 5).

3. Landslide hazard map has been prepared on 1:25,000 scale in GIS environment for Chamoli-Joshimath-Tapoban road sector in Garhwal Himalaya. Five landslide hazard units from very low, moderate, high and very high were identified in the area. Very high landslide hazard zone has 16.4 km^2 while high landslide hazard zone has 53 km^2 out of 427 km^2 study area.

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

Background

The concept of river basin planning and watershed management is not new. Present study aims at to study hydrogeomorphology, cover types, social and economic structures and develop environmentally sustainable model of development for Takoli Gad watershed, which forms the tributary of the Alaknanda river. The watershed has been selected for the following reasons: (i) irrigation facilities are less, non-effective and shortage of water reservoirs, (ii) viability for project implementation, (iii) willingness of the beneficiaries for watershed development, (iv) shortage of fuelwood and fodder, and (iv) increasing land degradation.

Objectives

1. To collect primary and secondary information related to socio-economic conditions, agriculture, livestock, water resources, natural resource utilization pattern, employment, irrigation, etc.

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

Results and Achievements

1. Delimitation of the study area and maps related to drainage, land use, road network and settlements were prepared. Takoli Gad WS has about 14670 ha area, out of which agricultural area is 35.7%, forest area is 50.4% and wasteland 13.9%.

2. Out of the total 75 villages within this WS, 31 villages were surveyed for socio-economic and natural resource-use pattern. Fuelwood consumption was estimated maximum (10.8 kg/household/day) in the high altitude villages (1500-2500 masl) villages, which declined towards the low altitude villages (10.6 kg/household/day) at 1000-1500 masl and 7.91kg/hh/day at < 1000 masl. Similar trend for fodder consumption was recorded. The high altitude villages consume 12.7 kg and the low altitude villages 11.9 kg fodder household/day.

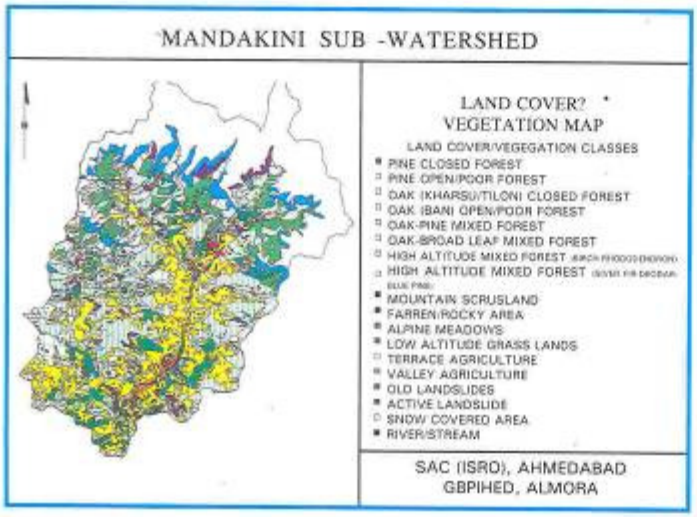
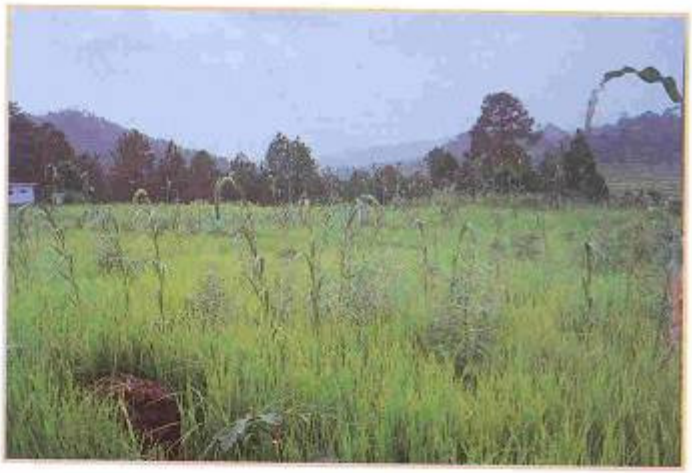


Fig. 5. Land use/cover map of Mandakini sub-watershed

3.2. SUSTAINABLE DEVELOPMENT OF RURAL ECOSYSTEMS



The Programmes under the mandate of this core are designed to provide some solutions to location specific problems of natural resource management. To study the availability, use, requirements and prospects of managing currently available resources more judiciously so as to reduce the pressure on limited resources. In Himachal the ability of pine forests to provide required organic resources needed for crop production and horticulture are being studied. In U.P. hills efforts are continuing to assess the impact of restoration models on soil physico-chemical characteristics to test the suitability of selected species for agroforestry systems.

In Arunachal the transhumant community dependence on natural resources as well as their management strategies were assessed. A focussed study on Nanda Devi Biosphere Reserve buffer zone villages was undertaken on peoples utilization of agricultural diversity and landuse/cover change database for analysing its impacts. Similar strategies are being tested in a development block (Hawalbagh block) where conservation priorities are not imposed to assess the natural resource based planning prospects.

Theme leader

K.S. Rao

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

(a) Natural Resource Management for sustainable development

Background

In order to understand the natural resource use pattern and the sustainable management practices by the different tribal communities of the region, this study was undertaken. In the first year, three tribal communities of West Kameng, Lower Subansiri and Changlang districts were studied in terms of developing and demonstrating the utilization potential of local resources for sustainable rural development based on participatory approaches.

Objectives

1. To assess natural resources,community structure and sustainable management practices among selected tribal communities
2. To quantify the status of resources and traditional utilization patterns
3. To assess effectiveness of Customary Laws and their functioning
4. To quantify and assess the ecological efficiency of traditional natural management practices

Results and Achievements

1. The West Kameng covers an area of 7422 sq. km and varies in altitude from 100 m in valleys to 7090 m and is inhabited by Monpas and Sherdukpens of Buddhist origin, besides, Miji, Aka, Bogni, Sulung and Nishis as other major tribes of this area. Monpas and Sherdukpens inhabit major part of the area.
2. West Kameng district forms a cultural transition zone from settled agriculture in Tawang to increasing shifting cultivation in West Kameng and other eastern region districts of Arunachal Pradesh and other northeastern states. Houses made up of bamboos replace the permanent stone and mud-constructed houses of Tawang. Nearly 56421 people inhabit the area according to 1991 census with a population density of 8 persons per sq. km.
3. As a result of differences in altitudes and topography there exists a multitude of different vegetation so peculiar to each locality governed by the associated locality facts. The problem perspective and management requirements of diversified resources in such a large area are different, and the Forest Department mainly takes care of biological resources through a network of Forest Divisions, viz. Khellong (Hqs- Bhalukpong), Shergaun (Hqs- Rupa), and Bomdila (Hqs- Bomdila).
4. Two wildlife sanctuaries, viz. Sessa Orchid Sanctuary, and Eagle Nest Sanctuary also fall in this area. The Sessa orchid sanctuary was established in 1979 in an area of about 85 ha, which was subsequently extended to 100 km^2, with an elevation range from 100 to 3000 m, to provide natural habitats for large number of orchids that inhibit the sanctuary. The vegetation is dense consisting primarily of subtropical evergreen forests, temperate and sub-alpine forests. There is no scientific supervision at present. Road/path network is virtually nil within the sanctuary.

(b) Land use models for Himalaya

Background

Tree-crop-livestock integrated subsistence rainfed farming is the predominant traditional land use in the central and western Himalaya. Species diversity, density and spatial patterns of multipurpose trees are highly variable in traditional farms because trees are maintained by selective protection of natural regeneration rather than by planting. Though substantial information is available on structure and ecological and economic attributes of agroforestry systems in the region, studies on impacts of trees on crop yields are limited and confined largely to exotic forest and commercial horticultural species. The aim of this study was to evaluate the impact of varied lopping regimes on productivity of important traditional crops.

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

(a) Central Himalaya

1. Photosynthetically active radiation (PAR) available to understorey crops increased with increasing intensity of lopping but differences between unlopped and 25% lopping treatments were not

significant (P>0.05) except for the month of September. Winter crops in unlopped, 25%, 50% and 75% lopping treatments received 15.97%, 19.04%, 44.56% and 80.60% of mean (of winter crop season) PAR received in 100% lopping treatment, as compared to 12.14%, 15.71%, 39.60% and 78.8%, respectively, in rainy season crops. Temporal fluctuations in PAR were more marked in 100%, 75% and 50% lopped treatments as compared to unlopped and 25% lopping treatments.

2. Air temperature 1.5 m above ground level increased with increasing intensity of lopping but the differences between two successive treatments were not significant (P>0.05) in most months. Mean temperature was higher by 0.26, 0.78, 1.38 and 2.1 °C in 25%, 50%, 75% and 100% lopping treatments as compared to unlopped plots in winter as well as rainy season crops (Fig. 6).

3. There were not significant (P>0.05) differences in grain or crop-by-product yields between unlopped and 25% lopping, and 75% and 100% lopping treatments (Fig. 3ab). Grain yield in wheat, mustard and lentil (winter crops) in 75% lopping treatment was 4.7, 3.7 and 3.9 fold higher, respectively, than that in 25% lopping treatment compared to 18.3, 15.8 and 11.7 fold difference in paddy, foxtail millet and barnyard millet, respectively. Crop by-product yield from winter crops in 75% lopping treatment was 2.3 – 2.8 fold of that from 25% lopping treatment compared to 8.8 – 10.5 fold difference in case of rainy season crops. For each crop, grain as well as by-product yields were positively correlated (P>0.05) with PAR available to crops and temperature 1.5 m above ground level.

4. Fodder and fuelwood availability from free component increased from 4.0 and 5.3 t ha^{-1}, respectively in 25% lopping treatment to 17.5 and 17.9 t ha^{-1}, respectively, in 100% lopping treatment (Table 2).

(b) Northeast Himalaya

1. Impact of hedgerows, and hedgerows+mulching on yield is being monitored for selected crops. The selected crops are traditionally used jhum farming systems. One control site was maintained at experimental site while data was also collected from the jhum fields. The experiment proves that hedgerow mulch has significant impact on the crop yields, and showed a positive impact, to a higher extent on vegetable crops, followed by food grains and to a lesser extent on underground crops.

Table 2. Fodder and fuelwood availability (mean ± standard deviation, n=9) from different lopping regimes (natural twig/ branch falls were not measured).

Lopping regime	Availability (t ha^{-1})	
	Fodder	Fuelwood
25% lopping	4.0±0.4	5.3±0.3
50% lopping	8.4±0.6	10.3±0.8
75% lopping	14.1±1.1	14.6±0.7
100% lopping	17.5±1.3	17.9±0.8
Least significant difference (P=0.05)	0.9	0.6

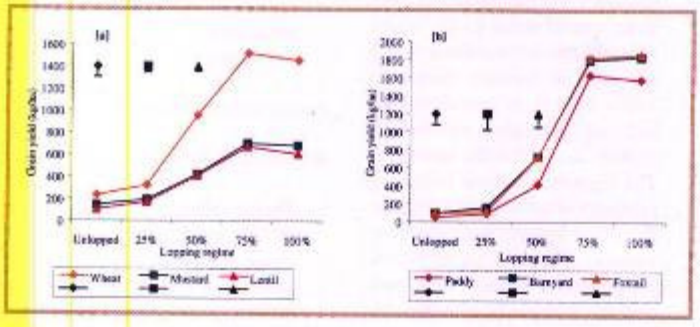


Fig. 6. Effect of lopping on yield of different crops

2. Four major hedgerow species (i.e *Desmodium rensonii, Flemingia macrophylla, Indigofera anil* and *Tephrosia candida*) have been selected to measure the mulch (prunned biomass) and litter decomposition rates in view to assess the nutrient release pattern. It was observed that the mulch decomposes faster than the litter. Among all the species tested, leaves of *D. rensonii* decompose much faster.

3. The soil showed an increase in nitrogen, phosphorus and carbon level in hedgerow sites than the control plots, indicating that faster nutrient back translocation through mulch help not only the crop but to soil as well (Table 3). To monitor soil-loss and run-off measurement, the experiment is being maintained at ATSCFS project Longnak in Nagaland.

3.2.2. Inventory, Commercial Utilization and Conservation of Agrobiodiversity for Sustainable Development of the Buffer Zone Villages of Nanda Devi Biosphere Reserve in Central Himalaya.

(Summary of the Completed Project)

Background

Agriculture in the buffer zone of the Nanda Devi Biosphere Reserve (NDBR) is characterized by a substantial diversity and a high degree of self-reliance. During the recent past a variety of changes have been observed in the traditional agricultural systems. These changes are driven by socio-economic-cultural changes, conservation policies, reduced availability of natural resources to support agriculture and poor off-farm economic avenues. The change from traditional food crop agriculture to traditional cash crop based agriculture has been advancing since last few decades resulting in huge loss of traditional agrobiodiversity. The ecological and economic security of the traditional farming system appears to be in jeopardy in this area as also observed in other parts of the Central Himalaya.

Objectives

1. To analyze the land management cultural practices and eco-physiology requirements of traditional under-utilized crops and their comparison with common crop agroecosystems.

2. To study the contribution of traditional under-utilized crops in meeting the food requirements of traditional societies in terms of quantity, energy and protein.

3. To survey all plant species of potential food value which have

Table 3. Status of soil at initial and after one-year of hedgerow incorporation at Midhpu, AP

Treatment/ Hedgerow spp.	Field location	Soil depth	pH	N (%)	C (%)
Initial:					
Control	All field	0-15	6.01±0.01	0.165±0.004	1.35±0.02
		15-30	6.00±0.02	0.141±0.009	1.33±0.01
Plots designated for	All field	0-15	6.21±0.11	0.181±0.009	1.38±0.09
hedgerows plots		15-30	6.10±0.01	0.168±0.021	1.34±0.08
After one year:					
Control	All field	0-15	6.29±0.35	0.160±0.013	1.42±0.01
		15-30	5.76±0.01	0.156±0.001	1.34±0.02
Flemingia + Indigofera	Mid-alley	0-15	6.28±0.01	0.188±0.005	1.51±0.02
		15-30	6.27±0.02	0.174±0.010	1.17±0.01
	Near hedgerows	0-15	6.18±0.01	0.261±0.001	2.65±1.20
		15-30	5.95±0.01	0.189±0.005	1.19±0.01
Tephroshia + Flemingia	Mid-alley	0-15	6.39±0.05	0.301±0.009	2.23±.001
		15-30	6.06±0.02	0.158±0.005	1.29±0.002
	Near hedgerows	0-15	6.24±0.01	0.366±0.005	2.24±0.01
		15-30	6.16±0.01	0.213±0.005	1.38±0.016

Samples for near hedgerow were collected for a distance <30 cm from hedgerow species

been domesticated by the traditional societies.

4. 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.

Results and Achievements

1. Present study reveals declining traditional crop diversity during a very short period of two and half decades (1970-95). Many traditional crops have been replaced by those which attained the status of 'cash' crops like potato, kidney bean, amaranth, and *Fagopyrum tataricum* (oggal). Reduction in crop diversity, in the present case, is a cumulative effect of a variety of factors including (i) reduced availability of biomass from the forests and pastures, the very base of sustaining traditional diversified agriculture, (ii) rapid socio-economic and cultural changes favouring a shift from subsistence to market economy, (iii) large scale migration for off-farm employment, and (v) lack of incentives for marketing of diverse products from traditional agroecosystems.

2. Limited opportunities for income generation force the farmers to sell surplus agricultural produce at low prices to the traders against case payment or bartered in exchange of food commodities like rice, sugar, salt etc. Farmers are not conscious about the margin of profits realized by, the middlemen or terminal traders.

3. Based on the findings of the project appropriate strategies were developed to improve the productivity and sustainability of the traditional agriculture of this region which includes: (i) need to improve the traditional technologies of soil fertility maintenance and agronomic practices to enhance the yield in their natural habitat while making use of locally available natural resources, (ii) mixed cropping of *Solanum tuberosum* + *Amaranthus* spp. or *Solanum* + *Phaseolus* needs to be emphasized since legumes are known to improve the soil fertility, while providing high economic returns, (iii) the agriculture particularly at lower region of buffer zone need to be further strengthened through agri-horticultural inputs (such as *Prunus* spp., *Juglans regia* etc.) which are highly remunerative and for which region has comparative advantages due to climatic and other factors, (iv) the proper compensation should be given to the farmers for crop damage caused by wildlife. Besides, the crops which are least damaged by the wildlife like *Amaranthus* spp. and *Hordeum* spp. and medicinal plants may be cultivated in areas where chances of damage from wildlife are more, (v) value addition in traditional crops is an indirect but viable and appropriate strategy for their conservation in their natural habitats. In addition, small cooperatives either at village or community level should be opened to take marketing responsibilities, so that the proper benefits could reach the local farmers, thereby increasing the interest of the farmers towards cultivation of these crops. This strategy will generate employment and improve income in rural areas. If demand is stimulated, farmers will be encouraged to enhance production of the traditional crops, and (vi) kitchen garden, a highly organized production system, needs to be strengthened through the cultivation of spices/condiments and medicinal plant species.

3.2.3. An assessment of agriculture production and strategy for sustainable development of bioresources.

Background

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

Objectives

1. To study the population dependency on agriculture.

2. To quantify the agricultural production in the existing conditions of different geo-environment condition.

3. To quantify the contribution of agricultural production to the total food requirement.

Result and Achievements

1. Maximum mixed cropping was found in the zone II.

2. Percent of irrigated land decreased with increasing altitude/ altituditional zones. It was about 5% in zone I and less then 1% in the zone III (Table 4).

3. Under the irrigated system potato cultivation was found only in the zone I while paddy and wheat are cultivated in the entire study area (Table 5).

4. Cultivation of paddy and wheat decreased with increase in elevation while cultivation of millets, potato and other crops increased (Table 4).

5. The crop yields were meet substantial part of requirements and deficits were found to increase with elevation for rice. However, for wheat and millets the high population pressure zone, i.e., zone II showed maximum deficit.

6. Traditional system of providing labour for intensive agricultural activities are still prevalent (Fig.7)

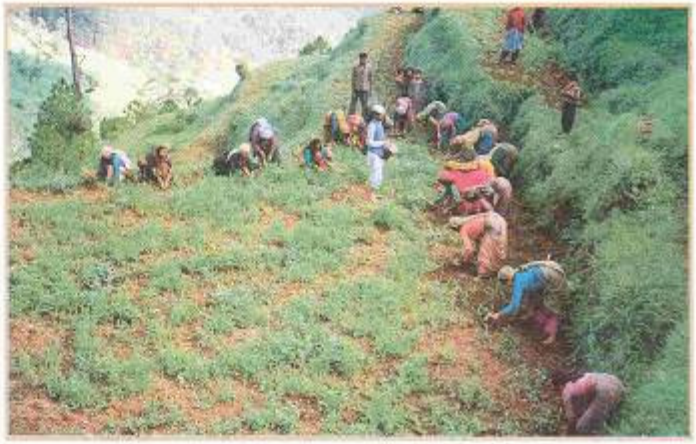


Fig. 7. Traditional system of labour efficiency through music

Table 5. Contribution of agricultural production to the total food requirement.

Zones	Rice	Wheat and millets
I	86.86	87.42
II	46.25	50.81
III	42.93	65.00

3.2.4. Farmers Field School-Cum-Training programme

Background

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

Objectives

1. To develop simple field manuals for farmers.

2. To train trainers in technologies described in the manuals.

3. To impart training through participatory learning methodology.

Table 4. Land under different crops (%)

Zone	Irrigated Land				Rainfed Land				
	% of total	Paddy	Wheat	Potato	% of total	Paddy	Wheat	Millets	Potato & Other
I	4.87	100	82	18	95.12	64.37	66.25	35.63	33.72
II	2.74	100	100	-	97.26	64.13	66.12	35.87	32.81
III	0.82	100	100	-	99.18	60.74	61.87	39.26	38.13

Result and Achievements

(a) Central Himalaya

1. A total of 30 local farmers were invited for the training at Gagil village of Hawalbagh Development block. Farmers were selected on the basis of initial interest and knowledge of the subject and ability to explain the technology to others.

2. A training manual was prepared based on the participatory discussions. The manual was distributed among the farmers for their future use.

3. To improve the status of land resource and also to boost the economic condition of the inhabitants a number of concepts were discussed and /or demonstrated, i.e, protected cultivation (polyhouse), bio-composting, green manuring, agroforestry, multipurpose tree plantations, cash crop cultivation, water harvesting technology, soil conservation measures, etc. (Fig. 8).

Table 6. Manpower training for contour hedgerow farming system technology

	1997	1998	1999	2000
Officials:				
Planners	3	13	40+	49
Extension workers	8	3	30	15
NGOs:				
Total no. trained	2	-	26	24
Total staff trained	2	5	40	25
Farmers:				
Trained	30	-	18	105
Primary exposure	20	17	25	100+
Students				57

(b) Northeast Himalaya

For the large-scale replication of various demonstrated technologies, frequent training and capacity building programmes were organized in view to be able to reach to the rural inhabitants. The training was organized at official, NGOs and farmers level as they are three important tiers for achieving sustainable development for any given area. The North East Unit in the region trains following manpower in contour-hedgerow-farming system and other allied technologies in different years.

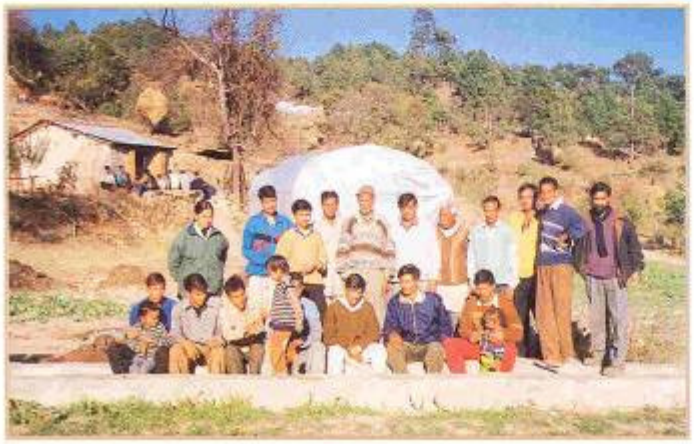


Fig. 8. Farmers training on protected cultivation (Polyhase)

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

Background

The people inhibiting in the buffer zone areas of the reserve are Bhotiya tribe belonging to Indo-Mangoloid ethnic group. Dependence of locals on natural resources for subsistence requirements existed in the buffer zone and adjoining areas of Nanda Devi Biosphere Reserve (NDBR) since time immemorial. The conservation priorities in NDBR are required changes in natural resources accessibility. This resulted in declining the population of many medicinal and aromatic plant species (MAPs) in their natural habitat, leaving little scope for their natural regeneration. Widespread poverty, population growth,

environmental degradation and lack of employment opportunities, characterize the life throughout the buffer zone areas. Lack of appropriate initiatives to enhance their capacity to gain economic benefits from the new market opportunity deprives the local communities from getting monetary benefits on one hand and gives way to unsustainable exploitation of the resource base on the other. Since the region is very much climatically favorable for the cultivation of MAPs and therefore, there is strong need of encourage local people to undertake their large-scale cultivation so as to achieve the socio-economic development and biodiversity conservation goal.

Objectives

1. To identify appropriate sites for the establishment of demonstration models for cultivation of medicinal plants having huge economic potential and market.

2. To develop agro-technology for economically suitable species and also document indigenous agronomic practice and uses of these medicinal plants which are already brought under cultivation.

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

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

Results and Achievements

1. Based on the in-depth survey carried out in the buffer zone villages of NDBR and its adjoining areas (Niti valley), five potential sites for demonstration of cultivation of medicinal plants were established in different villages namely Surithota (at road head), Tolma (3 km away from the road head), Rwing (4 km away from the road head), Zugzu (1 km away from the road head) and Garpak (12 km away from the road head). The selection of the sites was based on the interest of the local people or villagers towards cultivation of MAPs.

2. While conducting the survey it was recorded that about 16 species of MAPs i.e. *Allium strachyi, Allium humile, Angelica glauca, Carum carvi, Dactylorrhiza hatagirea, Saussurea costus, Megacarpea polyandra, Pleurospermum angelicoides, Aconitum heterophyllum, Picrorhiza kurrooa, Rheum australe, Potentilla, Plantago ovata, Polygonatum, Arnebia benthamii, Potentilla fulgens, Selinum vaginatum* have been brought under cultivation by the local people in small or larger scale about a decade back for their own use. The indigenous knowledge related to agronomic practices and uses of these MAPs have been well documentated.

3. About 15 low cost polyhouses (bamboo and iron pipe made) have been constructed in different demonstration sites located in far flung and remote areas and experiments are under way to evaluate the yield potential of different medicinal plants under two climatic conditions (polyhouses and control). Besides, low cost biocompost pits to make use of locally available weeds, tree leaf litter and crop residues as a manure or biocompost to enhance the yield of these medicinal plants have also been constructed.

4. Farmers to farmers training programme on medicinal plant cultivation was organized at Pangrasu, a buffer zone village of NDBR. 40 farmers from 10 villages of Chamoli and Almora districts participated in this training. On-site training of medicinal plant cultivation and simple rural technologies were given to the farmers.

3.2.6. Augmenting Food and Economic Security of Tribal Communities, particularly Women, in Arunachal Pradesh through simple, low-cost technological intervention

Background

The Edible food items that are available in the wild condition are found to be the major source of protein, minerals and vitamin required as the essential nutritional inputs by the expecting mother of the tribal communities. But due to large-scale deforestation and influx of modernization such knowledge as well as practices is on the verge of extinction. More over due to shortening of jhum cycle the agricultural productivity are also going down. Arunachal Pradesh has a very rich cultural as well as biological diversity and the knowledge of the wild nutritional plants and animals are found to be very rich among the tribal communities. To conserve the important information and to improve the socio economic status of the people it is very much necessary to first explore these informations and to develop some low cost technologies for *ex situ* conservation of the plants and animals.

Objectives

1 Augmenting traditional nutritional sources, especially of expecting mother, and to encourage their *ex situ* cultivation.

2 To introduce low cost technologies like cultivating the important plants in the form of hedgerows, use of polypits/ polyhouse raring of seedlings and animals.

3 Augment soil fertility in home gardens and jhum fields through simple measures such as biocomposting, vemiculture, rizosphere soil amendments and use of soil primers.

4 Explore the possibility of identifying local resources for value addition to augment income generation.

Result and Achievements

1. A total of 103 households has been surveyed and the practice of marrying woman much younger than themselves seems to be common among Nishi community.

2. The incidence of teenage motherhood is very common and prevalent even today. The data also points to the fact that although education has an influence on the number of children per individual, but has little influence to check teenage motherhood.

3. Education level has been found to have serious impact on women health status. It shows positive correlation with complicacies during birth, child mortality and number of children per individual (Table 7). But the fact that near about 80% of total women population fell under illiterate group, from surveyed sample, is a matter of concern (Table 8).

4. Since there is no any specific and special diet for expecting mother, so in general information regarding food habit of the community is studied. The information regarding wild edible plants are under process for identification.

Table 7. Educational of women among sample population and its influence on basic reproductive health parameters

Education Level	Individuals (%)	Age at first birth	Complicacy (mean)	Child Mortality (mean)	Mean No children
Nil	78.3	16.8	0.26	0.77	4.3
< Class VI	8.1	17	0.83	0.33	4
VI - VIII	4.1	14.3	0.33	0	2.7
IX – X	2.7	18.5	0	0	2
XI - XII	2.7	16.5	0	0	2.5
Degree	4.1	16.7	0	0	1.3

Table 8. Correlation between present age of mother, no. of children, spacing (year) and complicity at birth.

Mother age (Year)	Individuals (%)	No. Children (mean)	Spacing in two births	Complicity (Mean)
15-18	14	2	1	0
19-22	14.78	2.3	1.11	0
23-26	17.25	2.79	1.42	0.09
27-30	19.07	3.64	1.21	0.33
31-34	16	2.83	1.17	0.33
35-38	17	4.57	1.23	1
39-42	20	4.67	1.5	0.6
43-46	15	4.67	1.33	0.67
47-50	13	5.5	2.5	0.5
59-62	25.5	11.5	2	5.5
63-66	16	5	2	1
67-70	16	6	1	0
71-74	19	7	2	1

3.2.7. An assessment of agricultural Production and strategy for Sustainable Development of Bioresources by Identifying issues and options for improving livelihoods of marginalized farmer in shifting cultivation areas in North East India.

Background

In North East region of India traditional societies practice shifting cultivation (jhum) that has a very close linkage with food production system and the natural forest ecosystem. The rapid depletion of the natural resources in recent years, particularly due to deforestation, the productivity of the land has been adversely affected,

which has ultimately led to the marginalization of the traditional tribal societies. Most of the recent attempts for land use development based on the imported technology with high-energy subsidies has been rejected by the people. It becomes imperative to critically analyse and develop an integrated approach for the management of the system. Considering this the present project was taken up at two sites in Arunachal Pradesh one in Changlang where the Jhum cycle varies from 7-8 years and the second in Lower Subansiri where the jhum cycle is 2-3 years.

Objectives

1. To assess the factors leading to marginalization of jhum system
2. Assessment of alternatives to shifting cultivation and the reasons for their acceptance or rejection
3. To assess the impact of land use land cover change on socio-economics.

Results and Achievements

1. During recent years jhum cultivation is not able to sustain the families who depend upon it. For example the areas where the jhum-fallow cycle is still 7-8 years, the farmers are able to produce only 33% of their total rice consumption, whereas reduction of fallow period for just 2-3 years produces only 7.35% of their annual requirement.
2. Migration of people from villages, full time employment has decreased the labour forces in jhum. Although the customary laws are refined enough to ensure equity to all member of the community at all the times so the concept of land marginalization based on holding size does not apply in the areas of shifting cultivation. With increase in population and land being finite, the only option is to reduce fallow period.
3. Both Centre and State government have launched several schemes for restoration of jhum areas, which widely covered by various departments, i.e. Forest, Agriculture, Horticulture and Rural Works, and unfortunately there is no coordination among these departments.

3.2.8. ENVIS Centre on Himalayan Ecology

Background

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

Objective

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

Results and Achievements

1. ENVIS Bulletin Volume 8 No. 1 and 2 were published.
2. A monograph providing Demographic data base on Himalaya was published and distributed.
3. A user interface workshop was organized for the users of North East India where about 150 users from R&D Institutions, Universities & NGOs participated.

3.2.9. Tropical Soil Biology and Fertility (TSBF) Programme - South Asian Regional Network

Background

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

Objectives

1. To conduct collaborative research with/among participating scientsts.
2. To coordinate research networks and projects
3. To offer advice and assist scientists in the preparation of research proposals and obtaining funds

Results and Achievements

1. Compilation of abstracts and bibliography was continued.
2. Collaborative project submitted for possible funding from GEF was persued.
3. A national review meeting was organized to compile the state of the art reports in specific areas relevent to the SARNET.

3.3. CONSERVATION OF BIOLOGICAL DIVERSITY

The importance of maintaing Himalayan Biodiversity not only for the present but also for posterity is now well recognized. The core is strengthening its activities by developing both short (location specific) and long (broader spatial scale) term programmes. All activities are responsive to contemporary global thinking on the subject matter. It is in this context that the frame work of different projects are developed as per the guidelines provide by National Action Plan (NAP) and AGENDA 21 in conjunction with the Convention on biodiversity. It aims in harnessing potential bio-resources equitably and also in halting the increasing pressure on biological assets. Following research programmes are under progress.

Documentation and prioritization of important components of biological diversity; programme to identify and monitor the preocesses and activities responsible for depletion of biodiversity. Identification of priorities for maintenance of existing biodiversity in the Himalaya and assessing threats to biodiversity in selected protected areas. Efforts are also on toe complement *in situ* conservation with the help of *ex situ* methods and ensure peoples' participation in biodiversity conservation

Theme leader

U. Dhar

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

Background

The identification and characterization of habitats of the Himalaya, especially those supporting sensitive biota is of paramount importance for identifying the disruptions and magnitude of pressures leading to habitat degradation and extirpation of important species. Index of change in a system can effectively be monitored and conservation measures adopted when habitats are taken as study units. The project was initiated to study the habitat diversity, distribution pattern of native and non-native species and monitor changes in protected (Kumaun: Askot Wildlife Sanctuary, AWLS and Himachal Pradesh: Kanawar Wildlife Sanctuary, KWLS) and other biodiversity rich areas of the region.

Objectives

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

Results and Achievements

(a) *Askot Wildlife Sanctuary*

1. Based on habitat preference, population size, distribution range and anthropogenic pressure, 207 species belonging to 150 genera and 74 families have been identified as rare endangered. Frequency of distribution within different life forms was analyzed (8.70% trees; 14.49% shrubs and 75.86% herbs).
2. Along the vertical gradient maximum rare endangered species (56.52%) are distributed in the altitude zone <1,800m and minimum species (13.53%) in the altitude zone >3,800m.
3. Of the total rare endangered species, 57% species are native to Himalaya, 9.18% species are native to Himalaya and neighboring countries, together and 33.82% species are non-natives. 6.76% species are endemic to Indian Himalaya and 25.60% species are near endemic.
4. Ten species have been recorded in the Red Data Book of Indian Plants (Table 9).

(b) *Biodiversity studies of sub-tropical and temperate forests*

1. Survey and sampling of the vegetation and soil were continued in the Jakhdev forest beat and reserve forests of the Cantonment area in the Upper Siraunt Gad Catchment (Ranikhet area). For resource utilization pattern and extraction trend Dhyoni village was surveyed and sampled. Compilation and analysis of the data are in progress.
2. In Kaligad and Dalmoti forest beats five habitats (i.e., shady

Table 9. Rare-endangered species of AWLS recorded in the Red Data Book of Indian Plants

Taxa	Altitudinal range (m)	Threats observed	RDB Status
Athyrium duthiei (Bedd.) Bedd.	3,000-3,500	Habitat degradation	Vulnerable
Acer caesium Wall.	2,800-3,200	Over-exploitation	Vulnerable
Cymbidium eburneum Lindl.	1,000-1,400	Habitat degradation	Vulnerable
Cypripedium cordigerum Don	2,600-3,000	Habitat degradation	Rare
C. elegans Reichb.	3,000-3,500	Habitat degradation	Rare
C. himalaicum Rolf.	3,000-4,000	Habitat degradation	Rare
Dioscorea deltoidea Wall. ex Kunth	1,500-2,800	Over-exploitation	Vulnerable
Eria occidentalis Seidenf.	1,400-1,600	Habitat degradation	Rare
Nardostachys grandiflora DC.	3,300-4,200	Over-exploitation	Vulnerable
Picrorhiza kurrooa Royle ex Benth.	3,300-4,200	Over-exploitation	Vulnerable

moist, dry, riverine, depression and degraded) have been identified. Amongst the habitats richness of trees (30 spp.) and total density (7.63 ind./100m^2) were highest for riverine habitat. Total basal area (cm^2/100m^2) was highest for degraded habitat (5204.93) and lowest for riverine habitat (2495.15).

3. The richness of saplings was highest in riverine habitat (28 spp.) and seedlings in shady moist habitat (27 spp.) whereas total density (ind./100m^2) of saplings was highest in shady moist habitat and seedlings in riverine habitat.

4. Nine forest communities have been identified and distributed in the identified habitats, of these riverine and shady moist habitats represented maximum number (5, each) of communities. Among all the communities the total density and total based area of trees were recorded highest for *Cupressus torulosa*.

5. The soil moisture content of Kaligad and Dalmoti forest beats ranged from 6.00-23%, pH, 4.20 - 6.00, organic matter, 1.49-11.11%, organic carbon, 0.86 to 6.44% and nitrogen, 0.09-0.95%.

(c) *Biodiversity studies along disturbance gradient*

1. After extensive survey in Kumaon Himalaya, three different study sites Syahidevi Forest (1000-2350m); Kukucheena forest (1200-2400m) and Aicholi forest (1300-2200m) under three different levels of disturbance i.e., degraded, semi-degraded and pristine were selected.

2. Phytosociological studies (winter season) were conducted to know the forest structure and regeneration trend of tree species (analysis under progress).

3. Data collection for herbaceous species and tree recruits in different seasons is under progress.

(d) Studies in sensitive habitats - timberline

1. Information generated from nine (50X50 m) plots, three in each altitude zone (< 2800m; 2800-3200m; 3200-3600 m asl), in TLZ of Valley of Flowers National Park and adjacent areas was analyzed for compositional details under different life forms (Table 10). Plots were marked for continuos monitoring.

2. Compositional patterns from 18 (50X50 m) plots were recorded (analysis under progress). Soil samples collected from different plots for the analysis of physico-chemical properties.

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

1. Assessment of bioresources used as ethnomedicine was carried out in the lower zone of KWLS. Over 35 wild and 16 domesticated plant species, 2 wild fauna and 13 others (miscellaneous resources) have been documented in curing 19 common diseases.

2. *Aconitum heterophyllum* (31%), *Mentha* sp. (32%), *Beberis aristata* (26%), *Ajuga bracteosa* (21%), *Rheum australe* (22%) and *Origanum vulgare* (21%) are the preferred taxa used for the treatment of the maximum ailments. From users' point of view, *Ajuga bracteosa* (41%), *Aconitum heterophyllum* (34%), *Thymus serpyllum* (31%) and *Urtica dioica* (25%) appeared at the top.

3. Ethnomedicinal Use Index' (EUI) is obtained for upper zone (UZ) and lower zone (LZ) of KWLS. The analysis revealed that Aconitum *heterophyllum* (17.58-UZ, 2.30-LZ), *Picrorhiza kurrooa* (9.36-UZ, 1.81-LZ), *Viola* sp. (10.13-UZ, 1.97-LZ), *Thymus serpyllum* (5.39-UZ, 1.15-LZ), *Pyrus pashia* (5.26-UZ, 0.16-LZ), *Rheum australe* (4.9-UZ, 1.15-LZ), *Angelica glauca* (4.74-UZ, 0.16-LZ), *Mentha* sp. (4.44-LZ), *A. bracteosa* (2.55-UZ, 2.14-LZ), etc. are the most preferred taxa.

Table 10. Variations in analytical features of vegetation at different altitudes of TLZ in Valley of Flowers area

Parameter	2800 m asl	3200 m asl	3600 m asl
Tree species Richness	09	06	03
Dominant species	*R. arboreum* (IVI 79.8)	*Acer* sp. (IVI 70.9)	*Betula utilis* (IVI 210.5)
Tree density (ind. ha^{-1})	480	820	650
Tree basal area (m^2 ha^{-1})	35.2	56.2	25.8
Tree sapling/ seedling density (ind. ha^{-1})	780	1020	1580
Shrub density (ind. ha^{-1})	4000	1600	5800
Herb density (ind. m^{-2})	13.8	14.3	21.3

4. Quantitative assessment is made in lower zone for households' preference in curing diseases through allopathic or Ayurvedic/ herbal methods. Priority score reflects 45% for self treatment (herbal), 44% for local practitioner (Vaid) and 93% for allopathic doctors.

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

Objectives

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

Results and Achievements

1. Family Rutaceae of Indian Himalaya have been analyzed for species diversity, distribution pattern, nativity and endemism. A total of 70 species belonging to 19 genera have been recorded. These species are distributed within different life forms i. e., trees: 25 spp.; shrubs: 34 spp. and herb: 1 sp. Amongst genera *Zanthoxylum* (13 spp.), *Citrus* (11 spp.), *Evodia* (8 spp.), *Skimmia* and *Clausena* (6 spp., each) and *Glycosmis* (5 spp.), respectively were species rich.
2. Twenty-two species of family have been in use as medicine and 12 species as wild edibles.
3. Altitudinal distribution of the species showed high species richness in the sub tropical zone (i.e., <1800 m), the richness decreases considerably with the increasing altitude.
4. Across the biogeographic provinces the richness of the species increased from Trans, North West (22.88%) to East Himalaya (87.14%).
5. The Indian Himalayan Rutaceae represented high proportion of non natives (70%), only 21.43% species were native to Himalaya and 8.5% species native to Himalayan region and other countries, together.
6. Seven species (i.e., *Boeninghausenia schizocarpa, Citrus assamensis, Clausena dentata* var. *robusta, Glycosmis boreana, G. cymosa* var. *linearifolia, Paramigyna scandens, Zanthoxylum burkellianum, Z. pseudoxyphyllum* and *Skimmia laureola* subsp. *multinervia*) have been identified as endemic to Indian Himalaya.

3.3.3. Establishment and Maintenance of Functional Arboreta in the Himalaya

Background

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

Objectives

1. Developing a gene bank of Himalayan species including economically important taxa.
2. Developing propagation protocols for locally acceptable species for sustenance and conservation value.
3. Large-scale multiplication of species and making the saplings available to local people and also for rehabilitating degraded lands.

Results and Achievements

(a) Strengthening of arboretum- Kosi-Katarmal

1. Extension of the nursery and arboretum area for the introduction and establishment of germplasm including orchids and medicinal plants was carried out.
2. Propagules of over 45 species including orchids and medicinal plants were collected and accessioned. Germination and

growth responses of the species were monitored.

3. Mechanical scarification of seeds of *Terminalia chebula* improved germination from 10% to 88% and hot water treatment of seeds of *Ehretia laevis* improved germination from 25% to 72.33%. Among other species *Phytolacca acinosa* showed poor germination (8.4%) whereas *Paeonia emodi* showed no germination. Monitoring of developmental responses of some of the established saplings is continuing.

4. Over 6,000 seedlings were planted in the arboretum sites and Institute Campus. Seedlings of useful species were also distributed to local inhabitants through various projects of the Institute.

5. Germination of seeds of *Quercus semecarpifolia* collected from Prangras and Dhakuri populations was monitored in glass house, net house, shade house and nursery conditions. Seeds and seedlings of Pangras population showed maximum germination (55%) and growth in nursery condition whereas seeds and seedlings of Dhakuri population showed maximum germination (80%) in nursery and overall growth in glass house conditions.

(b) *Establishment of herbal garden (H. P.)*

1. To enrich gene banks, 70 accessions for 40 high value medicinal plants at Medicinal Plants Nursery- Kasol (Kullu) and 89 accessions for 54 high value medicinal plants at Herbal Garden-Mohal (Kullu), are systematically maintained and were monitored for their periodical survival and adaptability. Most species are native (58%) and few are endemic (25-28%).

2. Periodic observations were made for over 20 medicinal plants to study the adaptive phenological traits. Over a dozen phenophases were identified for long term monitoring of important taxa, including, *Angelica glauca, Aralia cachemirica, Bergenia* spp., *Dioscorea deltoidea, Hedychium spicatum, Podophyllum hexandrum, Polygonatum sp., Polygonum amplexicaule, Saussurea costus, Thalictrum foliolosum, Valeriana jatamansi*, etc.

3. Analysis revealed that, June 3rd week to August 2nd week was the period of high blooming (over 40-50% species), whereas fruiting occurs between August 2nd week to October 1st week (40-60% species).

(b) Propagation protocols for MPTs

(i) Cornus capitata (HQ)

Seed germination studies on *Cornus capitata*, one among top 20 MPTs of the west Himalaya, were undertaken to improve the germination ability of the seeds and to identify best responding provenance.

Viability of seeds collected from different sources (five distant populations) varied between 63.3% (Lolty) to 83.3 % (Devsari). Under control, seed germination was low (11.4 - 24.7%). Lolty (23.9%) and Binsar (24.7%) populations showed significantly ($p < 0.05$) high mean seed germination as compared to other three populations (Devsari 18.9; Jalana 18.9; Sitalakhet 11.4%, LSD 4.37, $p < 0.05$).

Pre-sowing treatments improved the germination responses. Sulphuric Acid (conc.) treatment for 5 mt significantly improved the germination (upto 82.8% - Devsari) in all the populations. Also, water soaking (36 h) improved the germination percentage considerably (range 44.4 - 56.1%) in seeds of different populations. Effects of various pre-sowing treatments (best responses only) to improve germination and reduce days for first germination are presented (Fig 9).

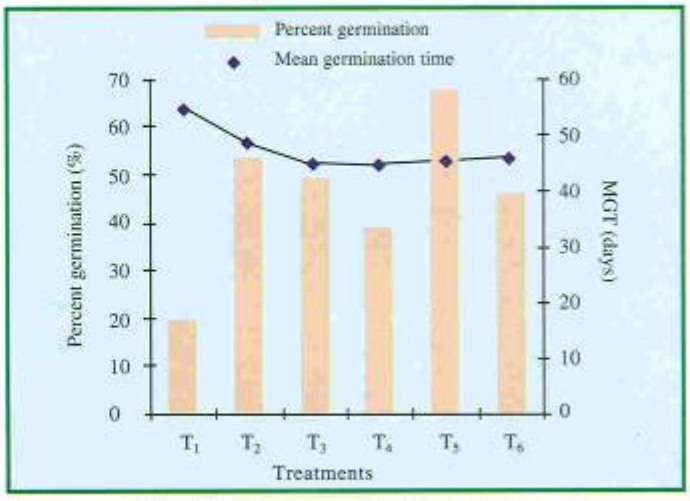


Fig. 9 Effect of best presawing treatment on germination

(ii) Aquilaria malaccensis (NE)

1. *Aquilaria malaccensis* Lamk. is distributed from India to Philippines, the species is nearly extinct in wild, but survives mainly in plantations and homesteads in India. The main cause of depletion is the extraction of an oleoresin from the diseased portions of the heartwood, a source of highly prized ' agar oil' used in medicine, perfumery and incense.

2. The fruit (a dehiscent capsule) has two locules with one seed in each locule. In the fruit population examined (n=865), one-seeded fruits were more (two-third of total) than two-seeded fruits (one-third of total) indicating an early abortion of developing seeds.

3. Fresh seeds varied several-fold in weight from 28.8 to 134.8 mg. However, seed weight did not vary significantly between the seeds from one-seeded and two-seeded fruits.

4. Seed germination is epigeous and completed in 13-40 days, with 90% germination achieved by 29th day. Germination drastically declined with storage time, from 31% for 2-days storage through 25% for 5-days storage to only 1% for 14-days storage.

5. Seed weight showed a strong effect on germination and germination time was negatively correlated with seed weight, i.e., heavy seeds germinated earlier than light seeds. The prevalent cause of germination failure was the abnormal embryo (unhealthy or dead) in light seeds, but rot of cotyledons in heavy seeds.

(iii) Ostodes paniculata (NE)

1. *Ostodes paniculata* (Bl.) Bijd. (Euphorbiaceae) is an evergreen tree that grows naturally in the subcanopy of moist tropical rain forest in Namdapha, Arunachal Pradesh. The seeds attain maturity and fall during November and December. The seeds are used in pharmacy.

2. A fruit produces three seeds. The seeds are ovoid, crustaceous, albumen fleshy, cotyledons broad, flat, seeds globose, brown and mottled smooth. The seeds were collected from Namdapha National Park in the first week of December 2000. The fresh weight of seeds varied from 0.86 to 1.15 g with an average of 0.55 g.

3. A total of 125 seeds were sown in root trainers in nursery on December 08, 2000. Total 85 seeds were germinated, and 40 seeds failed to germinate. The germination started 10 days after sowing and continued for 59 days. First leaf flush was recorded on January 09, 2001 i.e., 32 days after sowing.

4. Observations are continuing on seedling growth and mortality.

(c) Propagation protocols for medicinal and wild edible plants (H.P.)

1. Seed germination tests were conducted for *Hippophae rhamnoides*. A significant improvement in germination was observed for GA 100ppm (80%) treatment.

2. Three propagation experiments were conducted for *Angelica glauca*, first two sets using rhizome segments (without bud) with growth regulators at open beds and trays, and third using rhizome segments (with bud) without hormones in earthen pots. Only later showed good rooting response (76%).

3. Nursery level studies were made for 2 years' growth and yield for *Acorus calamus* using three positions and size of rhizome segments. Middle segments yielded 68% higher dry weight per plant over upper part and 58% over lower part. Segment size of 4.5 cm has produced 52% higher dry weight per plant over 1.5 cm and 39% over 3.0 cm segments.

(a) *Rhododendron arboretum – Sikkim Himalaya*

1. Continuation of rhododendron baseline data buid-up for assessing species availability, conservation status and threats was carried out for the second year at the Singalila National Park (Darjeeling hills); Lachen, Lachung, Yumthang (northern parts of Sikkim) and Dzongri/Barshay areas (western Sikkim).

2. This year the very rare *Rhododendron micromeres* was collected from Tsokha in Western Sikkim. Two seedlings are brought (October 2000) and is performing well so far at the Arboretum. Seedlings of *Rhododendron decipiens*, *R. pendulum* (status endangered) and *R. lepidotum* were collected and planted in the Arboretum.

3. Rhododendron seeds were collected (21 species) from different parts of Sikkim between June 2000 to January 2001. To propagate the plants, the same were sown in different substrata including soil brought from its habitat under greenhouse environment. The seedlings of earlier batch (1998) are also performing well, the tallest ones reaching 5-6 cm and with 9-13-leaved structure.

4. Seeds of the rare *Podophyllum sikkimensis* were collected (May 2000) from north Sikkim (4,200 m) and introduced in the Arboretum nursery under greenhouse condition. The growth in field soil at Pangthang (800 m) was remarkable with above 90 % survival.

5. Seeds of *Magnolia campbellii* were brought (July 2000, west Sikkim) and grown in nursery along with the species of *Abies, Acer, Hippophae, Larix, Picea, Populus* and *Tsuga* (November 2000, north Sikkim) and *Acer, Juniperus, Taxus* (October 2000, Singalila Range).

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

Background

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

Objectives

1. Promote and strengthen interactions with the target groups
2. Promote conservation science especially among School/College students
3. Impart on site training on collection, storage and propagation methods of target species focusing on teachers and students
4. Obtain and analyze response of different target groups with respect to location specific conservation option/priorities
5. Establish preservation models in college/community lands depicting locally important bioresources

Results and Achievements

(a) Participatory Biodiversity Programme (HQ)

1. Continuing with the series of Training Workshops, the VII two day Training Workshop was organized in Govt. Girls Inter College Dwarahat (Almora) on March 3-4, 2001 (Fig. 10).

2. A total of 62 participants (46 students, 16 teachers) from 17 educational institutions attended the workshop. Participants were exposed to various aspects of biodiversity conservation (viz., definition and dimensions; assessment and monitoring; value and value addition; propagation; importance of seeds and seed banks; relevance of genetic diversity; and maintenance of biodiversity). Also, the participants were introduced about the on going country wide process of developing National Biodiversity Strategies and Action Plan (NBSAP).

3. Analysis of participants responses for three workshops (Workshop V - Narayan Nagar, n = 60; VI - Saukiathal, n=63; VII - Dwarahat, n = 62) revealed that the training significantly improves the understanding and factual knowledge of participants. Improvement was more pronounced among students. The improvement of knowledge was particularly seen in subjects like - biodiversity value and value addition (2.2. to 43.4%; χ^2 - 65.514, $p < 0.001$), role of RS in biodiversity assessment (1-5 to

Fig. 10 Participatory biodiversity training workshop at Dwarahat (Almora)

42.6%; χ^2 - 67.0591, $p < 0.001$), role of tissue culture in conservation (5.1 to 43.4%; χ^2 - 54.0954, $p < 0.001$), level of improvement in different groups of students is presented (Table 11).

(b) Participatory Biodiversity Programme (NE)

1. Participatory Biodiversity Conservation Programme in Eastern Himalaya involved School students. Workshops, plantation programmes and poster competitions on Technology Day (May 11,2000) were organized.

2. The North-East Unit has taken PBC programme to the villagers, farmers and NGOs during organization of the training programmes on ATSCFS. In these programmes, participation has been ensured from all States of the NE Region.

3. A mass awareness campaign was organized to spread the message of biodiversity conservation in the society by organizing a Pavilion in Orchid Festival at Itanagar. High-level dignitaries, government officials, general public, village farmers and students visiting the pavilion were exposed to the Institutes' activities.

4. Bamboo is the most important resource for the tribes. Culm-cutting technology for bamboo propagation was successfully demonstrated to the farmers during training. Other low-cost technologies such as bio-briquetting, weed composting, water harvesting, contour hedgerow farming, nursery techniques have been demonstrated at Midpu site of the Unit.

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

Background

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

Objectives

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

To assess human dependence on different communities

To analyze changes of the vegetation

Results and Achievements

1. Comprehensive inventory of vascular plants of Pindari area has been prepared. A total of 843 species belonging to 148 families and 435 genera have been recorded. These species have been analyzed for diversity within the

Table 11. Variations in student's responses (across gender and class standard) regarding general understanding/ concerns on biodiversity (pooled information for three workshops)

Q No	Survey	< 10th Standard		> 10th Standard	
		Female(n=22)	Male (n=38)	Female(n=29)	Male (n=47)
1.	Pre	8(36.4)	10(26.3)	12(41.4)	26(55.3)
	Post	13(59.1)	22(57.9)	21(72.4)	37(78.7)
	χ^2 (d.f 1)	2.2774, ns	7.7727, $p < 0.01$	5.6945, $p < 0.01$	5.8238, $p < 0.01$
2.	Pre	6(27.3)	6(15.8)	8(27.6)	23(48.9)
	Post	11(50.0)	17(44.7)	22(75.9)	35(74.5)
	χ^2 (d.f 1)	2.3965, ns	7.5439, $p < 0.01$	28.0, $p < 0.01$	6.4826, $p < 0.01$
3.	Pre	8(36.4)	13(34.2)	13(54.2)	20(42.6)
	Post	15(68.2)	28(73.7)	23(79.3)	39(83.0)
	χ^2 (d.f 1)	6.2345, $p < 0.01$	11.9164, $p < 0.01$	7.3232, $p < 0.01$	16.4329, $p < 0.001$

families, genera, habitat, altitudinal range, nativity, endemism and rarity.

2. The richness of species is maximum in family Asteraceae (58 spp.), genus *Polystichum* (17 spp.), habitat-forests (323 spp.) and altitudinal zone 2,100-2,800m (547 spp.), 38 families are monotypic. Distribution of species diversity including native and endemic species along an altitudinal gradient has been presented (Fig. 11).

3. Among all the species, 219 species are represented in 3 or > 3 habitats and the remaining species are restricted to 1 or 2 habitats only. 414 species are native to Himalayan region, 50 species native to Himalayan region and neighboring countries, together, 12 species are endemic and 222 species are near endemic.

4. Amongst all the species, 8 species i.e., *Acer caesium, Picrorhiza kurrooa, Dioscorea deltoidea, Nardostachys grandiflora, Allium stracheyi, Cypripedium cordigerum, C. elegans* and *C. himalaicum* have been recorded in the Red Data Book of Indian Plants. Using new IUCN criteria, 29 species have been categorized as Critically Rare (14 spp.), Endangered (7 spp.), Vulnerable (7 spp.) and Low Risk Near Threatened (1 sp.).

Human dependence study was carried out in the Pindari area and the native communities for medicine, food, fodder, fuel, house building, fibre, agricultural tools and other purposes use a total of 224 species. These species have been analyzed for distribution and utilization patterns, nativity, endemism, rarity and indigenous uses.

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

Background

Recent conversion of the Khangchendzonga Biosphere Reserve in Sikkim through the up-gradation of the erstwhile Khangchendzonga National Park has opened up a completely new horizon calling in attention and concern from more multi-pronged approach. So far, the biosphere area is virtually undisturbed, rich in natural diversity and represents one of the biodiversity hot-spot from the eastern Himalayan region. On principle, the Biosphere Reserve acts as a natural conservation pool. Functioning independently and/or combined with anthropogenic component often leads to natural entropy or induced degradation, the two most common and obvious phenomena recorded from all over the world. For a clear understanding of the total biosphere system functioning insight into the various inherent natural cycles and its associated auxiliary cycles is primary. Towards this holistic understanding of the Khangchendzonga Biosphere Reserve is planned through this research project.

Objectives

1. Assessment of landscape change.
2. Man-animal-biosphere interaction on specific places.
3. Specialized habitat monitoring for identification of keystone species.
4. Functional understanding of vegetation types based on altitudinal distribution.
5. Evaluation of buffer and manipulation zones for sustainable resource management.

Results and Achievements

1. Remote sensing techniques were used to derive the inventory of resources and landscape characteristics of KBR for a period prior to the declaration of this BR. With the help of digital image processing of Indian Remote Sensing Satellite (IRS) data, the spatial composition of

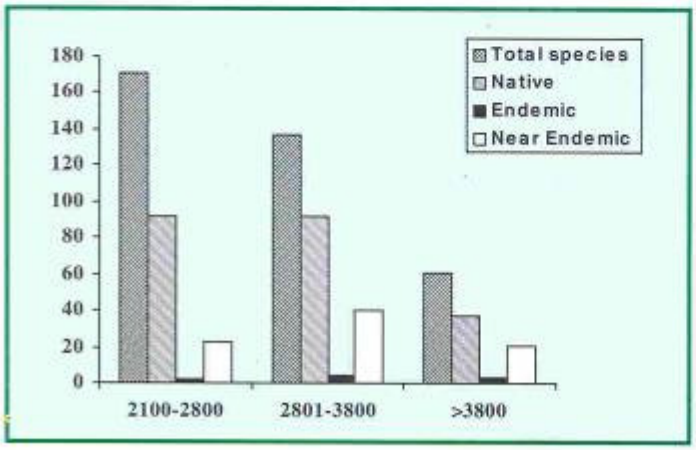


Fig. 11 Distribution of plant species along the altitudinal zones

important land use/cover of the biosphere area were determined.

2. Another important landscape characteristic was derived in terms of Normalised Difference Vegetation Index (NDVI) map for the similar period from satellite data. NDVI values were obtained for different land use/cover of the BR. Such estimates for KBR shall serve the purpose of baseline characteristics for assessment of landscape change, pressures due to fringe area human-animal activities, habitat monitoring and functional analysis of vegetation versus altitude.

3. Socio-economic and ecological indicators of the fringe area settlements in the North Sikkim were established by primary survey. Surveys along the fringe area blocks and villages were carried out at household level. This has revealed the settlement structures, socio-economic fabric, traditional agriculture practice and management, and the pattern of resources use. The human population living close to KBR is largely dependant upon the forests of buffer zones for non-timber forest product (NTFP) extraction, timber, fodder, open grazing and fuel wood use. This may lead to impact on the habitat degradation, and depletion of some flora and fauna of the KBR.

4. For observations on human dimensions of biosphere interference, a conservation attitude survey was conducted in the important fringe area settlements located crucially with BR. Contingent valuation method (CVM) with emphasis on willingness-to-accept (WTA) and willingness-to-pay (WTP) approach was adopted. The basic premise of this valuation was that the environmental conservation costs of enforcing BR principles of restrictions on the use of natural resources shall also be borne by the local populations or the stakeholders within their socio-cultural and economic framework of subsistence. To interpret the possible underlying issues, the entire responses were collected as conservation driven concerns, socio-economics driven concerns, willingness-to-accept (WTA)/ willingness-to-pay (WTP) driven concerns and participatory concerns in the BR concepts.

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

Background

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

Objectives

1. To quantify and assess population size of selected species in natural habitat
2. To analyze morphogenetic variability in selected species
3. To identify constraints in conventional methods of propagation
4. To develop *in vitro* propagation protocols in selected species particularly those of narrow geographic range
5. To develop germplasm bank of proposed taxa in selected sites

Results and Achievements

1. Quantification of species in natural condition was attempted (*Arnebia benthamii* and *Anglica glauca* - 10 populations, each; *Swertia angustifolia* - 9 populations). Five populations of *Saussurea obvallata* have been identified for detailed investigation.
2. Protein profile and isozyme patterns of *Swertia angustifolia* and *Saussurea obvallata* have been drawn. Morphological studies in seven populations of *Arnebia benthamii*, nine populations of *Swertia angustifolia* and eight populations of *Angelica glauca* have been conducted.
3. Seed germination protocols have been standardized for *Saussurea obvallata, Angelica glauca*, and *Arnebia benthamii* .

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

Background

To advice and oversee implementation of various research projects in designated and potential sites, Central Government has constituted a National Expert Advisory Group. Various relevant organizations have been encouraged to develop innovative, interdisciplinary research proposal for Biosphere Reserves including modeling system for integrating social, economic and

ecological data. The Central Government has designated Lead/ Coordinating Institution for each existing Biosphere Reserve to serve as a focal point for formulation of research projects and collection and dissemination of research based information for use in better management of Biosphere Reserves. G. B. Pant Institute of Himalayan Environment & Development, Kosi-Katarmal, Almora had been identified as a Lead/Coordinating Institution for Nanda Devi, Manas, Dibru-Saikhowa and Dehang-Debang.

Objectives

1. Collection, synthesis and dissemination of research based information in respect of Biosphere Reserves from all sources
2. Interaction with regional research organizations for development of suitable research projects
3. Interaction with Biosphere Reserve Managers to assess the research needs and crucial issues requiring research efforts
4. Publications of compendium of upto date information and bringing biannual publication aimed at educating stakeholders
5. Any other assignment which may be entrusted by Central/ State government to achieve larger objectives of the schemes

Results and achievements

1. Literature survey was carried out from different libraries of Government and Non – Government Organizations. Published papers/articles in journals, books, magazines, technical reports, etc. were collected, compiled, synthesized and documented on various aspects of Nanda Devi, Manas, Dibru-Saikhowa, Dehang-Debang and Kanchendzonga BRs. Research papers were also invited to compile the data base of these BRs.
2. Interaction/Coordination with the Central and State Government Organizations and NGO's was done through correspondence and project proposals in various themes were invited from these organizations.
3. Interaction was done with the Biosphere Reserves Managers regarding the research and development activities through letters, personally as well as through deliberations on various themes of biodiversity during the Training Workshop organized by WII, Dehra Dun for the Himalayan Biosphere Reserves Managers.
4. The Himalayan Biosphere Reserves Biannual Bulletin, Vol. 2 (1&2) was published. The Bulletin includes research papers on faunal (Mammals, reptiles and birds) and floral diversity, abstracts, project and Ph.D. summaries, news items, bibliography, format for the submission of the project proposals, list of projects and instructions to authors for submitting research papers/ articles.
5. Format for data collection and identification of gaps was updated by incorporating inputs received from the Director, Botanical Survey of India, Kolkata and sent to all the Lead/Coordinating Institutions and Himalayan Biosphere Reserves Managers for developing data base and identifying gap areas.

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

Background

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

Objectives

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

Results and Achievements

1. Timberline zone of proposed Uttarakhand Biosphere Reserve was surveyed and base maps (contour/landuse/drainage) prepared for locating the TLZ habitats, sample sites and preparing the distribution maps of sensitive taxa.

2. Preliminary survey of three belt transects containing 27 systematically laid sample plots was conducted. Plot data of vegetation patterns collected (analysis in progress).

3. Literature survey conducted and sampling designs for intensive investigation prepared.

3.3.10. Central Sector Scheme for Development of Medicinal and Aromatic Plants

Background

The use of Medicinal Plants in the Ayurvedic, Unani and other traditional systems has increased the demand of most of the high value species growing in the Himalayan region. The increasing demand of Medicinal and Aromatic Plants has increased pressure on most of the wild populations of such species. This has caused decrease in the population of most of the species to a great extent. Therefore, to meet the demand of different pharmaceutical industries, and reduce the pressure on the wild population of Medicinal and Aromatic Plants, Ministry of Agriculture and Cooperation has started promoting cultivation of Medicinal and Aromatic Plants under Central Sector Scheme for Development of Medicinal and Aromatic Plants through various organizations.

Objectives

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

2. To develop propagation packages for distribution to local communities

3. To promote cultivation of medicinal and aromatic plants among the local communities

Results and Achievements

1. Nursery was developed in the Institute premises (HQ) for the production of Medicinal and Aromatic Plants (Fig. 12).

Fig. 12. Aromatic and Medicinal plants nursery in the Institute premises

2. Six species i.e., *Acorus calamus, Origanum vulgare, Valeriana wallichii, Mentha piperata, Bergenia ligulata* and *Rose geranium* were selected. Among these *Acorus calamus* and *Valeriana wallichii* have been categorized as Critically Rare and *Bergenia ligulata* as Vulnerable.

3. Propagules of these species were collected from various locations and cultivated in the nursery. Planting materials of these species have been developed for distribution during the planting season.

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

Background

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

Objectives

1. Promoting accessibility and empowerment of rural women on economic resource and traditional health care by introducing *ex-situ* cultivation of medicinal plants.

2. Enhancing soil fertility through introduction of improved bio-composting techniques

3. Introducing appropriate and simple, low cost technological interventions to supplement ex situ cultivation

4. Training to target population on agrotechniques, nursery development, water harvesting, bio-composting, crop harvesting , drying, marketing, etc., which support ex situ cultivation of MPs, and education on conservation of biodiversity and its sustainable use

Results and Achievements

1. Base line survey on demography, socio-economy, perception on biodiversity conservation, role of medicinal plants as ethno-medicine and cultivation has been completed for six identified villages in Kullu district. Inventorization of bioresources is in progress.

2. Index of indicators for Conservation and Sustainability (IIC) by villagers of all six villages indicated that the medicinal plants as bioresource comes at fourth to fifth place (IIC 19.2 to 6.6) whereas fuel wood at the top (IIC 72.7 to 94) amongst seven indicators. However, they feel that orchards/horticulture would be the number one farm base economy (IIC 71 to 92) over second to fourth place (IIC 40 to 71) for medicinal plant cultivation amongst five indicators for farm based economy.

3. In order to mobilize villagers a field Workshop on "Medicinal Plants Cultivation" was organized at village Silha (Parvati valley). Households have been identified for two villages, viz., Silha (2080m) and Shat (1500m) who have shown willingness to adopt cultivation of medicinal plants in their land holdings, initially on experimental basis (Fig. 13). Further commitments are being sought. At village Silha, a demonstration plot of common visibility has been identified and the establishment work on medicinal plant cultivation initiated.

Fig. 13. Field workshop on Medicinal plant cultivation Silha village in Himachal Pradesh

3.3.12. Inventory of tree diversity in Namdapha National Park

Background

Namdapha National Park is a pristine habitat with unique biogeographical location at the tri-junction of India, Myanmar and China. The Area is extremely rich in faunal, floral and habitat diversity, thus making it a hotspot of biodiversity. The area has been proposed for a Biosphere Reserve to the Ministry of Environment and Forests, Government of India. This study has been taken up to inventory tree diversity in Namdapha National Park.

Objectives

1. To inventory tree species and record their distribution, frequency and phenology

2. To identify high value taxa including endangered and keystone species

3. To identify uses, use values and use patterns of tree products by indigenous tribes

Results and Achievements

1. Phytosociology survey was done in Namdapha National Park by laying five 100 m long and 20 m wide transects to sample 1 ha area. Each transect was divided into 8 plots of 10 m x 25 m. The transects were laid along a gentle gradient in altitude ranging from 300 to 660 m along a 12 km long trail.

2. The vegetation is a tropical rainforest with both evergreen and

deciduous species. All the individuals in the transects were mapped and tagged. The maximum height of the trees may reach beyond 30 m and the maximum girth around 485 cm.

3. A total of only 40 species could be identified during preliminary investigations. The most dominant species is an emergent, large tree *Altingia excelsa* of Hamamelidaceae. Identification of remaining species is in progress (Table 12).

Table 12. Importance Value Index (IVI) of the species with IVI > 10 cm in plots inventoried in Namdapha National Park.

Species	Habit	IVI	Maximum height (m)	Maximum girth (cm)
Altingia excelsa	Large tree	65.0	33	485
Suprosma ternatum	Small tree	50.3	10	41
Ostodes paniculata	Medium tree	26.5	15	107
Talauma hodgsonii	Large tree	11.9	21	133
Dysoxylum procerum	Large tree	10.5	16	161

3.4. ECOLOGICAL ECONOMICS AND ENVIRONMENTAL IMPACT ANALYSIS

Identification of strategies for ameliorating environmental damage and looking at alternate pathways for development are important aspects of environmental cost-benefit analysis. Keeping this in view, all development and intervention activities in the Himalaya need to be evaluated and monitored in terms of comprehensive Environmental Impact Assessment (EIA) framework and scientific system of natural resource accounting, making EIA a basic tool for decision making at various levels, i.e., local, regional and national.

To study the carrying capacity with respect to tourism in Kullu Manali complex, tourist flow and use of various modes of transport have been documented. Subsequently, recommendations for solid waste management, Kullu Dassehra has been finalized and submitted to District Administration. Similarly, the Pindari region and its surroundings, well known for famous glaciers viz., Pindari and Kaphani have also been studied for solid waste characterization. To study the concentrations of air pollutants, study is under progress for assessment and monitoring of atmospheric chemical transformations. The inter-links of community resources with socio-economics, culture and environment have been recognized, but, they have not been articulated in terms of clear policies and programmes. Hence, a study was carried out in the Central Himalayan region amongst Bhotiyas and Jaunsaries to understand integrated nature of tribal culture and its influences on resource use and management.

Theme leader

D.K. Agrawal

3.4.1. Carrying Capacity Assessment of Kullu-Manali Complex: A study of Tourism sector

Background

This study was initiated in 1993-94, keeping in view increasing pressure of tourists and related activities in the valley and to formulate a sustainable tourism plan. In earlier stages of the study, assessments regarding accommodation and tourist inflow by different means of transportation were made. Later, it was realised that Kullu and Manali spots in Kullu valley are facing infrastructural constraints, and as a result, solid waste is becoming a major environmental problem to be tackled. During 1994-95, recommendations regarding waste management and other amenities in local situations were submitted to district administration for implementation. The impact of these recommendations was assessed after a gap of 5 years during 1998, which showed a positive progress in creating basic amenities to the festivities except toilets. Solid waste study in semi-rural environment at Mohal was also conducted to know the role of women in waste management at household level. Municipal wastes from point sources (waste collection points) and non-point sources (dumping sites) were studied at Manali (1996) and Kullu (1997). After this study, it was felt that major point sources such as hotels and hospitals are prime contributors in municipal waste generation. Therefore, the study would focus around various aspects of hotel and hospital wastes; in order to suggest plans for minimizing the hotels and hospital wastes.

Objectives

1. To conduct solid waste characterisation survey from point sources (hotels, hospitals),
2. To find solid waste management options for each category of waste coming from different sources of its generation.

Results and Achievements

1. Nearly 30% hotels representing various categories (star equivalent, ordinary and deluxe hotels, guest house and paying guest house) were taken for solid waste characterisation study in Kullu and Manali. Two hundred and eighty two samples (1 ft^3) for both of the towns were segregated to derive waste compositions from management point of view at hotel level. Similarly, 48 samples from four hospitals—two from Kullu and two from Manali were selected to study hazardous wastes.

2. Readily biodegradable waste (RBW) that decomposes fast was above 70% of the total wastes generated at both of the locations in case of hotels. RBW when added with biodegradable waste, accounts for above 80% of the total waste (Fig.14). The slow decomposing biodegradable waste (BW) denotes about 11% in both the locations. This indicates ample scope for use of these wastes in biocomposting which can be practiced in the kitchen garden of the hotel premises.

The hospital waste characterisation from four hospitals showed that highly infectious waste- disposable syringes, needles, *etc.*, varied from 0.1% to 0.2% from Mission hospital (Manali) to Civil hospital (Bhuntar) respectively. Infectious wastes- bandage, cotton, saline tubes, *etc.*, ranged from 27.4% (Mission, Manali) to 43.7% (Civil hospital, Kullu; Fig.15). From management point of view, highly infectious and infectious wastes need to be treated and disposed after disinfections incineration and deep burial depending on the specific compositions. Hospital wastes thus need separate handling.

3.4.2. Ambient Air Quality Monitoring in Kullu Valley

Background

The study was initiated in 1993-94 to generate background data of ambient air quality in Kullu valley over a period of time. The study area—Kullu valley is an important tourist destination in western Himalaya. Measurements of total suspended particulate (TSP) matter during 1994-95 and 1995-96 were done

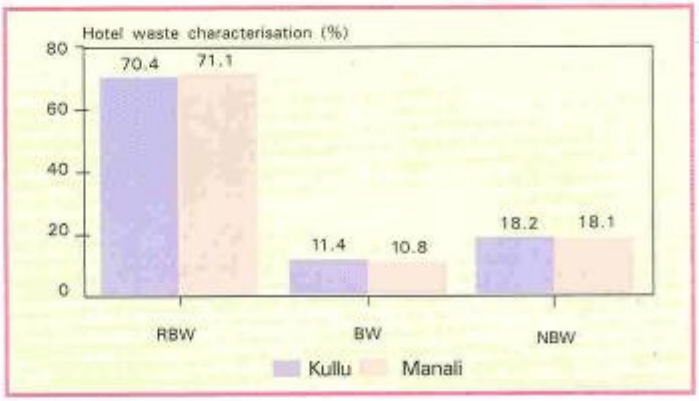


Fig. 14. Hotel waste characterisation in Kull-Manali Complex

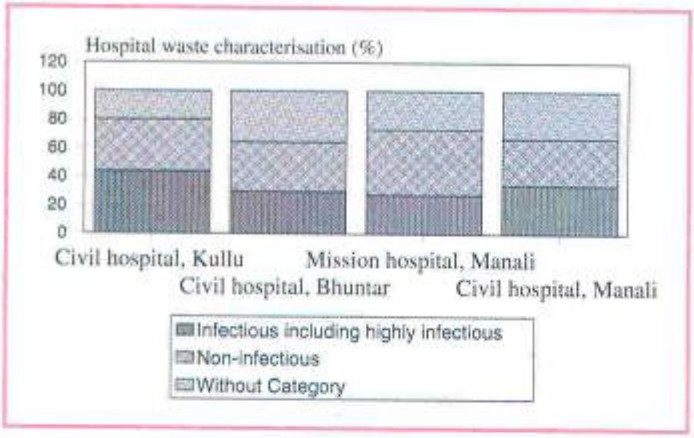


Fig. 15. Hospital waste characterisation in Kullu-Manali complex

at Mohal (1100m), Manali (1829m) and Kothi (2530m) in Kullu valley. In 1996-97, Mohal and Manali were the monitoring sites where as in 1997-98, Palchan (2320m) south to Kothi was the sampling site. 1998-99 onwards the monitoring site is Jagatsukh (2040m). The objective of shifting sites around Manali and Kullu is to get true background concentration of particulate matter and other air pollutants.

Objectives

1. To assess background concentrations of air pollutants, and
2. To pinpoint atmospheric chemical transformations occuring in the Himalayan ecosystems.

Results and Achievements

1. Total suspended particulate (TSP) concentration at Mohal (Kullu) and Jagatsukh (Manali) was monitored orbi-monthly for eight hours to obtain a sample using High Volume Sampler (HVS-APM 415). The TSP variations ranged from 64.5 (August-September) to 120.3 $\mu g/m^3$ (June) at Mohal and 68.4 (May) to 118.9 $\mu g/m^3$ (September) at Jagatsukh (Fig. 16). On the occasion of Kullu Dussehra, the average of 5 days sampling showed 535.6 $\mu g/m^3$ that is five times higher from its permissible level. Both of these locations have crossed its permissible level (100 $\mu g/m^3$) during summer and autumn when vehicular emissions and biomass burning due to high tourist influx remain high.

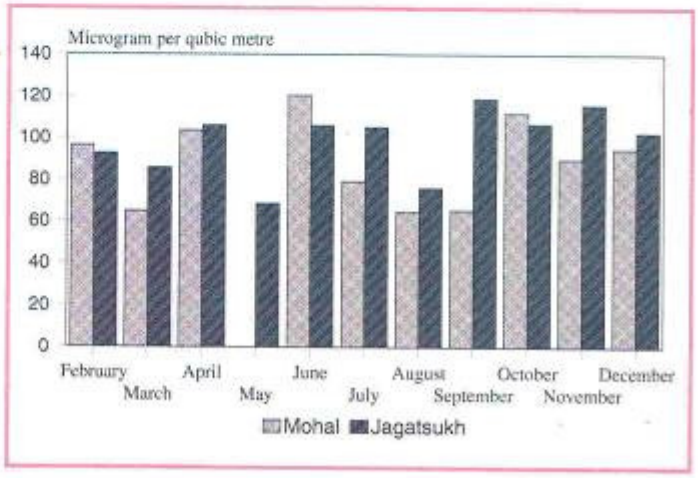


Fig. 16. TSP variation in Kull-Manali complex

2. The mass size distribution of aerosols showed almost bimodal distribution, with one peak in the fine size range (0.08 µm) and the other peak in the coarse size range (9 and 5.8 µm) at both the locations. The coarse particles are due to natural sources. The fine size particles to the total aerosols were about 62% and 79% at Mohal and Kothi respectively.
3. The concentration of Aitken Nuclei (A.N.) at Mohal varied from 900 to 2950/cm^3 with an average of 1777/cm^3, whereas it varied from 400 to 2480/cm^3 with an average of 1310/cm^3 at Kothi. The lower concentration of A.N. at Kothi than at Mohal indicates relatively less pollution.
4. The diurnal mean concentration of surface ozone (O_3) at Mohal varied from 9.2 (5 A.M.) to 26 (2.00 P.M.) parts per billion (ppb) with an average of 16.7 ppb for five days, whereas at Kothi it varied from 16 (4 A.M.) to 29 (3 P.M.) ppb with an average of 22.92 ppb.
5. The pH of rain water at Kothi varied between 4.42 and 6.95 with

an average of 5.07, indicating acid rain. Forty-three per cent of the samples were found to be acidic at Kothi. The acidity of rain water at Kothi may be due the low concentration of the neutralising components, especially Ca. Whereas, at Jagatsukh the pH varied between 5.60 and 6.87 with an average of 6.32 indicating alkaline rain.

3.4.3. An Empirical study of development of tribal communities from eco-cultural perspectives: a study in the Central Himalayan region of India

(Summary of the completed project)

Background

The Indian republic contains probably more tribal communities than any other single country in the world. In fact, the tribal population in India is about 1.2 times more than the total population of the United Kingdom or France, 2.5 times of Canada, 4 times of Sri Lanka and 2/3 that of Bangladesh. The Indian Himalayan region harbours as many as 171 of total 573 scheduled tribes of the country. Efforts to develop these communities by the Central and provincial governments continued with more vigour in the recent past. This study, carried out in the central Himalayan region of India covering two tribal communities viz., the Jaunsaries & the Bhotias, aimed at assessing the impact of development interventions from eco-cultural perspectives and also addressing the imaginary & realistic goals of sustainable development.

Objectives

1. To study the integrated nature of tribal culture and its influences on resource use & management,
2. To understand the concept of development from tribals' perception,
3. To trace the linkages between culture & development.

Results and Achievements

1. Based on empirical investigations, it was found that development interventions, in these tribal communities, were not appropriate and sustainable for a variety of reasons. The strategy for the development of these tribes needs to be holistic so as to improve the quality of community building upon the inner strength of tribal people and improving their organizational capabilities.
2. The basic components of the strategy should include realization and consideration of the peculiarities of the ecology and environment, appreciation of the values of the tribe in the maintenance of ecological balance, apart from its economic values.
3. It was also observed that economic and cultural forces guided the trends of development in both the tribal community. There was not any meaningful increase in the area of agricultural land of the Jaunsaries from 1952-53 to 1995-96. However, their mode of economy and cultural conservatism did not allow them much to diversify their economy. The Jaunsaries remained as traditional agriculturists and economically poor. Their demographic behaviour, to larger extent, is guided by conservative cultural principles which has affected the quality of life, particularly of females. The enterprising Bhotia tribe with a upward looking way of life had successfully taken advantage of economic and cultural elements for its growth with prosperity. They very aptly used their culture as framework for trying out new ideas and changes.
4. It was also established that the age-old economic and cultural practices of these tribes were attempting to maintain the sustainability of the community. Polyandry and Sayanachari among the Jaunsaries and transhumance and pastoralism among the Bhotias were appropriate adaptations for survival that finely blended economy with culture.
5. Therefore, it is suggested that development interventions in tribal communities need to be formulated and implemented in the light of both economic and cultural specificities and sustainable matrix of the concerned community.

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

Background

Increasing the well being of women in term of their health, education, economy & economic independence and personal autonomy, reportedly, has the effect of reducing their family size. This relationship has often been stated as the fertility decreasing effect of increasing the status of women. These factors improve the status of women and are supposed to reduce both the supply and demand for women. The women in Central Himalayan region of India are backbone of its economy. By virtue of their accountability to the agricultural system, they do enjoy certain work-autonomy. Level of literacy among the

females is also comparatively high. However, the nature of economy, the level of literacy and the status of the women in this region vary considerably from community to community and in different altitudinal zones. Keeping this in view, this study is undertaken to trace the impact of economy, education and altitude on fertility behaviour of women.

Objectives

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

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

Results and Achievements

1. In order to understand the effect of altitude, socio-economic condition and educational influence on fertility behaviour of women in central Himalaya, a sample of five village were selected according to distance from road head, altitude and multi-caste composition, etc. The total households of the villages were 237 with a population of 1636. Scheduled caste constituted 48.95 percent and 48.47 percent of the households and population, respectively.

2. A total of 181 respondents (mothers) between ages 15 to 45 year were surveyed, out of which 54.33 percent were from scheduled castes. Altitudinal effect on fertility was observed as the total no. of conceptions per mother in Ghurshon village situated at an altitude above 1600 m. was 3.19 against that of 3.69 in Ghoona village situated at an altitude of 1140m. However, no difference in number of pregnancy indicators was found among different castes (Table 13).

3. The effect of per capita income on total number of conceptions for mother was very significant. The number of conceptions and surviving children per mother gradually decreases with the increase in level of economy (Table 14).

Table 13. Impact of caste factor on number of conceptions and surviving children per mother

Caste	Total respondents	Total Conception		Total Surviving children	
Caste Hindus	86	304	3.52	263	3.06
SC	95	326	3.43	289	3.04
Total	181	630	3.48	552	3.05

Table 14. Impact of income on number of conceptions and surviving children per mother

Per capita income	No. of mothers	Total conception	Total surviving children	Total conception per mother	Total surviving child/month
< 11,000	17	67	54	3.94	3.18
15,000 to 20,000	55	201	177	3.64	3.22
20,000 +	109	362	321	3.32	2.94
Total	181	630	552	3.48	3.05

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

Background

Khairna valley, comprising of about 190 settlements, has an area of about 18,267 hectares. The valley area includes two development blocks of Nainital district and covers partially one development block of Almora district. The settlements in the valley are located within an altitudinal range of 900 to 2200 m amsl. Given the type of prevailing climatic conditions in the region, certain areas offer adequate scope for both season and off-season, vegetable cultivation, which appears to be economically rewarding. Though, the settlements have diverse natural setting, most of the villagers have adopted similar cropping pattern as their economic base. Under continuously increasing population, access to technologies and interventions, considerable changes are thus being noticed in landuse/land cover and cropping pattern in the Indian Himalayan Region in general and in Khairna valley in particular. It is, therefore, important to conduct overall impact analysis of the situation to quantify the positive and negative changes. With this background, the study is being conducted in the Khairna valley with long term objectives.

Objectives

1. Identify the extent and level of vegetable cultivation in the area.
2. Studying the management practices adopted for vegetable cultivation.
3. Documenting/identifying the driving factors that have lead to successful vegetable cultivation on a large scale in the region.
4. Studying the pattern of land use changes in the area together with its impact on the environment.

Results and Achievements

1. As many as 19 settlements, comprising of 10% of the total settlements, were identified for survey depending upon their accessibility and altitude variation. Survey of 10 settlements namely Tallakot, Ghoona, Daurab, Lohali, Jaurashi, Malauna, Simrar, Pazeena, Uprari and Ata-virta has been completed using detailed questionnaire to understand the extent and level of vegetable cultivation and the management practices.
2. A total of 459 households with a population of 3294 are covered in the survey. Male and female constituted 52.97% and 47.03%, of the total population, respectively. Main workers were 50.46% of the total population, out of which 75.15% are engaged in agriculture.
3. Total land holding is 260.01 hectares in the study area of surveyed villages and out of this 87.70% area is cultivated land. Irrigated and un-irrigated land is 53.84 ha and 180.96 ha, respectively, of the total cultivated land indicating that most of the cultivation is rain-fed.
4. The most important factor, which induced the farmer to adopt the vegetable cultivation, is probably the higher returns of vegetable crops as compared to the traditional crops. Total returns are on the higher side in case of vegetable crops as compared to the traditional crops. Net return shows the negative values for all the traditional crops, except Soyabean, whereas, the net returns are negative only for Tomato and Onion crops in case of vegetable crops.
5. Most of Farm Yard Manure used is produced by the farmers owned cattle's and labour is mostly family labour and if deduction is allowed from the total cost regarding these inputs the net returns become positive for almost all the traditional and vegetable crops (Figure 17).

3.4.6. Performance Evaluatio of Bio-engineering Treatments for Mitigating Landslide Hazards

Background

Bio-engineering is being practiced in mountainous region for mitigation of mass wasting processes. It includes use of plant material along with low cost civil structures. However, it is noteworthy that despite significant advancements in application of such practices little work has been done on performance evaluation of these treatments. After successful demonstration of bioengineering practices under MRE: India Project, it was envisaged to carryout performance evaluation of bio-engineering work. Initially survival rate of various plant species and their growth parameters were recorded. Subsequently, people's perception about such programmes were analyzed. Now, it has been tried to conduct economic evaluation of such treatments.

Objectives

1. To conduct economic evaluation of bio-engineering treatments.

Results and Achievements

1. For conducting economic evaluation, village Khoont site stabilized using bioengineering works under MRE (Fig 18): India Project in 1997-1998 was selected (for details of treatments, please refer earlier Annual Reports).
2. The economic returns calculated in the form of benefits received from various plant produces show that the activity was profitable at 11% discount rate with IRR, NPV and BCR of 18.25%, Rs 8,95,183 and 1 : 3.08, respectively, considering 20 years life span. These figure

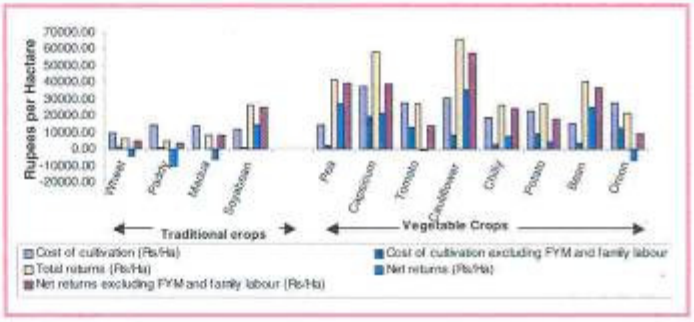


Fig. 17. Net returns from Traditional and Vegetable Crops in the Khairna Valley

Fig. 18.Growth of large cardamam under Alnus cover at village Khoont landslide stabilization site

were 6.824%, Rs 2,65,677 and 1 : 3.22, respectively, at 5% discount rate for 20 years life when the mortility rate of plant species is taken into account. The benefit cost ratio, which provides a basis for justification of project, indicates that each one-rupee investment on slope stabilization provides an income of Rs 3.08 without considering the mortality rate and Rs 3.22 while considering the mortality rate over a 20 years time period.

3. Slope stabilization has also provided additional indirect benefits. By using these techniques it is estimated that about 0.40 tons of soil and 0.84 m^3 of water is being conserved every year at this site.

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

Background

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

Objectives

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

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

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

Results and Achievements

1. As reported last year, roads have been undertaken for investigation considering the project thrust on mountain risk engineering (MRE). More field level investigations were undertaken on the road routes already selected for extensive ground-truth information. Two additional important routes Jorethang-Sombaria and Jorethang-Geyzing state highways with annual average daily traffic (AADT) of 200-500 were also taken up this year. There are many landslide zones falling along these routes as well.

2. Details were generated along the selected routes/road corridors to get the best geomorphological details in contiguity apart from other related geo-scientific parameters. These actually form a zone of investigation of which, roads form important objects leading to analyse not only the hazards along the routes, rather an object which is likely to be under landslide risks as well as causing landslide risks.

3. Map level works have yielded thematic details derived from topographic maps and remote sensing data by visual and digital interpretation along the selected investigation zones. Works on integration of ground truth details is being executed using a geographical information system (GIS).

4. Towards assessment of hazard, vulnerability and risks of landslides along the highways, a test case was carried out on the national highway 31A (NH31A). This has used remote sensing (RS) techniques and geographical information system

(GIS). Information on existing landslides, their field deposition, lithology, structural details, land use, volume of traffic and other allied factors have been organized and analysed around a GIS core. This has provided the hazard, vulnerability and risk ratings along this highway.

3.4.8. People, gender and indigenous knowledge in the use and conservation of resources in the Central Himalayan region of India: an empirical study

Background

The Central Himalayan region of supports remarkable cultural, ethnic and biological diversity. The qualitative relationship of the people of the Central Himalaya with its immediate environs and natural resources has evolved over long periods of time based on necessities and experiences. The cultural influence of the people on use and conservation of resources is quite significant; indigenous culture and traditions have helped evolve adaptive strategies to make effective use of natural resources. Important productive sectors like land, agriculture, forestry, animal husbandry, agro-based cottage industry, etc., are adequately maintained by traditional knowledge system. It is assumed that in this ecosystem, women's role in preservation of this traditional knowledge system is remarkable. Therefore, there is a necessity for a faithful documentation of peoples' indigenous/traditional knowledge system across the Central Himalaya on the altitudinal gradients, and ethnic communities and its integration with policy planning for sustainable use of resources that can meet the needs of the present generation without compromising the requirements the future generations.

Objectives

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

Results and Achievements

1. In the first phase, as many as 150 villages were preliminarily sampled based on latest available secondary data keeping in view the biophysical and socio-cultural parameters. In the second phase ten villages were selected out of the preliminarily selected 150 villages after a number of meetings and discussions with local level administrators (development officers), knowledgeable persons and other sources.
2. Primary survey on people and their socio-economy, gender and indigenous knowledge is in progress. Effort is being made to document indigenous knowledge on biodiversity management, ethnomedicine, land (rights, use and cover), weed control, pest control, crop varieties, cropping pattern, planting, harvesting, kitchen garden, livestock composition, livestock feeding, housing, anima health (ethnoveterinary), housing, food and food habits, clothing, family planning measures, socio-cultural practices and institutions, etc.
3. The ecosystem maintains about four million livestock population (Fig 19). Economic dependency on livestock, male migration to lower plains of India leaving the responsibility of cattle on women who are over-worked, lack of effective veterinary infrastructure, etc., have urged the local farmers, even today, to apply their indigenous knowledge to look after and maintain their livestock population.

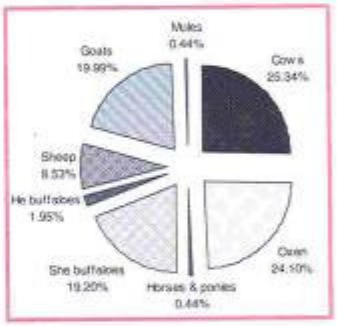


Fig. 19. Livestock composition as percentage of total livestock

4. A number of animal diseases and indigenously developed treatments for these diseases have been documented. In addition, indigenous treatments for bone fracture, leach infestation, dryness, anemia, artificial induction of heat for copulation and post calving care, have also been documented.

3.4.9. Environmental Impact Assessment of Desiltation Operation at Bhimtal Lake, Kumaun Central Himalaya

Please see section on quick appraisal studies

3.5. ENVIRONMENTAL PHYSIOLOGY AND BIOTECHNOLOGY

Plants being the primary producers, a thorough understanding of the factors that govern their productivity and functioning is of paramount importance, especially in the light of severe climatic conditions prevailing in the Himalaya, and current concern about the global climatic change. Judicious use and application of conventional techniques with the sophistication of biotechnology will help increase efficiency and productivity as well as environmental health. A number of bacteria (isolated from soil) have been developed as inoculants and shown to be beneficial for plant growth as well as for increasing per cent seed germination. Microoganisms obtained from various experiments are being maintained using appropriate methods. Nitrogen accretion studies and phosphate solubilization by symbiotic N_2 fixers are being studied in perspective for their use in agroforestry management. Efficacy of N_2 fixing *Alnus nepalensis* for improving productivity of large cardamom (a cash crop) has been demonstrated. In order to supplement production of quality planting material, propagation protocols have been developed using vegetative as well as *in vitro* methods for bamboo, oak, tea, Bulgarian rose, and some Himalayan medicinal plants. Significant improvement in seed germination was achieved using chemical treatments including plant growth regulators. In view of the predicted rise in atmospheric CO_2 and consequent global warming, short term effect of increasing CO_2 and other environmental factors on photosynthetic characteristics of plants have been assessed. Increased biotic pressure (mainly in terms of logging, crown removal, etc.) has threatened the survival/existence of Himalayan yew, an important medicinal plant; methods have also been developed for assessing canopy loss of this species. The role of fire in ecosystem processes has also been examined. Demonstrations on simple technological innovations/improvements, e.g., polypit, polyhouse, biocomposting, vermicomposting, biofencing, protected cultivation, etc. was conducted for betterment of rural people.

Theme leader

S.K. Nandi

3.5.1. Rhizosphere microbiology of Himalayan plants

Background

A variety of microorganisms like bacteria, actinomycetes and fungi including mycorrhiza (both ecto and endo) are used for improving plant productivity. The direct beneficial effects of these microbes include providing the host plant with (1) fixed nitrogen, (2) phosphorus and iron solubilized from the soil, and (3) phytohormones such as auxins, cytokinins and gibberellins. The indirect benefit to plant occurs due to the biocontrol properties possessed by a number of these microbes. The microbial community in an established tree rhizosphere should be more specific due to the prolonged length of time occupied by the species. This provides an opportunity for studying occurrence, distribution, quantification, isolation and characterization of the soil microflora which will lead to select beneficial microbes for developing inoculants for better plant growth of Himalayan region.

Objectives

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

Results and Achievements

1. Soil microbes selected on the basis of petridish as well as bioassays are being used for their beneficial effects on agricultural and forest species. Species of *Bacillus*, *Pseudomonas* and *Trichoderma* belonging to the rhizosphere of plant species of higher altitudes have been considered to be suitable for inoculations due to their adaptability to temperate regions. These microbes were found to possess plant growth promoting and disease controlling properties (Fig 20).

Fig. 20. Soil microbes belonging to the rhizospher of high altitude plant

2. Species of *Bacillus* and *Pseudomonas* in liquid formulation have been found suitable for biological hardening of tissue culture raised plants.
3. Microbial isolates are being maintained in the culture collection.

3.5.2. Large scale propagation of location specific elite plants using conventional and biotechnological methods

Background

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

Objectives

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

Results and Achievements

1. In order to study the endogenous factors that control *in vitro* root induction in *Rosa damascena*, polyamine levels were estimated in the shoots following IBA treatment. An increase in endogenous putrescine and spermine content

was detected prior to root induction.

2. Efforts are continuing to scale-up multiplication of important plant species for which propagation protocols have been already developed.

3. More than 100 tissue culture raised plants of *Rosa damascena* have been transferred to the field; these plants showed excellent growth and some of them flowered in the next season.

4. The flowering pattern of 7 different species of orchids collected from Sikkim Himalaya is being studied. Crosses were made between two species of *Cymbidium* and seeds from the hybrid pods were cultured *in vitro* (Fig 21).

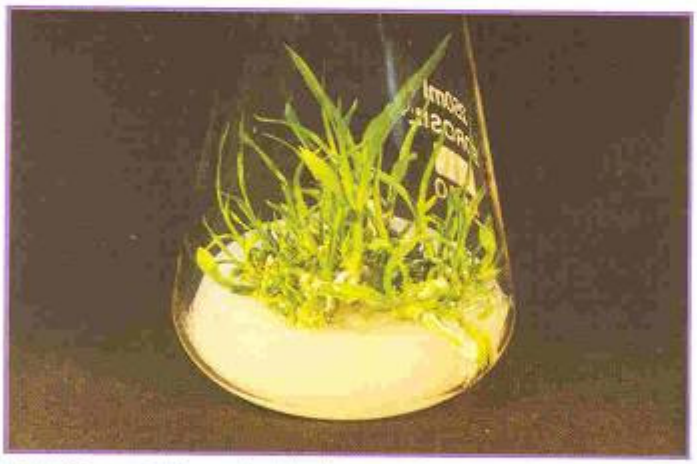


Fig. 21. Cultures raised from a pod resulting from a cross between two species of *Cymbidium*

3.5.3. Impact of stress and environmental changes on growth performance of plants

Background

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

Objectives

1. To determine biochemical basis of adaptations in plants.

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

Results and achievements

1. Considerable variations in chlorophyll contents (both chl a and b) among plant species with respect to seasons were recorded. In general, lower chlorophyll contents were recorded in winter months.

2. Irrespective of the season lowest chlorophyll content was recorded in *Boehmeria rugulosa*.

3. Contents of total soluble carbohydrates also varied with season in plant species. In general, all species showed considerably more total soluble carbohydrates in winter months than in the summer months.

4. Seasonal variation with respect to proline content was also observed in plant species (Table 15). Proline content was maximum in *Celtis australis* and minimum in *B. rugulosa* when comparisons were made across seasons.

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. 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.

Table 15. Seasonal variation in proline content (µg/ g fr.wt.) in plant species.

Plant Species	Season			
	Spring	Summer	Autumn	Winter
Boehmeria rugulosa	40.32	32.25	43.75	28.13
Celtis australis	357.61	85.01	562.50	218.75
Grewia optiva	440.63	158.5	62.50	42.82

Objectives

1. To understand phenological studies of some important forest species.
2. To determine physiological processes and their effect on productivity at community level.
3. Recruitment and plant behaviour in nature and/or modified environment.

Results and Achievements

1. In view of the medicinal importance of *Taxus baccata* (also threatened in this region), regeneration pattern of the species along the disturbance gradient and in different forest ecosystems was carried out at Jageshwar in the Kumaun Himalaya. In addition, effect of soil nutrients on recruitment of seedlings was also analysed.
2. Least disturbed forests showed stable population of *Taxus* as evident by greater number of small individuals than large individuals. In contrast, saplings and some of the subsequent size classes of this species were not found in moderately disturbed forests. Highly disturbed forest had only the oldest individuals of this species.
3. The least disturbed forests represented by high crown cover have nutrient rich soil with high moisture content, and the nutrient concentration (C, N & P) declined with increasing level of disturbance.
4. The number of seedlings and saplings was related to crown cover whereas soil pH of a site was negatively related to the presence of *Taxus* seedlings. Other than biotic factors, chilling temperatures, direct sunlight, warm and dry summer may also contribute to poor recruitment of seedlings.
5. The threat to this species is not only because of excessive harvesting but also due to degradation of forest sites as a consequence of various other reasons. This would not be realized as long as old trees will provide the raw material.

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.

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

(Summary of the completed project)

Standardization of protocols, both conventional and *in vitro*, have been developed for mass scale propagation of several target plants of the Himalayan region. Vegetative propagation of tea, deodar, oak and maggar bamboo, using single node/stem cuttings has been successfully developed and standardized using various chemicals. In addition to auxins which are known to promote rooting, the systemic fungicide Bavistin (containing 50% carbendazim) has been found to be an excellent rooting agent. The rooting capicity of shoots of *Quercus glauca* (Phaniyat oak), a difficult to root species, was achieved through air layering; shoots treated with IBA induced maximum (75%) rooting in air-layers compared to other rooting compounds examined.

Complete *in vitro* regeneration protocol has been developed for *Camellia sinensis* (L) O. Kuntze (tea; local chinery type), *Dendrocalamus hamiltonii* (maggar bamboo) and *Thamnocalamus spathiflorus* (dev ringal; a temperate bamboo). Shoot multiplication, somatic embryogenesis, regeneration and subsequent rooting steps have been optimised. Encapsulation of somatic embryos into 'synthetic seeds' has been standardized and conditions have been optimised for improving germination. Some proteins which are expressed specifically during

somatic embryogenesis in tea have been located on gels. Clonally propagated plants of *C. sinensis* and *D. hamiltonii* have been planted in the field. Comparison of gas and water vapour exchange rates of *in vitro* raised and seedling raised plants of *D. hamiltonii* and *T. spathiflorus* showed similar morphological, anatomical and a number of functional characteristics (Table 16).

Table 16. Comparison of some morphological features, chlorophyll content, RWC and specific leaf mass of *in vitro* propagated plants and seedlings of *Thamnocalamus spathiflorus*

Parameters	*In vitro propagated plants*	*Seedlings*
Leaf thickness (µm)	57.20 ± 1.84	82.40 ± 10.19
Stomatal frequency (stomata/ mm²)	431.00±4.83	496.40 ± 18.23
Chlorophyll a (mg/g fresh weight)	1.71 ± 0.10	1.51 ± 00.01
Chlorophyll b (mg/g fresh weight)	0.61 ± 0.01	0.55 ± 00.01
RWC (%)	87.77 ± 0.52	93.55 ± 00.12
Specific leaf mass (mg/cm²)	2.23 ± 0.02	2.16 ± 00.07

A micropropagation protocol has been developed for the first time for *Quercus glauca* and *Q. leucotrichophora*. High frequency shoot multiplication was achieved using cotyledonary nodes, and shoots were further multiplied. A two step method was adopted where treatment with IBA (25-100 µM) for 24 or 48 h followed by transfer to PGR-free and ½ strength WP medium resulted in improved rooting (upto 100%) in these two species. Following hardening under greenhouse conditions, photosynthesis and transpiration rates of 8 months old *in vitro* raised plants of both species were recorded, and compared with *ex vitro* plants of the same age. The results indicated that *in vitro* raised and hardened plants of both the species were comparable to *ex vitro* plants in terms of gas and water vapour exchange characteristics.

In vitro cultures of *Pinus wallichiana*, *P. gerardiana*, *Cedrus deodara*, *Quercus leucotrichophora*, *Q. semecarpifolia*, and *Q. glauca* have been established. Somatic embryogenesis has been achieved in *Q. semecarpifolia* and *Q. floribunda* via the callus phase. Multiple shoots formed in *Q. semecarpifolia* could be separated and rooted (nearly 100%) by using auxins; hardened plants have been transferred to pots. Bacterial isolates obtained from various types of soil (based on extensive survey) have been used for improvement of seed germination, disease control and establishment of seedling/tissue culture raised plants. Selected antagonistic bacterial isolates were used for inoculation of tissue culture raised tea plants during their lab to land transfer. These bacteria have been characterized for (i) production of antifungal compounds, and (ii) plant growth promotion properties. Survival rate of nearly 100% has been recorded with two of the bacteria against 40-50% in control plants. A patent has been processed on this aspect (biological hardening) through DBT.

Soil as well as microbial inoculations resulted in stimulation of various microbial communities, viz. bacteria, actinomycetes, and fungi in the rhizosphere of *Cedrus deodara*. The inoculations also improved the nutritional status of soil and plant (*Pinus wallichiana* and *Quercus semicarpifolia*). While the mycorrhizal inoculations gave best results in terms of enhancement in mycorrhizae infection, the overall performance in terms of biocontrol as well as growth promotion was recorded to be the best due to bacterial inoculation. A simple polypit technology (pit in the ground covered with polythene at the top) was developed which is an excellent set up of accelerated-optimal-growth of tree seedlings all through the year, particularly during winter months; this was demonstrated to greatly enhance growth and substantially reduced nursery time. An effective and simple method of physiological assessment for early selection of tea clones using CO_2 uptake and chlorophyll fluorescence has been developed. Photosynthetic CO_2 uptake, photochemical efficiency of photosystem II (Fv/Fm ratio) and shoot growth were recorded in six tea clones, originally from different agroclimatic zones of India to determine the suitability of using photosynthetic CO_2 uptake and Fv/Fm ratio as selection criteria. These clones are being used under the tea plantation programmes in Central Himalayan regions which experience considerable seasonal and diurnal variation in temperature.

3.5.6. Effects of N_2-fixing *Alnus* on the mechanisms of accelerated phosphorus cycling in large cardamom agroforestry in the Sikkim Himalaya

Background

Mixtures of N_2-fixing and non-N_2-fixing species differ from other sets of species by the direct and indirect effects of increased nitrogen supply. Nitrogen cycling in such stands have been observed to accelerate which is attributed to nitrogen fixation. The rates of phosphorus have also been shown to increase under the influence

of N_2-fixing species, however there is no understanding on the mechanisms that give rise to greater availability and accelerated phosphorus cycling. The project envisages to fill the above gap. The work emphasizes to test the following 2 hypotheses related to the mechanisms on ecosystem biogeochemistry as an effect of N_2-fixing species: (1) increased availability, and cycling of phosphorus under the influence of *Alnus* may cause a shift from sparingly available geochemical pools to rapidly cycling organic phosphorus pool, and (2) soil acidification due to rapid accumulation of nutrient cations in biomass may cause soil exchange complex to become more dominated by H^+. Nitrate leaching may also cause accumulation of H^+ in the soil. These hypotheses will be tested in large cardamom based agroforestry system where N_2-fixing *Alnus nepalensis* is extensively planted as associate shade tree. *Alnus* has a symbiosis with *Frankia* and is efficient in N_2-fixation. Large cardamom (*Amomum subulatum*) is the most important perennial cash crop of the Sikkim Himalayan region. The capsule (fruit) of the cardamom is used as a spice-condiment. It is cultivated usually on steep hill slopes under tree cover either in natural forest or plantation that forms a traditional agroforestry system in the region.

Objectives

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

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

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

Results and Achievements

1. There are many factors that contribute to the acceleration of P (phosphorus) cycling. The release of P from geochemical pools could be accelerated by rhizosphere acidification. In the growing season availibility of P increased for uptake by both *Alnus* and cardamom, as indicated by greater solubilization due to rhizosphere acidification. Available P values ranged between 4-60 µg/g soil across all stands. The highest values were recorded in stands with *Alnus* association. Available P values were higher in the rhizospheric soil of *Alnus* than the bulk soil. Mix tree cardamom agroforestry system showed less available-P than *Alnus* cardamom system.

2. The soil microbial biomass (a labile fraction of the soil organic matter) is an agent of transformation of added and native organic matter and acts as a source and sink of plant available nutrients. High microbial biomass-P values in winter and lower values in the growing season in the *Alnus* cardamom stands, indicated P-immobilization in non-growing season and mobilization in the growing season. In all the young, medium and old stands of *Alnus* cardamom, tree rhizospheric soil types showed the lowest microbial biomass-P during the rainy season.

3. The production of organic chelates could also increase the solubility of Fe- phosphates. Oxalic acid, a low molecular acid is also expected to play a similar role with Ca-, Al- and Fe phosphates. Oxalic acid produced by N_2- fixing *Alnus* in the roots could have increased P from mineral phosphates while chelating metals as oxalates in the *Alnus*-cardamom agroforestry systems. The oxalate formation was more in the rhizospheric soil than the bulk soil, indicating greater solubilization of P in rhizospheres whereby making more available P for the plant uptake.

4. Increased phosphatase activity has been suggested as a possible reason for increased availability of P across soil types. Phosphorus requirements of N_2-fixing trees are high. Therefore, higher phosphatase activity in young and medium aged *Alnus* -cardamom stands was explained by increased utilization of P by *Alnus* and associate cardamom. Comparison of rhizospheric soil types between the different age groups of *Alnus*-cardamom stands showed consistently higher phosphatase activity in combined cardamom and *Alnus* tree rhizospheres (Fig 22). This suggests that interactions between cardamom and *Alnus*, rather than *Alnus* alone might have produced organic chelates that played an important role in enhancing P solubility.

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

Background

In Sikkim, there are mainly three types of agroforestry systems i.e., (i) large cardamom based, (ii) mandarin orange based, and (iii) fodder-fuel tree based. Large cardamom (*Amomum subulatum*) is the most important perennial cash crop of the Sikkim Himalayan region that is cultivated in 26000 ha of Sikkim and Darjeeling between 600-2000 m elevations. Out of 23500 ha area of large cardamom cultivation in Sikkim state, 1316 ha of reserve forest is used for under canopy large cardamom cultivation on lease to farmers and remaining area is under

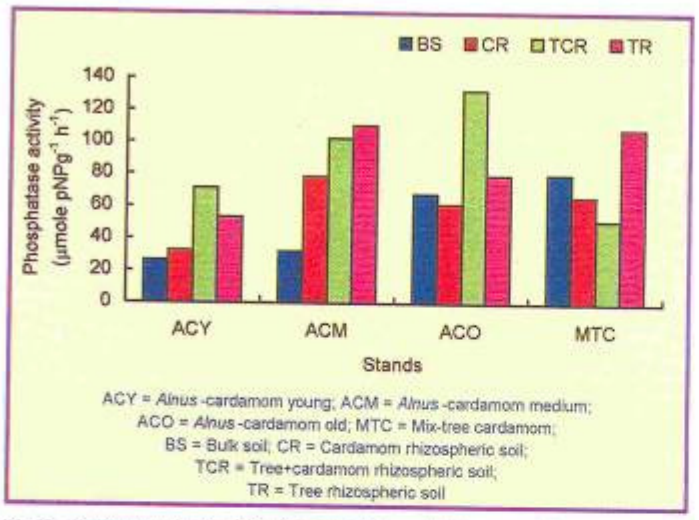


Fig. 22. Phosphatase enzyme activity in various soil types of different age *Alnus*- cardamom and Mix-tree cardamom stands in large cardamom agroforestry systems.

private large cardamom based agroforestry. Large cardamom is a low volume, high value and non-perishable crop that is providing ecological and economical benefits to the mountain people in Sikkim. There is no information on large cardamom and *Alnus nepalensis* based agroforestry system with respect to ageing of both cardamom and *Alnus*. Therefore, this study was planned to see the influence of both *Alnus* and cardamom age on the crop yield, biomass productivity and nutrient dynamics to examine the sustainability of the combination and practice.

Objectives

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

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

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

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

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

Results and Achievements

1. The availability and decreased soil nutrient status (organic-C, soil total nitrogen available-N, total-P, available-P etc.) beyond 15 years of stand age with corresponding decrease in productivity and agronomic yield of the understorey crop substantially comprehends for nutrient limitations in the older agroforestry stands and has significant effect on productivity and yield decrease. Production efficiency and energy conversion efficiency decreased with stand age to the lowest value at 40-year stand. Analyses in terms of production efficiency, energy conversion efficiency and N_2-fixation in the age series suggest that younger plantations function as the most productive system, while intermediate and older were least and less productive.

2. N-mineralization and nitrification rates were reduced in older stands beyond 20-year plantation age at low soil pH (below 4.3) and showed a marked variability with low rates at high moisture levels above 50%. The net N transformation rates under field conditions along the age series were limiting as the plantation stand aged followed by subsequent decline of soil nutrient supplies and low litter accumulation and decomposition.

3. Annual N accretion increased from the 5-year stand (52 kg ha^{-1}) that peaked at the 15-year stand (155 kg ha^{-1}) and then decreased with increase in plantation age (Fig 23). Nitrogen and P uptake was lowest in the 40-year stand, and highest in the 15-year and 5-year stand, respectively. Nutrient storage in the understorey cardamom was very high up to 31% N and 59% P in the 15-year stand. Nutrient use efficiency was higher (with faster turnover times) in younger stands and decreased (with slower turnover time) with subsequent increase in plantation age. Nitrogen back translocation increased while P decreased with advancing stand age. Nutrient standing state, uptake and return were also highest in the 15-year stand. Nitrogen and P cycling in *Alnus*-cardamom was functionally balanced. Nutrient cycling and dynamics indicated that *Alnus*-cardamom plantations performed sustainably up to 15–20 years, and the practice be modified

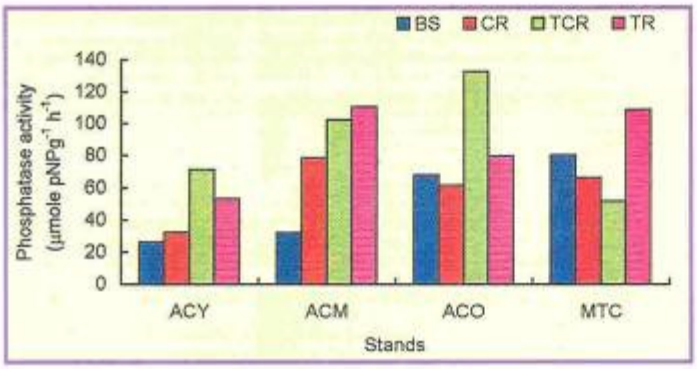


Fig. 23. Annual nitrogen accretion through fixation in an age series of *Alnus*-cardamom plantation stands

to follow replantation after this age.

4. Lastly, this study is the first type where combination of perennial cash crop and actinorhizal N_2-fixing tree association on performance and system functioning was investigated. Large cardamom agronomic yield increased up to 20-year stand and the rotational cycle for replantation could be followed after 20 years. Until this age, large cardamom cultivation is viable both economically and ecologically. Significant proportion of nitrogen is fixed by associate *Alnus* tree that contributes through nitrogen accretion and accelerated rate of its cycling.

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

Background

The Deprtment of Biotechnology (DBT) sponsored a multi-institutional project on bioprospecting of biological wealth, concerned with application of conventional, molecular and flow cytogenetics approaches to fingerprint chromosomes for systematic, analytical and transparent investment in conservation and sustainable use of biodiversity programmes of high priority endangered species like *Valeriana jatamansi, Rheum emodi, Gentiana kuroo, Coptis teeta, Aconitum* spp., *Podophyllum hexandrum, Polygonatum cirrhifolium, Picrorhiza kurrooa, Orchis latifolia* and *Thymus serphyllum* of medicinal, aromatic and other values. These investigations will also provide potential guidelines for the concerned species recovery and genetic enhancement programmes. The research work related to molecular aspect is being carried out at Delhi University and is assisted by two satellite units, one is Solan (H.P.) and another at GBPIHED, Kosi-Katarmal, Almora.

Objectives

1. Plant collection, herbarium vouchers, initial field notes and ethnobotanical data.
2. Storage of DNA rich materials.
3. Preliminary cytological studies.
4. Breeding systems and phyto-chemical work.

Results and Achievements

1. Germplasm collection, an ongoing activity of this program, has been continued. In addition to collection from Kumaun and Garhwal Himalaya, plant material have been collected from Sikkim and Himachal Pradesh.
2. Herbarium specimens of target species have been collected and preserved.
3. Growth performance of *in vitro* raised plants of *Podophyllum hexandrum, Aconitum balfourii* & *Picrorhiza kurrooa* was found to be normal. In addition, efforts are underway to standardize micropropagation protocol for *A. violaceum*.
4. Shoot culture of *P. peltatum* (American may apple; obtained through Prof. S.N. Raina) are also being multiplied. Rooting was achieved following IBA treatment and plants have been hardened under glass house conditions.
5. Seed germination studies were also carried out under controlled conditions at various temperature regimes. Effect of storage on seed germination of *P. kurrooa and Aconitum* spp. is in progress.
6. A marked variation (0.05-5.0% of dry wt.) in podophyllotoxin content was found among 16 different populations of *P. hexandrum* collected from Garhwal and Kumaun Himalaya. Generally it was observed that under natural conditions podophyllotoxin content increased with elevation.
7. Two field stations have been established following careful site selection (Fig 24). Determination of soil pH, moisture and nutrients (C, N, P, K) are being carried out to establish conditions for germplasm maintenance and multiplication.

Fig. 24. Cultivation of Aconitum balfourii at Kheljuni field station

3.5.9. Selection of plant growth promoting microbes for potential use in mountains

Background

Through participation of the Institute in Panchachuli Multidimensional expenditon- 1998, soil samples were obtained from rhizospheres of various tree species of subtropical, temperate and alpine locations. The soil samples were analysed for three groups of microorganisms, namely bacteria, actinomycetes and fungi. The encouraging results obtained from this analyses led to formulate this project. The project is functional from 15 March 2001.

Objectives

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

Results and Achievements

1. Soil and root samples are being collected from rhizospheres of target species from selected locations.
2. Isolation of soil microbes including vesicular arbuscular mycorrhizae is in progress.

3.5.10. Microbes in Himalayan Soils: Biodiversity and Potential Applications

Background

Since 1993 a number of studies related to soil/ rhizosphere microbiology have been initiated, namely, (a) Rhizosphere microbiology of tea; (b) Microbial diversity in Mamlay Watershed (Sikkim); (c) Isolation and selection of microbial inoculants for hill crops; (d) Plant-microbe interactions in conifers; and (5) Selection of biocontrol agents for providing cross protection. Through these projects a large number of microorganisms have been isolated, purified and maintained for further study. In view of continuity of these studies the above cited project has been formulated and is now functional w.e.f. March 2001.

Objectives

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

Results and Achievements

1. Collection of soil samples from various locations (including extreme conditions) and isolation of microbes from these samples are in progress.
2. 'Thermophilic bacteria' isolated from sulphur spring are being characterized.

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

Background

Rhododendrons are the denizens of high altitude which have a characteristic slow growth rate. Its horticultural value is internationally known. About 98% of the Indian species are found in the Himalayan region out of which 72% are found in Sikkim. Therefore, Sikkim is the most appropriate location for conservation and propagation studies of rhododendrons in India. Owing to

several man-made reasons the natural populations of rhododendrons of entire Himalaya are gradually diminishing. These alpine plants may be wiped out from the biota in short time if proper conservation measures are not made. Using both biotechnological and conventional methods this project strives to counter the threat on survival of these plants. The goal of the proposed project is to (a) develop protocols for local species, (b) mass propagation of selected rare and endangered species, (c) hardening of mass propagated plants, and (d) test trials in arboretum and fields. *Ex situ* conserved species at Pangthang arboretum will act as gene pool bank for rhododendrons in India. Biotechnological facilities envisaged to be developed will be unique for the north-east India and will benefit institutions in the region.

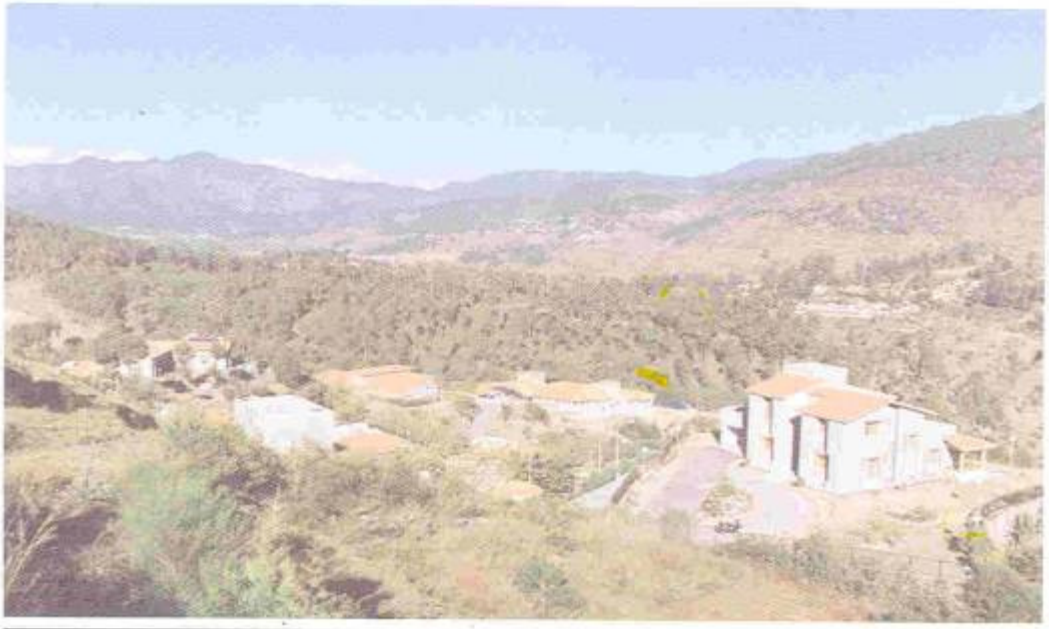
Objectives

1. To develop *in-vitro* propagation protocols.
2. Mass propagation of selected rare and endangered rhododendrons
3. Hardening of mass propagated plants
4. Field trials of tissue culture raised plants in arboretum and under natural conditions.

Results and Achievements

Extensive field survey was conducted and seeds of 22 species were collected

1. *In-vitro* experiments were conducted on a few selected species. In *Rhododendron madenii* 60-70% germination was achieved on hormone-free MS media and 85-90% on moist filter paper.
2. The seedlings of four species namely *R. maddenii, R. niveum, R. pendulum* and *R. micromeres* (rare and endangered) have been raised under aseptic conditions. Light and relatively higher temperature (26°C) were necessary and resulted in 60-70% germination; seeds did not germinate in dark.
3. These seedlings were used for shoot multiplication. Apical dominance played a significant role and hence in vitro shoot removal of tips of seedlings was necessary for multiplication. MS media fortified with BAP 4 µM, 8 µM and WP media with BAP 4 µM were established as optimal for *in-vitro* shoot multiplication and maintenance in *R. maddenii*.
4. Attempts are also in progress to establish *in-vitro* cultures from nodal shoot segments. Extensive browning of the shoot segments was observed due to considerable amount of phenolics and polyphenolics. The levels of phenolics and total extractable polyphenolics have been tested in fresh and dry stem and leaf samples of 14 species. Studies are in progress to relate the levels of these with altitude and seasons.



3.6. INSTITUTIONAL NETWORKING AND HUMAN INVESTMENT

Networking of the existing Institutional infrastructure in the Himalayan region is critical for optimal use of the available scientific talent. Peoples' perceptions of environment and development activities are considered important for involving them in the effective management of natural resources. The Core INHI of the Institute, which was established in October 1993, serves as a nodal point for networking with associated Institutions/Universities/NGOs/Voluntary agencies working on problems relevant to the Indian Himalayan region (IHR). During the year, 15 new projects (six to NGOs, seven to Universities and two to Govt. Institution/Autonomous Organization) were sanctioned and funded under the Integrated Ecodevelopment Research Programme (IERP) of the Institute. However, 41 IERP projects were on-going in 10 Himalayan states of the Country. Environmental awareness was also created by the Core among the villagers/farmers/rural women/NGOs/Govt. organizations and others after organizing various meetings and on-site training programmes on various aspects of Himalayan environment and development.

Theme leader

P.P. Dhyani

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

Following fifteen projects (six to NGOs, seven to Universities and two to Govt. Institution/Autonomous Organization) were sanctioned on the basis of recommendations of the Project Evaluation Committee(s) and subsequently funded by the Institute during the year.

1. Investigation of diversity and economic attributes of Bhabar grass of Hamalayan tarai forests by Dr. A.K. Srivastava, Department of Botany, Ch. Charan Singh University, Meerut, U.P. [Total outlay : Rs. 4,35,280/-].

2. Inventory, biodiversity value, status and strategies for conservation of panchayat forests - a common property resource of Garhwal Himalaya by Dr. N.P. Todaria, Department of Forestry, HNB Garhwal University, Srinagar, Uttaranchal. [Total outlay : Rs. 4,99,200/-].

3. Aquatic insect diversity in relation to the environmental factors in various stream orders of a Central Himalayan watershed by Dr.(Mrs.) M.P. Gusain, Department of Zoology, HNB Garhwal University, Srinagar, Uttaranchal. [Total outlay : Rs. 2,50,000/-].

4. Studies on conservation of *Trachycarpus takil* BECC. (Arecaceae) : A rare and endemic palm of Kumaun Himalaya by Dr. Y.P.S. Pangtey, Department of Botany, Kumaun University, Nainital, Uttaranchal. [Total outlay : Rs. 5,23,240/-].

5. Study of propagation behaviour of some multipurpose trees of Garhwal Himalaya with an agroforestry prospective by Dr. D.P. Vashishth, Department of Botany, HNB Garhwal University, Srinagar, Uttaranchal. [Total outlay : Rs. 4,00,000/-].

6. Development of vegetative propagation techniques in forestry species of dry temperate cold desert regions by Dr. G.S. Shamet, Department of Silviculture and Agroforestry, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P. [Total outlay : Rs. 3,77,300/-].

7. Conservation of nitrogen fixing plants : A reliable approach for the re-habilitation of degraded sites in Himalayan ecosystems by Dr. T.C. Pokhriyal, Division of Botany, Forest Research Institute, Dehradun, Uttaranchal. [Total outlay : Rs. 5,48,780/-].

8. Conservation of Bhojpatra plantation and ecological awareness campaign in Gaumukh area by Dr. (Miss) Harshvanti Bisht, Department of Economics, Govt. P.G. College, Uttarkashi, Uttaranchal. [Total outlay : Rs. 5,00,000/-].

9. Conservation and development of Himalayan rural ecosystem for economic security and economic prosperity by Mr. G.P. Maithani, Himalayan Village Resource Development Society, Dehradun, Uttaranchal. [Total outlay : Rs. 3,90,000/-].

10. Misrit krishi vaniki, nakadi fasal utpadan evam takniki hastantaran dwara gramin nirman birj ke liye samajik arthik unnayan by Mr. J.N. Pant, Neo Integrated Development of Himalaya (NIDHI), Pithoragarh, Uttaranchal. [Total outlay : Rs. 2,49,800/-].

11. Parvatiy vanaspati pradarshan evam prasar by Mr. S. Kumar, Aakashdeep Sewa Sansthan, Pithoragarh, Uttaranchal. [Total outlay : Rs. 2,49,800/-].

12. Garhwal Himalaya urgam ghati mei prakritik falon ke vividhikaran mein mahilawon ki arthik udhyami pariyojana by Mr. B.D. Shastri, Punch Puspa Kalyan Sansthan, Urgam, Chamoli Garhwal, Uttaranchal. [Total outlay : Rs. 3,50,000/-].

13. Screening of plants for the natural dyes traditionally used by tribals of Garhwal and Kumaun region specially to the upliftment of the weaker section by Dr. M.C. Purohit, Society for Rural and Entrepreneurship Development, Srinagar, Uttaranchal. [Total outlay : Rs. 2,70,020/-].

14. Conservation studies in lesser Himalaya – Competition, niche and diversity relations by Dr. A.B. Bhatt, Department of Botany, HNB Garhwal University, Srinagar, Uttaranchal. [Total outlay : Rs. 3,22,640/-].

15. Environmental upgradation by soil conservation and afforestation of the Rakasiya Raula area of Bithoria-Bamori of Haldwani tahsil in Nainital district by Dr. M.S. Karki, Nari Utthan Samiti, Haripur Nayak, Haldwani, Uttaranchal. [Total outlay : Rs. 4,63,000/-].

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

1. Twenty five (25) fresh project proposals were screened carefully and subsequently processed/referred for preliminary evaluation to the subject experts. Annual Progress

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

2. Tenth meeting of the PEC was convened at the Headquarters of the Institute on January 14-15, 2001 for finalization of 45 pending project proposals. Eight members (including one Special Invitee) attended the meeting. Follow-up action on the decisions of the IX PEC meeting was completed. However, on the recommendations of the 10th PEC meeting, follow-up action was initiated.

3. Funds for twenty six (26) ongoing/ completed projects were released during the year after careful examination of Utilization Certificates and Statement of Expenditures. First instalments of grant of two (2) newly sanctioned projects were also released. In all, forty one (41) R&D projects were on-going in 10 Himalayan states of the Country.

4. Final Technical Reports (FTRs) of nine (9) completed IERP projects were received by the Institute. These reports were mailed to the various Organisations/Institutions/ Departments etc. for follow-up action/utilization of research findings and also to the subject experts for their comments/ suggestions.

5. Executive summaries of nine (9) completed IERP projects were published in the ENVIS Bulletin [No. 8(1) and 8(2)] of the Institute. The issues of these bulletins were distributed by the ENVIS Centre to various organisations/user agencies.

6. Follow-up action on almost ninety one (91) project files (old/fresh/on-going etc.) was initiated/ completed and financial targets/ objectives set for the programme were achieved successfully.

7. The progress report of IERP (1.4.1992-31.12.2000) was evaluated/reviewed by the members of Institute Internal Committee and Project Evaluation Committee (PEC). All the members expressed their full satisfaction on the progress of IERP.

3.6.2. Strengthening of Central Nursery at the Headquarters

The main aim of this activity is to ensure availability of sufficient plant material for Institute's R&D activities and supply of well-established saplings for afforestation programmes. During the year, central nursery was strengthened and maintained successfully at Kosi campus (1,120m amsl) of the Institute. Seeds of eighteen (18) promising mountain trees/shrubs were collected in large quantities from time to time and subsequently sown in the nursery beds/seedlings trays/ polybags at the nursery. Seed germination potential of eleven (11) species was also recorded under natural conditions. Almost 850 cuttings of four (4) promising trees/shrubs (namely, *Lagerstroemia indica, Nerium indicum, Populus nigra* and *Rosa moschata*) were collected during the year and subsequently planted in the beds at the nursery. In addition to this, eleven thousand and four hundred twenty (11,420) seedlings of 16 promising trees/ shrubs (namely, *Acer Caesium, Alnus nepalensis, Celtis australis, Cupressus torulosa, Ehretia laevis, Emblica officinalis, Grevillea robusta, Grewia oppositifolia, Jacranda mimosifolia, Leucaena leucocephala, Ligustrum nepalense, Melia azedarch, Picea smithiana, Quercus glauca, Quercus leucotricophora* and *Thuja orientalis*) were also raised in the nursery during the year. Nine thousand and eight hundred fifty (9,850) seedlings/cuttings of 13 trees/shrubs were distributed during the year, free of cost, to the farmers, rural women, students, NGOs and government departments for plantation purpose in mid altitude degraded areas. However, four thousand and one hundred fifty seven (4,157) seedlings/cuttings of various trees/ shrubs were used for R&D and plantation purpose by the Institute. As on 31st March 2001, five thousand and nine hundred fifty eight (5,958) seedlings/cuttings of 23 promising trees/ shrubs were available at the Central Nursery in Kosi.

3.6.3. Environmental Awareness and Training Programmes

The main aim of this programme is to create environmental awareness (through on-site training programmes) among identified target groups. During the year, a three day on-site training programme (ninth of its kind) on nursery development, tree plantation techniques and natural resource conservation and management was organized (from September 26 to 28, 2000) at Dohranala village (District - Kullu) of Himachal Pradesh. The target groups included farmers, rural women, ex-service army personnel and representatives of local NGOs/village level Institutions. In all, fifty two (52) participants from Kullu district attended this short term on-site training programme. The participants were trained successfully by the staff of INHI Core and HP Unit of the Institute. The training programme was considered successful in terms of developing close linkages between the local people and Institute. In addition to the above, a two days training workshop on 'natural resource base and options for development' was also organized at village Deonai (District- Bageshwar)

from December 21 to 22, 2000. Almost 75 local participants including women, school children, ex-service army personnel, farmers and NGOs attended this workshop. A number of entry points in term of taking development initiations were identified during the occasion of this workshop. (Fig 25).

3.6.4. Dissemination of Information through Networking

The main aim of this activity is to disseminate Research and Development (R&D) inputs of the Institute, through its regular in-house publications [namely, Hima-Paryavaran (a biannual newsletter) and Institute Annual Report], to various academic scientific/ Govt. departments, NGOs and individuals working on various aspects of mountain environment and development. During the year, three volumes of Hima-Paryavaran [11(1), 1999; 11(2), 1999 and 12(1), 2000] and one Institute's Annual Report (1998-99) were distributed to almost 574 individuals/subject experts working at various academic and scientific institutions including government departments and NGOs etc. Institute's folders /leaflets/annual day lectures and other publications were also distributed during the year to almost 1,700 individuals on the occasion of various workshops/seminars and GB, SAC, PEC and EFC meetings of the Institute.

Fig. 25. On-site training programme at Dohranala village in Kullu (A) and training workshop at Deoni village in Bageshwar (B).

3.7. INDIGENOUS KNOWLEDGE SYSTEMS

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

Theme leader

N.A. Farooquee

3.7.1. Documentation and analysis of indigenous knowledge and management practices of high altitude societies

Background

Native people inhibiting high altitude region at a close proximity to natural wilderness have been found to possess sound knowledge about their ecosystem and the use of different plant and animal species found in the region. The ecological and traditional knowledge of Bhotiyas of high altitude Central Himalaya have been found to be holistic, intuitive, qualitative and practical, and is part of their folk tradition that is continuing since past unknown. The cultural influence of the people on use and conservation of resources is quite significant and indigenous culture and traditions have helped evolve adaptive strategies to make effective use of natural resources.

Objectives

1. Documentation of indigenous practices relating to natural resource management
2. Scientific analysis of various indigenous practices and
3. Identification of possible options for value addition to their practices.

Results and Achievement

1. Wool and woollen products are integral part of the high altitude society, as they are required throughout the year by the inhabitants. Various indigenous practices have been associated with the wool-based products, and one of the important practices is the colouring and dying of wool using natural vegetations obtained from the nature (Fig 26). Use of natural vegetation for colouring of wool is in practice in the Bhotia society. This study explores the indigenous methods of dying and colouring in the wool based traditional cottage industry in the higher Kumaoun Himalayan region.

Fig. 26. Washing of wool before dying using natural dye.

2. In this region only a few selected plant species were used to make dye for their woollen products. The Indigenous method involves use of various plant parts of different plant species ranging from herbs to large trees (Table 17) to make base colours, viz., three different shades of yellow, a *khroti-rong* (light brown) and pink, apart from the natural white color of the wool. A number of intermediate colours and their shades are produced by mixing of these base colour dyes into different combinations. For example, the colours obtained from *tatori*, *akhrot*, and *dolu* plants are used together to produce a bright red pigment. In this way a whole range of different colors are produced to suit the aesthetic requirements. The other commonly used plants in the making of dye by this community are *sayama* and *kilmora*.
3. Indigenous knowledge also extends to identify the appropriate time to collect the required plant part for making dye. For example, in the case of walnut it is believed that the best time to collect the required parts of the plants for making quality dye happens to be after the flowering stage. It is believed that plants absorb more water during the flowering stage so all the qualitative contents remain in a condition of dilution. The scientific rationale behind it may be linked as (i) identification of proper time and season to suite temperature

Table 17. Plants used in wool processing and for dyeing.

Plant	Local Name	Botanical	Purpose / Part used	Color
Tree	Reetha	*Sapindus mucoraceae*	Washing – Fruit	-
	Akhrot	*Juglans regia*	Dyeing – Bark	Light Violet
			Fruit	Intermediate shade
			Root	Dark Violet
Shrub	Kilmora	*Berberis asiatice*	Dyeing -Root	Yellow
Herb	Dolu	*Rheum emodi*	Dyeing -Root	Yellow
	Sayama	*Rumex nepalensis*	Dyeing -Root	Yellow
	Tatori	*Rheum sp.*	Dyeing -Root	Pink

requirement in the cold climate of high altitudes – developing isotherms on phenological based events was past practice in the Europe, and (ii) to maintain resources- flowering in walnut (winter deciduous tree) occurs during March–April, an early harvesting will cause heavy loss of nutrients by the same amount of plant part to make dye than harvested after flowering. This loss of nutrient may damage the tree and subsequent regeneration through seeds. The required plant parts are collected accordingly and stored for future or off-season use after sun drying.

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

Background

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

Objectives

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

Results and Achievement

1. The fallow system under rainfed conditions during winter season was observed. In the observed cropfields, the fallow period was almost similar (~156 days) irrespective of ownership and different dates of earlier harvest and the next seedbed preparation.
2. In the fallow system practice, 27 weeds appeared during fallow period (Table 18). These 27 weeds belong to 15 families. Family Asteraceae contributes maximum genera (6) followed by Poaceae (3).

Table 18. Weeds that occupy crop fields during fallow period.

Name	Family
Dicliptera roxburghiana Nees	Acanthaceae
Amaranthus hybridus L.	Amaranthaceae
Ageratum conyzoides L.	Asteraceae
Conyza stricta Willd	Asteraceae
Crepis japonica Benth	Asteraceae
Cyathocline purpurea (Don) Ktze.	Asteraceae
Erigeron bonariensis L.	Asteraceae
Galinsoga ciliata (Rafin) Blake	Asteraceae
Cerastium cerastioides (L.) Britt.	Caryophyllaceae
Cyanotis cristata (L.) Don	Commelinaceae
Cyanotis vaga (Lour.) Schult.	Commelinaceae
Euphorbia hirta L.	Euphorbiaceae
Phyllanthus sp.	Euphorbiaceae
Flemingia semialata (Roxb.)	Fabaceae
Lathyrus Sativus L.	Fabaceae
Juncus bufonius L.	Juncaceae
Malvastrum coromendelianum Garcke.	Malvaceae
Oxalis corniculata L.	Oxalidaceae
Oxalis latifolia HBK	Oxalidaceae
Dichanthium annulatum (Forsis) Stapf	Poaceae
Eleusine indica (L.) Gaertn.	Poaceae
Eragrostis unioloides (Retz.) Nees ex Stoud	Poaceae
Anagallis arvensis L.	Primulaceae
Antirhinum orontium L.	Scropulariaceae
Lindernia sessiliflora (Benth.) Wettst.	Scropulariaceae
Solanum nigrum L.	Solanaceae
Triumfetta pilosa Roth.	Tiliaceae

3. Weeds in the fallow cropfields may appear as early as within 12 days after the previous crop harvest or towards the very end of the fallow period, i.e., only 25 days before the next ploughing (Fig 27). The number of new weeds appearing decreased with increase in the length of fallow period ($P < 0.01$).

Fig. 27. Traditional agricultral practice under rainfed conditions.

4. Multiple cropping is a traditional mechanism to increase crop production per unit area and time. This practice has the potential to achieve the maximum output from a cropland. Multiple cropping patterns during rabi season were analyzed in two villages of Kumaun region. Cultivation of following crop combinations is in practice: cereal + oilseed, pulses + oilseed, and cereal + pulses + oilseed. Cereal based multiple cropping dominates the cultivation.

5. Wheat grown with mustard is most common multiple cropping combination among two crops combination during rabi season. Total agronomic yield of this combination differs widely between the two villages (Table 19) as well as with in the village. In village Matela, agronomic yield varies between 3.5 and 4.0 qu/ha while large variation (6.6-10.8 qu/ha) was observed in village Katarmal.

6. Among the various crop combinations, three-crop combination was found more efficient than the single crop and two crop combination (save lentil + mustard which is not a common practice) as apparent from harvest index. In village Katarmal, agronomic yield of wheat as single crop cultivation was greater than the total agronomic yield of wheat + mustard combination, however, latter one was more efficient practice (0.27 harvest index) than the single crop cultivation (0.25 harvest index).

Table 19. Efficiency of multiple cropping patterns during *rabi* season.

Cropping Pattern	Agronomic yield (Qu/ha)	Harvest Index
Two crops	Village Matela	
Wheat + Mustard	3.76	0.28
Lentil + Mustard	7.55	0.39
Three crops		
4.07	0.36	
Single crop	Village Katarmal	
Wheat	11.16	0.25
Two crops		
Wheat + Mustard	8.66	0.27

QUICK APPRAISAL STUDIES

Environmental Impact Assessment of Desiltation Operation at Bhimtal Lake, Kumaun Central Himalaya

Background

Bhimtal Township having a beautiful lake, is well known for one of the largest lake of Kumaun Central Himalaya. The surface area of the lake is about 53 ha with maximum length and width of 1715.5 m and 486.5 m, respectively. Lake has storage capacity of 4245.7 x 10^3 m^3 with maximum and minimum depths of 24.75 m and 12.13 m, respectively. Approximately 100 m^3 water of the lake is used for drinking purposes in a day. Catchment area of Bhimtal lake in particular, is well known for high erosion rates due to loss of vegetal cover for construction of hotels, roads, residential complexes and agricultural activities (Figure 2). On account of these, one third of the Bhimtal lake area, towards the northern side (i.e., the main entry

point for runoff from the catchment), started drying up during summer months in previous years forming marshy and weedy patches. Visualizing the consequences the Irrigation Department of the State Government responsible for operation and management of the lake, decided to undertake desilting operations (Figure 3). The salient features of the desilting operation include desilting an area of 225 m x 225 m with depth ranging from 1 to 3.5 m. The total amount of silt to be removed from the lake has been worked out as 53000 m^3 with total expenditure of Rs 90,00,000. Four alternative locations were identified near to Silari Village, Harinagar Village, Aamdali Village and Ramlila Ground for dumping of silt. However, soon after the initiation of work, it was felt that the silt dumping sites are probably not suitable as at one of the sites, the dumped silt started sliding down causing downstream damages. With this background it was planned to undertake a quick appraisal study to conduct EIA of desilting operations.

Objectives

1. To highlight the need of Environmental Impact Assessment (EIA) study for developmental projects requiring alteration/ modification of natural setting in Himalayan region, such that the adverse impacts of developmental project could be minimized.

Results and Achievements

1. The silt dumping locations at Aamdali, Harinagar and Silari Village are along the Bhimtal-Kathgodam road and about 3.0 km, 5.5 km and 6.0 km, respectively, away from the Bhimtal lake. Average elevation of dumping location at Silari, Harinagar and Aamdali is around 1175 m amsl, 1279 m amsl and 1320 m amsl, respectively, whereas the average hill slope below the road head is 50°, 55° and 45°, respectively. Landuse pattern at these sites mostly consists of wastelands with sparse vegetation (Fig 28). Buildup area and agricultural fields are, however, further below the dumping sites in distant valley except Aamdali, where the village is situated on one side of the dumping location.

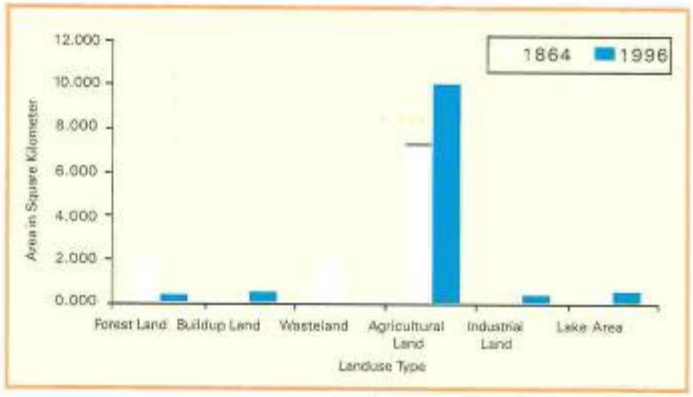


Fig. 28. Landuse pattern in the catchment area of Bhimtal Lake

2. From the EIA study it is concluded that the desiltation operation will have maximum beneficial impacts on the lake water quality and its storage capacity, which in turn will reduce the treatment cost of water supply. It will also have positive impacts on the aquatic ecosystem, irrigation and drinking water supply.

3. The silt dumping on steep slopes will have adverse impact on slope stability because by altering the drainage pattern, increased erosion and destruction of vegetation cover, etc., would take place (Fig 29). Silt dumping at Silari site, altered the drainage pattern and a gully, almost 200 m long and 3.8 m wide and 1.5 m deep, was formed. The sliding debris, despite five number of reasonably high gabion works, rolled over and covered around 1200 m^2 agricultural land having Ginger, Turmeric and Corn crops in addition to loss of 6000 m^2 area of Banana and Mango garden. The debris flow also caused damage to one house.

4. As per the EIA study the most suitable site for silt dumping is Ramlila ground, Bhimtal, which has total positive impact of about 467, whereas Silari, Harinagar and Aamdali have the impact score – 4126, -3460 and -3259, respectively indicating the unsuitability of them as dumping sites.

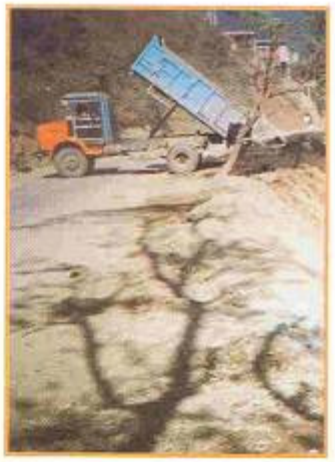


Fig. 29. Silt Dumping site at Salari Vilalge

4. MISCELLANEOUS ITEMS

1.1. Addition to the Library

Addition of 673 books during the financial year 2000-2001, the total number of books available in the Library is 10493. A total of 136 periodicals (Foreign/Indian) are being subscribed in the library including some periodicals being subscribed by the ENVIS Centre on Himalayan Ecology at the Institute. Library database have been updated by using the Network Version of the Software Package PALMS (Prasad Automated Library Management Systems) and Computerised Current Awareness Services (CAS). Selective Dissemination of Information (SDI) Services, Indexing, Abstracting, Bibliographical, Reprographic, Reference and Indexing Services are being provided by the Library. Fifteenth and Sixteenth volumes of Published Research Papers, Popular Articles and Books have been compiled and Bibliography (1989-2000) has been updated. Library is also receiving some books and periodicals from some national and international organizations as complimentary/gratis or exchange.

4.2. Membership of Professional Societies/Committees

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

Life Member, Central Himalayan Environment Association, Nainital. (P.P.Dhyani, K.S. Rao & S.K. Nandi)

Life member, Indian Library Association, Delhi. (R. C. Prasad)

Life member, Indian Association of Special Libraries & Information Centres, Kolkata. (R. C. Prasad)

Life member, Uttar Pradesh Library Association, Lucknow. (R. C. Prasad)

Life Member, People's Association for Hill Area Research, Nainital. (Kireet Kumar)

Life Member, Central Himalyan Environment Association, Nainital. (S. S. Samant)

Life Members, The U.P. Association for the Science & Technology Advancement, Lucknow. (P.P. Dhyani, K.S. Rao, R.K. Maikhuri, S.S. Samant, R.S. Rawal, S.C. Joshi & G.C.S. Negi)

Member, Delhi University Botanical Society, Delhi. (R.S. Rawal)

Associate Member, Institution of Engineers (India) (D.K. Agrawal)

Life Member, Indian Association of Hydrologists, Roorkee. (D.K. Agrawal & G.C.S. Negi)

Member, National Institute of Ecology, New Delhi. (E. Sharma, A.P. Krishna, K.K. Singh, S.C.R. Vishvakarma, Uma Shankar, G.C.S. Negi & V. Joshi)

Life Member, Mountain Action Research Group, Nainital. (G.C.S. Negi & V. Joshi)

Life Member, Society of Biological Chemists, India (S.C. Joshi)

Life member, Indian Society of Tree Scientists (S.C. Joshi)

Life member, Sikkim Science Society, Gangtok. (S.C.R. Vishvakarma & S. Sharma)

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

Member, International Society for Conservation of Natural Resources (R.C. Sundriyal)

Member, Centre for Tourism Research and Development, Lucknow. (J.C. Kuniyal)

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

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

Member, International Association for Plant Tissue Culture & Biotechnology (L.M.S. Palni & A. Kumar)

Life Member, Indian Science Congress Association, Kolkata. (N.A. Farooquee)

Life Member, International Society of Environmental Botanists (S.K. Nandi)

Life Member, Indian Phytopathological Society (A. Pandey)

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

4.3. Award/Honour

Member, Expert Committee – Task Force in Biotechnology, Dept. of Biotechnology, New Delhi (L.M.S. Palni)

Member, Governing Council, Central Himalayan Environment Association, Nainital (L.M.S. Palni)

Member, Advisory Committee, Biotechnology Programme, Kumaun University, Nainital (L.M.S. Palni)

Member, Committee on Research (Medicinal Plant Board), Department of Biotechnology, New Delhi (U. Dhar)

Member, Review Committee on Genetic Manipulation, Department of Biotechnology, New Delhi (U. Dhar)

Coordinator, NBSAP TWG- Wild Plant Diversity (U. Dhar)

Leadership in Environment and Development, India (LEAD India) as associate (Kireet Kumar)

Member of Research Advisory Board of the American Biography Institute, Inc. (Uma Shankar)

Second prize in All India Essay Competition (Hindi) organised by MoE&F, GOI. (R.G. Singh)

Co-chairperson (Forestry Session) 21st Asian Conference on Remote Sensing, Taipei, Taiwan. (S. Sharma)

4.4.1. Scientific Papers

(I) Scientific Journals

Agnihotri, R.K., S. Chandra, S. Sharma and L.M.S. Palni (2000). Genetic varibility in photosynthesis and chlorophyll content of various landraces of upland rice. *International Rice Research Notes*, 25(2): 13-14.

Airi, S., R.S. Rawal, U. Dhar and A. N. Purohit (2000). Assessment of availability and habitat preference of Jatamansi- a critically endangered medicinal plant of west Himalaya. *Current Science*, 79(10): 1467-1471.

Badola, H.K. (2000). Growth and size of shoot populations in canopy layers of *Quercus leucotrichophora* (Fagaceae). *Selbyana*, 21(1,2): 97-104

Bag, N., S. Chandra, L.M.S. Palni and S.K. Nandi (2000). Micropropagation of Dev Ringal [*Thamnocalamus spathiflorus* (Trin.) Munro] - a temperate bamboo, and comparison between *in vitro* propagated plants and seedlings. *Plant Science*, 156: 125-135.

Bhatt, I.D. and U. Dhar (2000). Combined effect of cytokinins on multiple shoot production from cotyledonary node explants of *Bauhinia vahlii*. *Plant Cell Tissue Organ Culture*, 62(1): 79-83.

Bhatt, I.D. and U. Dhar (2000). Micropropagation of Indian wild strawberry. *Plant Cell Tissue Organ Culture*, 60: 83-88.

Bhatt, I.D. R.S. Rawal and U. Dhar (2000). Improvement in seed germination of *Myrica esculenta* Buch-Ham. ex D. Don a high value tree species of Kumaun Himalaya, India. *Seed Sci. & Tech.* 28: 597-605.

Bhatt, I.D., R.S. Rawal and U. Dhar (2000). The availability, fruit yield and harvest of *Myrica esculenta* in Kumaun (west) Himalaya. *Mount. Res. Dev.*, 20:146-153.

Bhuyan, P., M.L. Khan and Uma Shankar (2000). Trade-off between dispersal efficiency and seedling fitness in *Oroxylum indicum*, a wind dispersed tropical tree. *International Journal of Ecology and Environmental Sciences*, 26: 67-73.

Bisht B.S., S. K. Bhuchar, S. S. Bisht, B. P. Kothyari and L. M. S. Palni (2000). A Functional Analysis of Women's Participation in Various Activities in Hills: a Case Study from Village Arah in Kumaon Himalaya, India. *Jour. Hum. Ecol.*, 11(6): 487-489.

Dhar, U, R.S., Rawal and J. Upreti (2000). Setting priorities for conservation of medicinal plants a case study in the Indian Himalaya. *Biol. Cons.*, 95: 57-65.

Dhar, U., J. Upreti and I.D. Bhatt (2000). Micropropagation of *Pittosporum napaulensis* (DC.) Rehder & Wilson- a rare, endemic medicinal tree. *Plant Cell Tissue and Organ Culture*, 63: 231-235.

Farooquee, N.A. and K.S. Rao (2001). Changing values in the transhumant Monpa pastoralists and ecological implications on Rangelands in Eastern Himalaya, India. *Nomadic Peoples*, 5(1): 56-61.

Farooquee, N.A. and D.S. Rawat (2001). Social status and work participation of transhumant pastoral Bhotiya women in the Kumaon Himalaya. *Indian Journal of Gender Studies*, 8(1): 97-106.

J. Paul, R. Burgmann, V.K. Gaur, R. Bilham, K. M. Larson, M. B. Ananda, S. Jade, M. Mukal, T. S. Anupama, G. Satyal, and D. Kumar, (2001) The motion and active deformation of India, *Geophysical Research Letter*, Vol. 28 (4): 647-650.

Jain, A., S.C. Rai and E. Sharma (2000). Hydro-ecological analysis of a sacred lake watershed system in relation to land-use/cover change from Sikkim Himalaya. *CATENA*, 40: 263-278.

Joshi, S.C., N. Bag, L.M.S. Palni, M.S. Bisht, and P. Vyas (2000). Use of CO_2 uptake and chlorophyll fluorescence for early selection of tea clones: an assessment. *Journal of Plant Biology*, 27: 247-252.

Joshi, S.C., R.K. Maikhuri and V. Joshi (2000). Chlorophyll fluorescence characteristics, growth and solute accumulation during summer in seedlings of native plant species grown in abandoned agricultural and degraded lands. *Journal of Sustainable Forestry*, 11: 97-114.

Joshi, V. and A.P. Krishna (2000). Control measures for checking soil erosion, landslides and debris flow in Hindu-Kush Himalayan belt of PR of China. *Indian Journal of Soil Conservation*. 28 (1) :1-6.

Krishna, A. P. (2000). Landslide management in the Himalayas. *Geo Asia-Pacific*, June-July issue : 30-32.

Kumar, A., A. Sood, U.T. Palni, A.K Gupta and L.M.S Palni (2001). Micropropagation of *Rosa damascena* from mature bushes using thidiazuron. *Journal of Horticultural Science and Biotechnology*, 76: 30-34.

Kumar, A., L.M.S. Palni, P.K. Nagar and A.K. Gupta (2001).

Changes in endogenous abscisic acid and phenols in gladiolus cormels in relation to storage and dormancy. *Physiology and Molecular Biology of Plants*, 7: 67-74.

Kuniyal, J.C. and Jain, A.P. (2000-2001). Tourists' Involvement in Solid Waste Management in Himalayan Trails: A case study in and around Valley of Flowers, India. *Journal of Environmental Systems*, 28(2)

Maharana, I., S.C. Rai and E. Sharma (2000). Environmental economics of the Khangchendzonga National Park in the Sikkim Himalaya, India. *GeoJournal*, 50: 329-337

Maharana, I., S.C. Rai, and E. Sharma (2000). Valuing ecotourism in a sacred lake of the Sikkim Himalaya, India. *Environmental Conservation*, 27: 269-277

Maikhuri, R.K., Nautiyal, S., Rao, K.S. and Semwal, R.L. (2000). Indigenous knowledge of medicinal plants and wild edibles among three tribal subcommunities of the central Himalayas, India. *Indigenous Knowledge and Development Monitor*, 8 (2): 7-13.

Maikhuri, R.K., Nautiyal, S., Rao, K.S., Chandrasekhar, K., Gavali, R. and Saxena, K.G. (2000). Analysis and resolution of protected area - people conflicts in Nanda Devi Biosphere Reserve, India. *Environmental Conservation*, 27(1): 43-53.

Maikhuri, R.K., Rana, U., Rao, K.S., Nautiyal, S. and Saxena, K.G. (2000). Promoting ecotourism in the buffer zone areas of Nanda Devi Biosphere Reserve: An option to resolve people-policy conflict. *International Journal of Sustainable Development and World Ecology*,7: 333-342.

Maikhuri, R.K., Semwal, R.L., Rao, K.S., Nautiyal, S. and Saxena, K.G. (2000). *Cleome Viscosa* Capparidaceae: a weed or a cash crop? *Economic Botany*, 54 (2): 150-154.

Negi, G.C.S. (2001). The need for micro-scale and meso-scale hydrological research in the Himalayan mountains. *Environmental Conservation*, 28(2): 95-98.

Negi, G.C.S. and V. Joshi (2000). Water management and sustainability of agriculture in the Himalayan mountains. *ILIEA (LEISA India)*, 2(1): 12-13.

Negi, G.C.S., K. Kumar, V. Joshi, Y.S. Panda and G.S. Satyal (2001). Water yield and water quality of some aquifers in the Himalayan mountains. *International Journal of Ecology and Environmental Sciences*, 27: 55-59.

Nautiyal, S. K. S. Rao, R.K. Maikhuri, R.L. Semwal and K.G. Saxena (2000). Traditional knowledge related to medicinal and aromatic plants in tribal societies in a part of Himalaya. *Journal of medicinal and aromatic plant Sciences* 22(4A) & 23 (1A): 528-541.

Pandey, A., L.M.S. Palni and N. Bag (2000). Biological hardening of tissue culture raised plants through rhizosphere bacteria. *Biotechnology Letters*, 22: 1087-1091.

Pandey, H., S.K. Nandi, M. Nadeem and L.M.S. Palni (2000). Chemical stimulation of seed germination in *Aconitum heterophyllum* Wall. and *A. balfourii* Stapf.: important Himalayan species of medicinal value. *Seed Science and Technology*, 28: 39-48.

Rai, L.K., P. Prasad and E. Sharma (2000) Conservation threats on some important medicinal plants of the Sikkim Himalaya. *Biological Conservation*, 93(1): 27-33

Ramprasad B.K., B.P. Kothyari and Pande R.K. (2000), Evaluation of rainfall erosivity in Bheta Gad catchment, Kumaun Hills of Uttar Pradesh, central Himalayas, *The Environmentalist*, 20: 301-308.

Rao, K.S., Maikhuri, R.K., Semwal, R.L. and Saxena, K.G. (2000). Canopy development studies in an ecoregeneration site in Garhwal Himalaya. *Sylbyana*, 21 (1/2): 105-111.

Rao, K.S., Nautiyal, S., Maikhuri, R.K. and Saxena, K.G. (2000). Management conflicts in the Nanda Devi Biosphere Reserve, India. *Mountain Research and Development*, 20(4): 320-323.

Rawat, D.S., R. Joshi and M. Joshi (2000). Indigenous Methods for Storage and Use of Bioresources: Case study, Indian Central Himalaya. AMBIO, 29(6): 356-358.

Rikhari, H.C., S. Sharma, M. Nadeem and L.M.S. Palni (2000). The effect of disturbance levels, forest types and associations on the regeneration of *Taxus baccata:* Lessons from Central Himalaya. *Current Science*, 79: 88-90.

Samal P.K., Y. S. Topal and Pushpa Pant (2001), Educating a Nomadic Tribe: The problems and the prospects. *Jour. Hum. Ecol.*, 12(1) 2001: 1-8.

Samal, P.K., Topal, Y.S. and Pant Pushpa, (2001). Retrospective and perspective analysis of development of Rajis: a primitive mountain tribe in Indian Central Himalaya. *Journal of Rural Development*, 20(1): 21-42.

Samant, S.S., U. Dhar, and R.S. Rawal (2000). Assessment of fuel resource diversity and utilization

patterns in AWLS, in Kumaun Himalaya. *Environmental Conservation*, 27: 5-13.

Sharma, E., R. Sharma, K.K. Singh and G. Sharma (2000). A boon for mountain populations: Large cardamom farming in the Sikkim Himalaya. *Mountain Research and Development*, 20(2): 108-111

Sharma, E., S.C. Rai and R. Sharma (2001). Soil, water and nutrient conservation in mountain farming systems: A case study from the Sikkim Himalaya. *Journal of Environmental Management*, 61(2): 123-135

Singh, K.K., A.P. Krishna and E. Sharma (2000). Effects of altitude and shade-tree types on large cardamom chlorophyll, nitrogen and spectral properties in the Sikkim Himalaya. *International Journal of Ecology and Environmental Sciences*, 26: 139-147

Sundriyal, Manju and R.C. Sundriyal (2000). Potential of wild edible plants in the Sikkim Himalaya: Conservation concerns. *Journal of Non Timber Forest Products*, 7(3/4): 253-262.

Sundriyal, Manju and R.C. Sundriyal (2001). Seed germination and response of stem cuttings to hormonal treatment in six priority wild edible fruit species of Sikkim Himalaya. *Indian Forester*, 127(6): 695-706.

Sundriyal, Manju and R.C. Sundriyal (2001). Wild edible plants of the Sikkim Himalaya: Nutritivevalues of selected species. *Economic Botany*, 55(3): 377-390.

Tamta, S., V.K. Purohit, S.K. Nandi and L.M.S. Palni (2000). Chemical induction of root formation in *Quercus leucotrichophora* L. stem cuttings. *Indian Journal of Forestry*, 23: 135-138.

(II) Chapters in books/ Proceedings

Agrawal, D.K. (2000). Complexities and Measures for Environmental Management in the Indian Himalayan Region. In: R.S. Goel (Ed.) *Environmental Impact Assessment of Water Resources Projects*. Oxford & IBH Publishing Co. pp. 403-413.

Bhuchar S.K., S.S. Bisht, B.K. Joshi, B.P. Kothyari and B.S. Bisht (2000), Plant-Microbial Community Dynamics Associated with Soil Nutrient Gradient in Newly Rehabilitated Degraded Land: A Case Study from the Indian Central Himalayas, In: R. Allen, H. Schreier, S. Brown and P.B. Shah (eds.), *Proceedings of PARDYP Workshop*. pp 271-280.

Bisht B.S., S.K. Bhuchar, P. Pant, B.P. Kothyari and L.M.S. Palni (2000). The Pivotal Role of Women in the Hills: Gender Analysis in Arah Village in Uttar Pradesh, Central Himalayas, India, In: R. Allen, H. Schreier, S. Brown and P.B. Shah (eds.), Proceedings of PARDYP Workshop. pp 35-46.

Dhar, U. (2000). Prioritization of conservation sites in the Timberline zone of west Himalaya. In Shekhar Singh, A.R.K. Sastry, Raman Mehta & V. Uppal (eds.) *Setting biodiversity conservation priorities for India (Vol. I)*, WWF-India, New Delhi. pp.

Kumar R, Agrawal, D.K. and Goel, R.S. Management of Environmental Disasters in Indian Himalayan Region: Problems and Remedies. Proceedings International Conference on Construction Industry, Disaster Management and Environmental Management, IE(I), Chandigarh. pp. 206-217.

Kumar, K. and D. S. Rawat (2000) Environmental impacts of mineral extraction in Kumaon Himalaya, In: A. K. Sinha and Pankaj Srivastava (Eds.) *Earth Resources and Environmental Issues*, ABD Publishers, Jaipur, India, pp. 47-56.

Kumar, K. and G. S. Satyal (2000) Physical Accounting of Water: Micro Watershed Analysis: In: Kadekodi, G. K., Murthy, K. S. R. and Kumar, K. (Eds.) *Water in Kumaon: Ecology, value and rights*, Gyanodaya Prakashan, Nainital, pp. 127-153.

Maikhuri, R.K., U. Rana, R.L. Semwal and K.S. Rao (2000). Agriculture of Uttarakhand: Issues and management prospects for economic development. In: M.C. Sati and S.P. Sati (eds.). *Uttaranchal Statehood: Dimensions to Development* Indus Publishing Co., New Delhi, pp 151-167.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao and K.G. Saxena (2000). Garhwal Himalaya : Nanda Devi Biosphere Buffer Zone – *Socio-Ecological Profile*. Pages 219-226. In: P.S. Ramakrishnan, U.M. Chandrashekara, C. Elouard, C.Z. Guilmoto, R.K. Maikhuri, K.S. Rao, S.Sankar and K.G. Saxena. (Eds.), *Mountain Biodiversity, Land Use Dynamics, and Traditional Ecological Knowledge* Oxford & IBH Publication, India (P) Ltd., New Delhi.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao and K.G. Saxena (2000). Garhwal Himalaya : Nanda Devi Biosphere Buffer Zone – *Traditional Agroecosystems*. Pages 227-239. In: P.S. Ramakrishnan, U.M. Chandrashekara, C. Elouard, C.Z. Guilmoto, R.K. Maikhuri, K.S. Rao, S.Sankar and K.G. Saxena. (Eds.), *Mountain Biodiversity, Land Use Dynamics, and Traditional Ecological Knowledge*

Oxford & IBH Publication, India (P) Ltd., New Delhi.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao and K.G. Saxena (2000). Garhwal Himalaya : Nanda Devi Biosphere Buffer Zone – *Animal Husbandry*. Pages 240-252. In: P.S. Ramakrishnan, U.M. Chandrashekara, C. Elouard, C.Z. Guilmoto, R.K. Maikhuri, K.S. Rao, S.Sankar and K.G. Saxena. (Eds.), *Mountain Biodiversity, Land Use Dynamics, and Traditional Ecological Knowledge* Oxford & IBH Publication, India (P) Ltd., New Delhi.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao and K.G. Saxena (2000). Garhwal Himalaya : Nanda Devi Biosphere Buffer Zone – *Forest Ecosystem*. Pages 253-264. In: P.S. Ramakrishnan, U.M. Chandrashekara, C. Elouard, C.Z. Guilmoto, R.K. Maikhuri, K.S. Rao, S.Sankar and K.G. Saxena. (Eds.), *Mountain Biodiversity, Land Use Dynamics, and Traditional Ecological Knowledge* Oxford & IBH Publication, India (P) Ltd., New Delhi.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao and K.G. Saxena (2000). Garhwal Himalaya : Nanda Devi Biosphere Buffer Zone – *Village Ecosystem*. Pages 265-298. In: P.S. Ramakrishnan, U.M. Chandrashekara, C. Elouard, C.Z. Guilmoto, R.K. Maikhuri, K.S. Rao, S.Sankar and K.G. Saxena. (Eds.), *Mountain Biodiversity, Land Use Dynamics, and Traditional Ecological Knowledge* Oxford & IBH Publication, India (P) Ltd., New Delhi.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao and K.G. Saxena (2000). Garhwal Himalaya : Nanda Devi Biosphere Buffer Zone – *Reserve-People Conflicts*. Pages 299-309. In: P.S. Ramakrishnan, U.M. Chandrashekara, C. Elouard, C.Z. Guilmoto, R.K. Maikhuri, K.S. Rao, S.Sankar and K.G. Saxena. (Eds.), *Mountain Biodiversity, Land Use Dynamics, and Traditional Ecological Knowledge* Oxford & IBH Publication, India (P) Ltd., New Delhi.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao and K.G. Saxena (2000). Garhwal Himalaya :Nanda Devi Biosphere Buffer Zone – *Ecosystem Rehabilitation and Conflicts Resolution*. Pages 310-324. In: P.S. Ramakrishnan, U.M. Chandrashekara, C. Elouard, C.Z. Guilmoto, R.K. Maikhuri, K.S. Rao, S.Sankar and K.G. Saxena. (Eds.), *Mountain Biodiversity, Land Use Dynamics, and Traditional Ecological Knowledge* Oxford & IBH Publication, India (P) Ltd., New Delhi.

Murthy, T.V.R., M.M. Kimothi, A.S. Arya, T.S. Singh, J.K. Garg, V. Joshi, G.C.S. Negi, R.K. Maikhuri and O.P. Bhatt (2000). Landslide hazard zonation in a part of the Alaknanda valley, Garhwal Himalaya, using remote sensing and GIS techniques. Space Applications Centre (ISRO), Ahmedabad, pp. 33.

Negi, G.C.S., V. Joshi, K. Kumar and L.M.S. Palni (2000). Drinking water management in a Himalayan watershed. In: *Proceeedings of International Conference on Innovative Technologies for Rural Water Supply and Environmental Sanitation* held at University of Roorkee, pp. 190-201.

Palni, L.M.S. and D. Choudhury (2000). Agricultural self-reliance in north east India: The potential of indigenous technical knowledge and traditional practices. In: Proceedings of the National level seminar on Resources Management for self Reliant Agricultural Economy of NE Region, organised by NERIWALM and G.B. Pant Institute of Himalayan Environment and Development, pp. 132-143.

Palni, L.M.S. (2000). Biodiversity conservation programme of G.B. Pant Institute of Himalayan Environment and Development. In: *Proceedings of Consultative Workshop: Linking People with Nature: Biodiversity Conservation Strategy for Himalyan region* (Nishat, A., M. Waliuzzaman, and J. Ahmed, eds.) pp. 22-23.

Palni, L.M.S., K. Kumar and M. L. Dewan (2000) Issues and Strategies for Sustainable Land and Water Resource Management in the Himalayan Region, In: *Advance in Land Resource Management for 21st Century*, pp.153-162.

Pandey, D.C. and Kuniyal, J.C. (1998). Dynamic Dimensions of Fruit Crops' Ecofarming in an Hill Environment. In:, P.C Pande, R.K. Pande and R. Pande (eds.) *The Himalayan Environment and Challenges*, Daya Publishing House, Delhi, pp. 90-100.

Ramprasad B.K., B.K. Joshi, A.K. Mishra, B.P. Kothyari and R.K. Pande (2000), Rainfall variation and soil erosion in the Bheta Gad watershed of Uttar Pradesh in the Central Himalaya, In: R. Allen, H.s Schreier, S. Brown and P.B. Shah (eds.), Proceedings of PARDYP Workshop. pp 199-207.

Ramprasad B.K., M. S. Miral, R. Pant and K.S. Rao (2000), Identification of Potential Water Harvesting sites using GIS and Remote sensing Technologies: A case study of Sadiya Gad Watershed, central Himalaya, India. In: Proceedings of an International Workshop on

Integrated Water Resource Management for Sustainable Development, R Mehrotra, B Soni & KKS Bhatia (eds.). NIH, Roorkee: 1224-1233.

Semwal, R.L., R.K. Maikhuri and K.S. Rao (2001). Agriculture, ecology, practices and productivity. In: O.P. Kandari and O.P. Gusain (eds.). *Garhwal Himalaya: Nature, Culture and Society*, TransMedia, Srinagar Garhwal, UA, pp 261-276.

Sharma, E., K.K. Singh and R. Sharma (2001). Large cardamom agroforestry a sustainable practice in the Sikkim Himalaya. Discussion paper on integrated Development of Spices, Dept. of Horticulture, Govt. of Sikkim, pp 1-9.

Sharma, S., L.M.S. Palni and P.S Roy (2000). Analysis of fragmentation and anthropogenic disturbances in the Himalayan forests: use of remote sensing and GIS. In: *Proceedings of the 21st Asian Conference on Remote Sensing* held at Taipei, Taiwan. pp 264-269.

Sharma, S., L.M.S. Palni and P.S. Roy (2000). Integration of human dimension in the landscape analysis: Case study of a Himalayan district using remote sensing and GIS for forest management. In: *Proceedings of 2nd National Seminar on IT in Forest Management*. IIFM, Bhopal. pp 31-42.

Topal Y.S., S.K. Bhuchar, P. Pant and B.P. Kothyari (2000). Sustainable Management and Utilisation of Common Property Resources: a case study in the Bheta Gad - Garur Ganga watershed in the Central Himalayas, In: R.d Allen, H. Schreier, S. Brown and P.B. Shah (eds.), Proceedings of PARDYP Workshop. pp 109, 121.

Uma Shankar (2000). Increasing biomass scarcity in north-eastern India: Options with the villagers. In A. Arunachalam & M.L. Khan (eds.) A. Arunachalam & M.L. Khan (eds.) *Forest resources management and sustainable development*. International Book Distributors, Dehradun, pp. 168-183.

(III) Authored/Edited Books

Dhar, U., R.S. Rawal, and S.S. Samant (2000). *Himalay Ki Jaiv Vividhata Sanrakshan Mei Janta Ki Bhagidari*, GBPIHED, Kosi-Katarmal, Almora.

Kumar, K., D.S. Rawat, G.C.S. Negi, D.K. Agrawal, P.K. Samal, V. Joshi, G.S. Satyal, and L.M.S. Palni.(2000). Village Environment Action Plan: Community Manual (In Hindi). G B Pant Institute of Himalayan Environment and Development, Almora. 85p.

Nandy, S.N., Rekha Pant and K.S. Rao (2000). Indian Himalaya: A Demorgraphic Database. ENVIS Monograph 2. G.B. Pant Institute of Himalayan Environment and Development, Almora.

Ramakrishnan, P.S., U.M. Chandrashekara, C. Elouard, C.Z. Guilmoto, R.K. Maikhuri, K.S. Rao, S.Sankar and K.G. Saxena. (2000). *Mountain Biodiversity, Land Use Dynamics, and Traditional Ecological Knowledge* (edited). UNESCO and Oxford & IBH Publication, India (P) Ltd., New Delhi, XV+450.

Samal, P.K., Y.S. Topal and Pushpa Pant (2000).Van Rawat: A Tribe in peril, Gyanodaya Prakashan, Nainital, pp 132.

4.4.2. Popular Articles

Agrawal, D.K. (2001). Jaiv Vividhta ka Jaliya evam Mrida Paryavaran se Antarsambandh. In: Dhar, U, Rawal, RS and Samant, SS. Eds. Himalaya ki Jaiv Vividhta – VII.). G B Pant Institute of Himalayan Environment and Development, Almora. 12-18.

Airi, S and B. Pandey (2000). Jav vividhata: Moolya Evan MoolyaVridhi. In U. Dhar, R.S. Rawal & S. S. Samant (eds.) *Himalay Ki Jav Vividhata (Sanrakshan Mei Janta Ki Bhagidari)*., GBPHIED, Kosi-Katarmal Almora. pp. 42-45.

Bhatt, A. and R.S. Rawal (2000). Jav vividhata Sanrakshan Ki Vidhiyan. In U. Dhar, R.S. Rawal & S. S. Samant (eds.) *Himalay Ki Jav Vividhata (Sanrakshan Mei Janta Ki Bhagidari)*. GBPHIED, Kosi-Katarmal Almora. pp. 33-37.

Bhatt, I.D. (2000). Padap Sambardhan: Paramparagat Vidhiyan Evan Mahattv. In U. Dhar, R.S. Rawal and S. S. Samant (eds.) *Himalay Ki Jav Vividhata (Sanrakshan Mei Janta Ki Bhagidari)*, GBPHIED, Kosi-Katarmal Almora. pp. 51-55.

Bisht, A.K. and M. Joshi (2000). Jav Vividhata Sanrakshan Mei Beejon Ki Mahatta. In U. Dhar, R.S. Rawal & S. S. Samant (eds.) *Himalay Ki Jav Vividhata (Sanrakshan Mei Janta Ki Bhagidari)*., GBPHIED, Kosi-Katarmal Almora. pp. 46-50

Bisht, G., S. Airi and I.D. Bhatt (2000). Anukoolan Evam Paudhon Ki Uttarjeevita. In U. Dhar, R.S. Rawal & S. S. Samant (eds.) *Himalay Ki Jav Vividhata (Sanrakshan Mei Janta Ki Bhagidari)*., GBPHIED, Kosi-Katarmal Almora. pp. 61-63.

Dhyani, P.P. (2000). Common plant species have potential for economic upliftment of rural populace – Bantulsi a case in point. Hima-Paryavaran 12 (1) : 11-13.

Joshi, G. and S. Majkhola, (2000). Jav vividhata Ke Adhyyan Mei Anuvanshik Guno Ka Mahatti. In U. Dhar, R.S. Rawal & S. S. Samant (eds.) *Himalay Ki Jav Vividhata (Sanrakshan Mei Janta Ki Bhagidari)*, GBPHIED, Kosi-Katarmal Almora . pp. 38-41.

Joshi, M. (2000). Padap Uttak Sambardhan Evam Jav Vividhata Sanrakshan. In U. Dhar, R.S. Rawal & S. S. Samant (eds.) *Himalay Ki Jav Vividhata (Sanrakshan Mei Janta Ki Bhagidari)*, GBPHIED, Kosi-Katarmal Almora. pp. 56-60.

Kumar, K., D.S. Rawat, G.C.S. Negi, D.K. Agrawal, P.K. Samal, V. Joshi, G.S. Satyal and L.M.S. Palni (2000). Community Training Manual on Village Environment Action Plan (VEAP).

Mahar, G. and U. Dhar, (2000). Rashtriya Jav Vividhata, Neeti Evam Kary Yojna. In U. Dhar, R.S. Rawal & S. S. Samant (eds.) *Himalay Ki Jav Vividhata (Sanrakshan Mei Janta Ki Bhagidari)*, GBPHIED, Kosi-Katarmal Almora. pp. 7-11

Negi, K.S., Manral, H.S. and S. Nautiyal. (2000). Uttaranchal mein aarthikopayogi vanaspatiyon ka sangrahan. *PARIJAT* 5: 9-11. (in Hindi).

Nautiyal, S., Rao, K.S., Maikhuri, R.K., Nautiyal, M. and K.S. Negi, (2000). [*Apne He Gharh Mein Kho Gayie Mukhmar*] *ENVIS Bulletin - Himalayan Ecology and Development*, 8 (2): 82-83. (in Hindi).

Oli, B.P. (2000). Himalaya Ki Jantu Sampada Evam Sanrakshan. In U. Dhar, R.S. Rawal & S. S. Samant (eds.) *Himalay Ki Jav Vividhata (Sanrakshan Mei Janta Ki Bhagidari)*, GBPHIED, Kosi-Katarmal Almora. pp. 28-32.

Oli, B.P., B.M. Joshi and S.S. Samant (2000). An inventory of reptilian fauna of Manas and Dibru-Saikowa Biosphere Reserves. *Himalayan Biosphere Reserves* 2(1&2): 37-52.

Samant, S.S., B.P. Oli and B.M. Joshi (2000). Himalayan Biosphere Reserves (Biannual Bulletin), Vol. 2 (1 & 2), GBPIHED, Kosi- Katarmal, Almora.

Samant, S.S., H.C. Joshi, and S.C. Arya (2000). Diversity, nativity, and endemism of vascular plants in Pindari area of Nanda Devi Biosphere Reserve-II. *Himalayan Biosphere Reserves* 2 (1&2): 1-29.

Samant, S.S., H.C. Joshi, and S.C. Arya (2000). Ranikhet Tahsil Ki Padap Vividhata: Ek Avlokan. In U. Dhar, R.S. Rawal & S. S. Samant (eds.) *Himalay Ki Jav Vividhata (Sanrakshan Mei Janta Ki Bhagidari)*, GBPHIED, Kosi-Katarmal Almora. pp. 19-27.

Sundriyal, R.C. (2000). Counter-Hedgerow-Farming-Technology: Experiences from North East India, a quick appraisal brochure on hedgerow-intercropping technology and ATSCFS project experiences in the North East India.

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

Role of Science & Technology in the integrated development of Uttarakhand, 21-23 April, 2000 (Convener : L.M.S. Palni)

"A day with the students" on 5th June 2000 at GBPIHED, Kosi-Katarmal, Almora (Convener: K. Kumar)

ENVIS - User Interface workshop for NE Region on 17th & 18th June 2000 at Gangtok (Convener: K.S. Rao)

Orientation Workshop for Summer Students from Canada from June 19-20, 2000 at GBPIHED, Kosi-Katarmal, Almora (Convenor: P K Samal)

Training on Village Environment Action Plan organized at institute HQs and Garhwal unit for two batches of SWAJAL on 7-14 July and 31 July-6 August, 2000 (Convener: K. Kumar).

Two Science Awareness programme for high school students organized by Garhwal Unit, GBPIHED, Srinagar-Garhwal from 28 August – 1 September, 2000 and 20-24 November, 2000 (Convener: R.K. Maikhuri).

Ninth INHI On-site Training Programme on Nursery Development, Tree Plantation Techniques and Natural Resource Conservation and Management, Dohranala Village, Kullu, Himachal Pradesh, September 26-28, 2000 (Convener: B.P. Kothyari).

National Seminar on Himalayan Biodiversity 2000: Options for Development at GBPHIED, Almora. November 02-04, 2000 (Convener: U. Dhar)

Creating awareness for conservation of plant genetic resources and Farmer- to - Farmer technology transfer at Phagti village on 17-18th November, 2000 (Convener: K.S. Rao).

Two days Farmer training programme on Biodiversity, its importance and conservation organized by the Institute at Pangrasu, Phagti village of NDBR. 17-18 November 2000 (Convener: R.K. Maikhuri).

Training workshop on natural resource base and options for development at Deonai, Bageshwar, December 21-22, 2000. (Convener: B.P. Kothyari).

Uttaranchal Medicinal Plant Growers Workshop (jointly organised by GBPIHED- Kosi-Katarmal and ERA, Champawat), 19 - 21 January 2001. (Convener: P.P Dhyani & S.S. Samant)

4.5.1 Participation in Symposia/ conferences/ training courses/ workshops

Training on Internet and Web Publishing by ICIMOD. March 26-April 02, 2000 (Uma Shankar)

Regional Gender Training Course – Phase –II at ICIMOD, Nepal, April 10-25, 2000. (P. Pant).

Participated as resource person in Diversity, of medicinal and wild edible plants, assessment of fodder and fuel resources, and role of PRA in the Planning and Development in the Training Workshop for Biosphere Reserves Managers, from 24th April to 1st May, 2000 organized by Wildlife Institute of India, Dehra Dun (S.S. Samant)

Millennium Youth Parliament at Vigyan Bhawan, New Delhi, organised by the Nehru Yuva Kendra Sangathan, New Delhi. 26-27 April, 2000 (Uma Shankar)

National Symposium on "Biotechnology for Sustainability in Agriculture" at Pantnagar. 27th April 2000 (L.M.S. Palni)

Institutional Cooperation Programme with NORAD at Goa. 28th April 2000.(L.M.S. Palni)

Workshop on Indian Institutions Presentation on Completed Project and Future Possibilities at Goa. 29th April 2000 (L.M.S. Palni)

"National Conference on Mountains in the Perspective of Information Technology" sponsored by UGC at Government College, Gangtok (May 9, 2000) and delivered invited theme lecture on "Management of Mountain Resources and Hazards: Role of Remote Sensing and GIS". (A.P. Krishna)

Delivered a Lecture "Principles and Application of GIS Technology" on 11th May 2000, at GBPIHED, Almora on the eve of National Technology Day (K.S. Rao).

Participation and presentation in Regional Consultation on Eco-Rehabilitation of Himalaya at FRI, Dehradun 20-22 May 2000 (L.M.S. Palni)

"Watershed Training Programme for the Members of the Watershed Committee, Watershed Association, User Groups and Self Help Groups at Hee Dentam Watershed", West Sikkim (23 May 2000) under Integrated Watershed Development Programme (IWDP) organized by Forest Department, Government of Sikkim. (A.P. Krishna)

Participated in the CIDA-SICI Partnership Project Dissemination Workshop on Urban Development and Environmental Impact, Manali, 24 May 2000 (J.C. Kuniyal).

Participated in workshop on Development of IPNS for vegetable and fruit production systems. VPKAS, Almora 3-4 June 2000. (K.S. Rao).

"International Mountain Research Workshop" (June 4-7, 2000) organized by Pole' Europeen at Grenoble/ Autrans, France. (A.P. Krishna)

Fifth NNRMS Course on Remote Sensing and Geographical Information System Applications in Forestry and Ecology at Indian Institute of Remote Sensing (IIRS), Dehra Dun. June 05-July 28, 2000 (Uma Shankar)

Seminar on Medicinal Plants: Problems & Prospects in Uttrakhand organized by Himcon at Ranichauri, Tehri Garhwal. 6-8 June, 2000 (R.K. Maikhuri).

Participated in Zone V workshop of NATP on Plant Biodiversity on 12th June 2000 at VPKAS, Almora. (K.S. Rao).

Shastri Indo- Canadian Summer Programme (student exchange programme), 2000, June 21, 2000 to July 25, 2000. (A.K. Mishra).

Planning workshop, Establishment of a sustainable, community based medicinal/aromatic plant product industry in Himachal Pradesh, IHBT, IACR-UK, CASA-Delhi, BIOSYS-UK, Palampur. 26-28 June, 2000. (H.K. Badola)

Third International Symposium on Adventitious Root Formation, Veldhoven, The Netherlands, 27 June-1 July 2000 (S.K. Nandi)

Delivered lecture entitled "Geography, Topography and Flora/Fauna of Sikkim" to the "Central Services Trainees" (4 July 2000) at the Accounts and Administrative Training Institute, Government of Sikkim, Gangtok. (A.P. Krishna)

International Conference on Microbial Biotechnology, Trade and Public Policy, Osmania University, Hyderabad, 15 -17 July 2000 (Anita Pandey)

Participated in Task Force Meeting of Bio-Geo Data Base on Himalaya and Ecological Modelling at DST, New Delhi on 18th July 2000. (K.S. Rao & R.K. Maikhuri).

Seminar on Uttar Pradesh Mein Jari-Buti Ki Krishikaran Ki Sambhavanaye organized by Forest Dept., U.P. Govt. at NBRI, Lucknow. 28 July, 2000 (R.K. Maikhuri).

Participated a short Course on *Air Quality Monitoring & Management* organised by Envirotech Centre for Research and Development, New Delhi and Uttar Pradesh Pollution Control Board (UPPCB), Govt. of U.P., Ghaziabad (U.P.), 9-12 August, 2000 (J.C. Kuniyal).

Seminar on Industrial Policies of Uttaranchal: Problems and Prospects organized by Institute of Entrepreneurship Development, U.P. (IEDUP) at HAPPRC, Srinagar Garhwal. 26-27 August, 2000 (R.K. Maikhuri).

Participated in the Workshop "Parvatiya Kshetro mei Matsya Palan

Evam Vikas ki Sambhawnain", organized by ICAR at National Research Centre on Cold Water Fisheries, Bhimtal on September 07, 2000 (B. P. Oli)

World Bank Review Mission Workshop of IWDP (Hills-II) on Comprehensive Siwalik Watershed Development Strategy at Chandigarh. September 15-16, 2000. (D.K. Agrawal, N.A. Farooquee & S.Sharma)

Participation in DBT sponsored Brain Storming Session on Biodiversity Conservation at NEHU, Shillong. 16th September 2000 (L.M.S. Palni)

Training Workshop on EPA, PRA and Microplanning for JFM sponsored by National Afforestation and Ecodevelopment Board and organized by HNB Garhwal University, Srinagar Garhwal. 19 September, 2000 (R.K. Maikhuri, G.C.S. Negi).

Workshop, Himalayan Essential Oils, EOAI, HIMPA, Institute of Himalayan Bioresource Technology, Palampur. 23-24 Sep. 2000. (H.K. Badola)

INHI core-HP unit on-site training, Nursery Development, Plantation Technology, Natural Resoruce Management & Conservation and Farm Based Techniques, Dohranal, Kullu. 26-28 September, 2000. (H.K. Badola)

"Seminar on Community Participation and Public Awareness" on the occasion of National Day for Natural Disaster Reduction organized by Government of Sikkim at Gangtok (October 11, 2000) (A.P. Krishna)

International Workshop on Community Based Natural Resource Management (2nd), held at Guiyang, PR China, October 13-22, 2000. (B.P. Kothyari).

National Symposium on Prospects and Potentials of Plant Biotechnology in India in 21st Century, JNV University, Jodhpur, 18-21 October, 2000 (L.M.S. Palni, Anil Kumar and Hemant Pandey)

Workshop on "Role of Institutions in Development of Uttaranchal" on October 23, 2000 at UP Academy of Administration, Nainital (L.M.S. Palni, P.K. Samal and N.A. Farooquee)

7th International Congress of Ethnobiology organized by Georgia University at Athens (Georgia), USA. 23-28 October, 2000 (R.K. Maikhuri).

Participated in Programme Inception Workshop of Mac Arthur Project at SFRI, Itanagar on 24th & 25th October, 2000. (K.S.Rao)

Presented a lead talk at the 70th annual session of the National Academy of Scieces and symposium on "Harnessing Science and Technology for the New Era", Allahabad, 3-6, November 2000. (L.M.S. Palni)

Attended the Protected Area Workshop U.P, IGNFA Dehra Dun, November 17, 2000 (U. Dhar)

Conference, Growth of Ayurveda-Industry's Perspective, AIACMA, New Delhi. 8 Nov. 2000. (H.K. Badola)

GEF Awareness Workshop, NBRI, Lucknow. November 16-18, 2000. (D.K. Agrawal & N.A. Farooquee)

Farmers to Farmers Training Workshop on Medicinal Plant Cultivation, Pangrasu Village, Surauithota, Chamoli Garhwal, Uttaranchal, November 17-18, 2000. (L.M.S. Palni, P.P. Dhyani, K.S. Rao, R.K. Maikhuri, H. Pandey & B. Chandra).

Participated in Rose Jirenium evam anya pramukh aushadhiya evam sagandhiya podhon (Jari-Booti) par Krishak Prashikshan. Organized by National Bureau of Plant Genetic Resources, under National Agriculture Technology Project of Indian Council of Agriculture Research at Regional Station- Bhowali, District – Nainital from November 28-29, 2000 (S. Nautiyal).

Paper presented in National Seminar on Sustainable Development policy for Uttaranchal. Organized by *NAVDANYA*, in High Altitude Plant Physiology Research Centre, H.N.B. Garhwal University Srinagar (Garhwal) between 20 and 21 January 2001 (S. Nautiyal).

International Conference on Construction Industry, Disaster Management and Environmental Management, IE(I), Chandigarh. November 19-21, 2000. (R. Kumar)

Second five days Science Awareness programme for high school students organized by Garhwal Unit, GBPIHED, Srinagar Garhwal. 20-24 November, 2000 (K.S. Rao, R.K. Maikhuri, S.C. Joshi, G.C.S. Negi, V. Joshi, P. Prasad, H.S. Basera, A.K. Pandey, Aditya Purohit, K.D. Kandpal)

National Seminar on Natural Resource Management and Sustainable Development at Assam Administrative Staff College, Guwahati, organized by the Department of Culture, Government of India and KVIC as a part of the national debate on development reforms for resurgent India during Republic 50 celebrations. November 21-23, 2000 (L.M.S. Palni & Uma Shankar)

Scope and dimension of agar (*Aquilaria* sp.) plantation in the NE Region at Assam Administrative Staff College, Guwahati, organized by the All Assam Agar Traders & Agar Oil Manufacturers' Association, Hojai, November 21-23, 2000 (Uma Shankar)

National Seminar on Geodynamics and Evironmental Management of Himalaya, HNB Garhwal University, Srinagar Garhwal. 4-5 December, 2000 (G.C.S. Negi, V. Joshi, A.K. Pandey & D.C.S. Rawat).

21st Asian Conference on Remote Sensing, Taipei, Taiwan. December 4-8, 2000. (S. Sharma)

Invited expert on National Seminar on Fifty years of Indian Republic, IIM, Bangalore, 8-10, December 2000 (L.M.S. Palni)

Training Course on Measures of Success of Sustainable Forestry, held at IIFM, Bhopal, December 11-16, 2000. (S.K. Bhuchar & B.S. Majila).

Training course on Environmental Impact Assessment at Wildlife Institute of India, Dehradun. December 18-23, 2000. (D.K. Agrawal & J.C. Kuniyal)

Participated in International Conference on Integrated Water Resources Management for Sustainable Development, organised by NIH, Roorkee at Kaniska Hotel, New Delhi, 19-21, December 2000. (K.S. Rao & B.K. Ramprasad)

First Indian Science Congress in the Millennium (88th Session), Indian Agricultural Research Institute, New Delhi, 3-7 January 2001 (S.C. Rai & Anita Pandey)

Workshop on Sustainable Development in Hill and Mountain Areas: A CAPART's Initiative organized by HESCO at Wildlife Institute of India, Dehra Dun. 5-6 January, 2001 (R.K. Maikhuri).

NGO's Training Workshop on 'Contour Hedgerow Farming Systems Technology (CHFST), Multidisciplinary Training Centre, Midpu, Doimukh, Itanagar, organized by the G.B. Pant Institute of Himalayan Environment & Development, January 17-18, 2001 (Uma Shankar)

"Workshop on Recent Trends in Landslide Assessment and Monitoring" (17-19 January 2001) at the Center of Studies in Resources Engineering, Indian Institute of Technology, Mumbai and made presentation entitled "Landslide Hazard Assessment along the Selected Highways in Sikkim Himalaya – A Remote Sensing and GIS approach". (Sanjib Kundu)

Reforms for Resurgent Republic Seminar on Developmental Reforms. Sponsored by - Department of Culture Ministry of Tourism and Culture Government of India. Organised by - Lokbharti Uttaranchal 19 and 20 January, 2001. (D. S. Rawat & G. S. Satyal)

GBPIHED-ERA Workshop of Uttaranchal Medicinal Plants Growers, Kosi - Katarmal (Almora), Uttaranchal, January 19-21, 2001. (P.P. Dhyani, S.K. Nandi, S.S. Samant).

Attended "Uttaranchal Medicinal Plants Growers Workshop, Organized ERA & GBPHIED, Kosi- Katarmal, from Jan 19-21, 2001 (K.S. Rao, H.K. Badola, S.S. Samant, R.S. Rawal, B.P. Oli, H.C. Joshi & S.C. Arya)

Participation in the workshop on Ecotourism Planning and Management organised by WII at Ramnagar. 20-21 January 2001 (L.M.S. Palni)

Discussion Seminar on Sustainable Development Policy for Uttaranchal organized by NAVDANYA, Dehra Dun at HNB Garhwal University, Srinagar-Garhwal. 21 January, 2001 (R.K. Maikhuri & G.C.S. Negi).

Seminar on Sustainable Development Policy for Uttaranchal organized by Research Foundation for Science, Technology and Ecology, Dehra Dun at HAPPRC, HNB Garhwal University, Srinagar-Garhwal. 21 January, 2001 (R.K. Maikhuri).

Short-Term Scholar at East-West Center, Hawaii, USA during February 5-23, 2001, to participate in the "Training Institute on Climate and Society in the Asia-Pacific Region". (A.P. Krishna)

Workshop on Disaster Management sponsored by Ministry of Agriculture, New Delhi at Srinagar Garhwal. 5 February, 2001 (R.K. Maikhuri, G.C.S. Negi & V. Joshi).

Participation in Golden Jublilee Symposium of Delhi University Botanical Society at INSA as Invited Speaker. 7-9th February 2001 (L.M.S. Palni)

Participation in Swadeshi Vanvasi Mela and Symposium, JNU Stadium, New Delhi and talk on medicinal Plants cultivation in the hills. 10th February 2001 (L.M.S. Palni)

International Symposium on Frontiers of Fungal Divesrsity and Diseases in South East Asia, organised by Mycological Society of India at DDU Gorakhpur University, Gorakhpur, February 9-11, 2001. (S.S. Bisht).

Participated in 2nd zonal workshop on Plant-Biodiveristy, under National Agriculture Technology Project of Indian Council of Agriculture Research at Defence Agriculture Research Organization (DARL) Haldwani from February 10-11, 2001. Organized by National Bureau of Plant Genetic Resources, Regional Station- Bhowali, District – Nainital (S. Nautiyal).

Annual Symposium and Tea Research Association meeting at Jorhat, presentation as Invited Speaker. 12-13 February 2001 (L.M.S. Palni)

Participation and presentation in Symposium "Economic Development of NE: Problems and Solutions" at India International Centre, New Delhi. 15-16 February 2001 (L.M.S. Palni)

National seminar on Indigenous Knowledge System of the Tribes of Northeast India: Implications and Emerging Issues, Department of Tribal Studies, Arunachal University, February 15-16, 2001 (Panna Deb)

One-Day Workshop on Baseline Survey for NERCRM Project, Polo Towers, Shillong, organized by the ORG-MARG. February 16, 2001(Uma Shankar)

Participation in Tropical Soil Biology and Fertility Symposium at Jawaharlal Nehru University, New Delhi. 21-22th February 2001 (L.M.S. Palni)

Participated in TSBF-SARNET meeting at School of Environmental Sciences, Jawaharlal Nehru University, New Delhi on 21-24th February 2001. (K.S. Rao)

Participated in UNESCO/MoEF Regional Meeting of National Mab Committees and Biosphere Reserves in South and Central Asia, at Forest Research Institute, Dehra Dun on 24-25th February 2001.

Conference on Policy for Education and Employment in Uttaranchal, Srinagar Garhwal. 25 February, 2001 (G.C.S. Negi).

Participated in Orientation Workshop under HRD component of NATP Plant Biodiversity programme at NBPGR, New Delhi on 27th February to 1st March 2001. (K.S. Rao)

LEAD first International session on sustainable community development attended at Lahore Pakistan on 20th February – 3rd March (Kireet Kumar).

Workshop on National Environment Awareness organized by Govt. Intermediate College, Daihalchauri, Tehri Garhwal. 2 March, 2001 (R.K. Maikhuri).

Workshop on Uttaranchal Mein Jari-Buti ki Kheti organized by Wildlife Institute of India at Dehra Dun. 3-4 March, 2001 (R.K. Maikhuri).

Workshop on International Women Day organized by Sadharmyam Research and Dialogue Centre at Srinagar. 8 March, 2001 (R.K. Maikhuri).

Attended IUCN-RSUP, Review and Planning Workshop on Himal Programme, Lalitpur-Kathmandu , March 15-17, 2001 (R.S. Rawal)

Certificate Course in Conservation Biology- Applied Research Methods and Approaches in Biodiversity Conservation. Arunachal University, Itanagar, organized by the Arunachal University and ATREE. March 15-17, 2001 (Uma Shankar)

Participated in Trainers Training Programme on Plant Genetic Resource management under Human Resource Development Component on National Agricultural Technology Project on Sustainable Management of Plant Biodiversity, Organized by National Bureau of Plant Genetic Resources, New Delhi from 2/03/2001 to 21/03/2001 (S. Nautiyal).

International Workshop of South-Asian CO_2 Enrichment Rice Research Project jointly organized by IARI and NPL at Indian Agricultural Research Institute, New Delhi, March 16-18, 2001 (S.C. Joshi).

National Seminar on Vikasatmak Sudhar: Parvatiya Kshetra Ka Samgra Vikas, Chunautiya evam Rarneeti – vishesh sandharbh Uttranchal, held at HNB Garhwal University, Srinagar, March 23-24, 2001.(A.K. Mishra).

Attended as a Resource person in meeting of Capacity Building Programme for Voluntary Organizations for Sikkim, held at hotel Heruka, Gangtok from 30th April to 1st May 2001. The meeting was organized by Council for Advancement of People's Action and Rural Technology (CAPART), New Delhi. (S.C. Rai)

4.5.2 Meetings

Expert Committee meeting on Network programme on Tea Biotechnology at the Department of Biotechnology, New Delhi, 4th April 2000 (L.M.S. Palni)

State-wise review meeting of IWDP (Hills-II) at Ministry of Agriculture, New Delhi. May 2, 2000. (D.K. Agrawal)

World Bank Review Mission meeting of IWDP (Hills-II) on Comprehensive Siwalik Watershed Development Strategy at Ministry of Agriculture, New Delhi. May 25, 2000. (D.K. Agrawal)

EFC Meeting in Ministry of Environment and Forest, 27th May 2000 (L.M.S. Palni)

National Workshop on the Reforms for a resurgent republic seminar on development reforms, Department of Zoology, Kumaun University, Almora 19th to 21st June, 2000 (G.S.Satyal).

Meeting with Academics & Staff at Laboratoire de Physiologie du Developpement des Plantes, Universite P. et M. Curie, Paris, France on 26th June 2000 (S.K. Nandi)

Interactive meeting and discussion with Scientists at the Plant Research International, Wageningen, The Netherlands, 29th June 2000 (S.K. Nandi)

Presented progress of the project in Task Force Meeting on Medicinal Plants, July 15, 2000 (U. Dhar)

Discussion meet on Landslide Hazard Zonation, Programme coordinated by NRSA, Hyderabad and organized by CBRI, Roorkee. 18-20 July, 2000 (V. Joshi).

Task Force Meeting on Plant Biotechnology for presentation of completed project entitled 'Network programme for mass propagation and improvement of tree species of the Himalayan region, at the Department of Biotechnology, New Delhi, 24th July 2000 (L.M.S. Palni)

Meeting on possibilities of setting up nurseries of essential oil / fragrances bearing plants at selected locations in Uttaranchal region organised by DST, Govt. of India, Delhi, August 18, 2000. (B.P. Kothyari).

Core Group Meeting of the ICEF-WWF Project on Resource Material

Production in Arunachal Pradesh on Environment at WWF-India, Itanagar, August 28, 2000 (Uma Shankar)

Meeting of Expert Committee of National Bioresource Board at the Department of Biotechnology, New Delhi, 30th August 2000 (L.M.S. Palni and S.K. Nandi)

BRPC Meeting on Network programme on Tea Biotechnology at the Department of Biotechnology, New Delhi, 31st August 2000 (L.M.S. Palni and S.K. Nandi)

Presented progress of two projects in the "Management of Biosphere Reserves in India-Review Meeting, organized by Ministry of Environment & Forests, New Delhi, at Kerala Forest Research Institute, Peechi, from 8-11 September, 2000 (S.S. Samant)

Founding Committee Meeting of the Arunachal Science Academy at Arunachal University, Doimukh. September 25, 2000 (Uma Shankar)

Meeting with the World Bank and MoA Officials on Comprehensive Siwalik Watershed Development Strategy at Ministry of Agriculture, New Delhi, September 26, 2000. (D.K. Agrawal, N.A. Farooquee & S. Sharma)

LEAD national orientation session was attended at Delhi in Oct 2000 (Kireet Kumar).

Task Force meeting, Bio-geo database and Ecological Modelling for Himalaya (DST, New Delhi), Shimla. 15-16 Nov. 2000. (H.K. Badola & S.C.R. Vishvakarma).

Participated in the Meeting on "National Biodiversity Strategy and Action Plan (NBSAP)- Western Himalayan Eco-Region, Coordinator, NBSAP-WHER. At Indian Institute of Remote Sensing, Dehra Dun on 2-3 December, 2000 (S.S. Samant)

Expert committee meeting of the Task Force at Department of Biotechnology, New Delhi, 6th December 2000. (L.M.S. Palni)

Meeting on Environmental Conservation Programme at SSB Group Centre, Srinagar 7th December 2000 (S.C. Joshi).

Task Force Meeting "Bioprospecting for Biowealth - Medicinal Plants" at DBT, Delhi. 11-12 December 2000 (L.M.S. Palni)

Attended first NBSAP meeting TWG-Wild plant Biodiversity- December 27, 2000 (U. Dhar, S. Airi, I.D. Bhatt & Mitali Joshi)

Participated and delivered a lecture on Public Awakening on Solid Waste Management in Kullu town organised by H.P. State Mahila Kalyan Mandal of Kullu district, Kullu, 28 & 30 December, 2000 (J.C. Kuniyal).

Participated in the Meeting of the Committee on Cultivation and Conservation of Medicinal Plants including Conservation of Rare Endangered species at Department of Agriculture and Cooperation, New Delhi, January 04, 2001 (S.S. Samant)

Annual Meeting of Town official Language Implementation Committee, Itanagar' CRPF, Sinkhi View, Itanagar. January 10, 2001 (Uma Shankar)

Attended State level Meeting on "Vikashonmukhi Sudhar, Kumaun University Campus, Almora on January 20, 2001 (R. S. Rawal)

Villager's Society Meeting organised by Self Help Group, Maulidhar (Lawbanj), January 15, 2001. (B.P. Kothyari, P. Pant, S.K. Bhuchar & Y.S. Topal).

Meeting organised by Joint Forest Management (JFM) Group at Bhitarkot, January 23, 2001. (Y.S. Topal & S.K. Bhuchar).

Society meeting of the Institute in Ministry of Environment and Forest, New Delhi, 5th February 2001 (L.M.S. Palni).

Meeting in the office of District Magistrate, Nainital regarding Nainital Lake, 2nd March 2001. (LM.S. Palni).

Attended meeting of the committee on research on Medicinal Plants Constituted under Medicinal Plants Board DBT, New Delhi, March 12, 2001 (U. Dhar)

Participated a meeting and delivered a lecture on Public Involvement in Solid waste Management in Kullu-Manali complex organised by Town and Country Planning in collaboration with H.P. State Mahila Kalyan Mandal, Kullu, 20 March, 2001 (J.C. Kuniyal).

Participation in meeting on Biodiversity of Eastern Himalaya - WWF, New Delhi, 16th March 2001. (L.M.S. Palni).

Meeting with 'Women Group' of Aichar, organised by Bhramri Gramydyog Samiti, Vajula, March 23, 2001. (S.K. Bhuchar).

Meeting with 'Women Group' of Ayartoli, organised by Bhramri Gramudyog Samiti, March 24, 2001. (S.K. Bhuchar).

Participated in Meeting of CFD Course Approval Committe at Forest and Vanpanchayat Training Institute, Haldwani on 24th March 2001. (K.S. Rao).

Meeting on Traditional Water Management in Himalaya organized by Himalayan Institute of Culture and Development, Naini Tal. 30 May, 2001 (G.C.S. Negi).

Meetings of High Level Committee on Past Floods in Upper Alaknanda Valley organized by Ministry of Agriculture (Govt. of India), New Delhi. 12 January, 4 July 2000 & 12 February 2001 (V. Joshi).

4.5.3 Delivered Lectures as Resource Person

Delivered a lecture on Environmental Conservation in the Himalaya at Degree college, Kullu on the occasion of NSS Training of Programme Officers of the Degree Colleges on the invitation from Institute for Development & Communication, NSS Training and Orientation Centre, Chandigarh; Kullu, 30 May, 2000 (J.C. Kuniyal).

Delivered lecture on "Medicinal Plants of Indian Himalaya" to Canadian Students during the "Summer Programme 2000, sponsored by Shastri Indo-Canadian Institute and organized by GBPHIED, Kosi-Katarmal, from 17 June-01 July, 2000 (S.S. Samant).

Guest Lecture on Plantation Technology and Degraded Land Rehabilitation to the students of Govt. Girls Intermediate Collage, Srinagar Garhwal, 10, September 2000. (R.K. Maikhuri).

Contact Programme - 2000, for talented students of district Almora, Uttaranchal, 1-7 October 2000. (D. S. Rawat)

Lecture to participants of Continuing Education Programme of Defence Research Laboratory, held at Haldwani on 5, December 2000 (L.M.S. Palni and S.K. Nandi)

Lecture on Restoration Ecology to forestry students of North Eastern Region Institute of Science & Technology (NERIST), Itanagar at Experimental site, Banswara, Dist. Rudraprayag, 22 December, 2000. (R.K. Maikhuri).

Lectures on Earthquake: awareness and preparedness organized by the Arunachal Science Academy (ASA), Itanagar, December 27, 2000 (Uma Shankar).

Presented invited lecture in 88th Session ISC under the Women and Science Forum New Delhi, January 3-7, 2001 (U. Dhar).

Lecture on Natural Resource Management to SSB Jawan at SSB premise, Srinagar Garhwal (R.K. Maikhuri).

Lecture on Soil and Water Conservation in NSS Camp of Govt. Polytechnic, Srinagar-Garhwal on 28 February, 2001 (V. Joshi).

Lecture on Spring Recharge to the farmers participating in nursery and plantation technology training, HAPPRC, Srinagar Garhwal on 22-23 March, 2001 (V. Joshi).

M/S A.K. KASHYAP & CO.
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672966, 672836
FAX : (0135) 655634

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

Dear Sir,

We have audited the Balance Sheet of G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT, ALMORA, as on 31-03-2001, which are in agreement with the books of accounts, maintained by the Institute.

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

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

i) In the case of Balance Sheet of the State of Affairs of the above named Institute as on 31-03-2001 and

ii) In the case of Income & Expenditure Accounts of the INCOME of its accounting year ending 31-03-2001.

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

(ASHOK KASHYAP)
F.C.A. Partner

Dated : 11th June, 2001

M/S A.K. KASHYAP & CO.
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672966, 672836
FAX : (0135) 655634

NOTES FORMING PART OF THE REPORT OF THE STATEMENT OF ACCOUNTS FOR THE YEAR ENDING ON 31ST MARCH, 2001 IN RESPECT OF G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT, KATARMAL-KOSI, ALMORA-263643.

1. Books of Accounts have been maintained on Cash basis, subject to Para 4 below.

2. Depreciation has not been provided on the Fixed Assets, the same has been valued at cost.

3. All purchases of consumables, laboratory expenses, chemicals, glassware and stationery, have been treated as revenue expenditure.

4. Stock/Asset registers have been maintained by the institute for movement of assets, stores, vehicles, which have been physically verified at regular intervals.

6. Provident Fund liabilities and investments of the institute have 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 should be obtained.

8. Outstanding entries, pending adjustments in the Bank Reconciliation statement need to be adjusted.

9. Deposits of Rs. 18,15,63,464/- for Construction, with CCU (MOE & F), New Delhi, needs to be adjusted for the work which has already been completed.

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

(ASHOK KASHYAP)
F.C.A. Partner

Dated : 11th June, 2001

M/S A.K.KASHYAP & CO
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672966, 672836
FAX : (0135) 655634

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
BALANCE SHEET AS ON 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
SOURCES OF FUNDS			
General Fund :			
Last Balance :		4391909.49	
Addition during the year		1162367.65	
		5554277.14	
Less: transferred to R&D Fund		3000000.00	**2554277.14**
Endowment Fund :			
Last Balance:		4726952.15	
Interest Earned		465885.00	**5192837.15**
Fixed Assets Fund :			
Last Balance		108705341.84	
Addition during the year		8030028.00	**116735369.84**
Construction Fund :			
Last Balance:		181563464.00	
Addition during the Year:		0.00	**181563464.00**
Provident Fund :			
Last Balance		9803957.40	
Addition during the Year		3147320.00	
		12951277.40	
Less: Final Settlement/Transfer during the year		792900.00	**12158377.40**
Project Funds :	1		
MOE & F : RESEARCH & DEV./OTHER EXPENSES		169260.60	
CONSTRUCTION WORK		48583.00	
IERP Activity		(5903.54)	
ENVIS Activity		(16434.00)	
WWF (CBD) Project		(5065.00)	
UNDP (HAIGAD) Project		(28035.00)	
UNESCO (EXPERT FEE)		63300.00	
PTCA National Symposium		99671.00	
NATIONAL WORKSHOP (N.E.)		32363.00	
NEC Shillong Fund		(6981.00)	
MOE & F (US) Project		40339.00	
MOE & F (SSS) Project		17108.00	
MOE & F (RSR) Project		7805.00	
MOE & F (RKM) Project		(14625.00)	
MOE & F (NDMD) Project		(28486.00)	
MOE & F (KSR) Project		156735.00	
MOE & F (KBR) Project		49751.00	
MEDICINAL PLANT WORKSHOP		120193.00	
LAND USE Project		60.00	
FAO BIO DIVERSITY Project		500.00	
Balance Carried Forward		**700139.06**	**318204325.53**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
BALANCE SHEET AS ON 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward		**700139.06**	**318204325.53**
DST (KK) Project Fund		226252.00	
DST (RSR) Project Fund		1032.00	
DST (SKN) Project Fund		(66087.00)	
DST(HCR) Project		50671.00	
DST (GCSN) Project		106562.00	
DST Contact Prog.		(29364.00)	
DOS-DBT (NE)Project		110764.00	
DOS-DBT Project		(7757.00)	
CSIR (HCS/GCSN) Project Fund		2761.00	
CSIR (RCS) Project Fund		45.00	
CSIR (SCR) Project		6658.00	
BIOTECH (V II) Project		68472.00	
BIOTECH (V I) Project		561710.00	
BIOTECH (V) Project		(34562.00)	
BIOTECH (IV) Project		8536.00	
BIOTECH (III) Project		(9882.00)	
BIOTECH (I) Project		668.00	
ALAKNANDA VALLEY Project		121889.00	
AGRI BIO DIVERSITY Project		(38.00)	
ISRO(APK) Project		152635.00	
IEG Project		147.00	
ICAR(KSR) Project		169729.00	
ICAR (ES) Project		(10155.00)	
MOE & F (SCRV) Project		(6775.00)	
DST Workshop		9300.00	
BIOTECH (V III) Project		294147.00	
BIOTECH (X) Project		318624.00	
BIOTECH (IX) Project		1853269.00	
BIOTECH (V) Project Fieldstation		85592.00	
BIOTECH (XII) Project		8322000.00	
DST (SCR/KKS) Project		595632.00	
ICSSR (PKS/AP) Project		9626.00	
MEDICINAL/AROMATIC PLANT		(372.00)	
Shivalik Consultancy		(676.00)	
Swajal Project		337800.00	
WWF Consultancy(SK)		49115.00	
WWF Consultancy(NE)		1266.00	
NBSAP(UD) Project		72492.00	
NBSAP(UP) Project		149700.00	
CSIR(AP) Project		115749.00	
IIRS(US) Project		235000.00	
BIOTECH (XI) Project		1315341.00	
TSBF Project		95053.00	
MACARTHER UNESCO Project :		0.86	
ICIMOD REH.Project Fund		43151.05	
ICIMOD (SALT) Project		246326.21	
ICIMOD (PKS/NAF) Project		31779.00	
ICIMOD (PARDYP) Project		10185.00	
ICIMOD (FIBRE) Project Fund		(17722.00)	
ICIMOD (CBD) Project Fund		11000.00	
ICIMOD (LAND SLIDE) Project Fund		19521.00	
ICIMOD (DSR) Project		41917.00	
INDO CANADIAN Summer Programme		29539.00	
ECO TOURISM (IDRC)Project		38777.00	
ICIMOD (RCS) Project		29199.00	**16466381.18**
Balance Carried Forward			**334670706.71**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
BALANCE SHEET AS ON 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward			**334670706.71**
Other Liablities :			
Advance K.S.Rao		1990.00	
Security Payable		450.00	
Retirement Gratuity		17050.00	
Salary Payable		5466.70	
Medical Claim Payable		230.00	
E.M.D. Payable		40219.17	
Caution Money		20350.00	**85755.87**
TOTAL LIABILITIES RS..			**334756462.58**
APPLICATION OF FUNDS :			
Fixed Assets :	**58**		**116735369.84**
Deposits With :			
CCU for Constructions			**181563464.00**
Security Deposits			**53973.00**
Closing Balances	**60**		**36403655.74**
TOTAL ASSETS RS..			**334756462.58**

AUDITOR'S REPORT
As per our separate report of even date annexed'

FOR A.K.KASHYAP & CO.,
CHARTERED ACCOUNTANTS

DR. L.M.S. PALNI
(Director)

DR. U. DHAR
(D.D.Officer)

(ASHOK KASHYAP)
FCA PARTNER

DATED : 11th JUNE, 2001.
PLACE : DEHRA DUN

HARISH CHANDRA
(Finance Officer)

M/S A.K.KASHYAP & CO
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672066, 672836
FAX : (0135) 655634

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
A) INCOME :			
Grant In aid :			
Designated Project Grant For :			
MOE & F : RESEARCH & DEV./OTHER EXPENSES		27500000.00	
IERP Activity		2517452.60	
ENVIS Activity		595039.00	
BIOTECH (V III) Project		475000.00	
BIOTECH (X) Project		438000.00	
WWF Consultancy(SK)		250000.00	
WWF Consultancy(NE)		55000.00	
Bio Diversity Workshop-2000		30000.00	
NBSAP(UD) Project		149700.00	
NBSAP(UP) Project		149700.00	
CSIR(AP) Project		165333.00	
IIRS(US) Project		235000.00	
NATIONAL WORKSHOP (N.E.)		90000.00	
MOE & F (SCRV) Project		30000.00	
MOE & F (SSS) Project		160000.00	
MEDICINAL PLANT WORKSHOP(UTTAR.)		25000.00	
DST (KK) Project		300000.00	
MOE & F (NDMD) Project		148000.00	
DOS-DBT Project		154450.00	
MOE & F (KBR) Project		260000.00	
MEDICINAL/AROMATIC PLANT		80000.00	
ICAR(ES) Project		400000.00	
DST Workshop		861645.00	
DST (GCSN) Project		200000.00	
ICSSR (PKS/AP) Project		51750.00	
Shivalik Consultancy		135375.00	
CSIR (SCR) Project		148160.00	
CSIR (RS) Project		113200.00	
Swajal Project		682972.00	
BIOTECH (V II) Project		392000.00	
BIOTECH (V I) Project		1074000.00	
BIOTECH (IX) Project		2146000.00	
BIOTECH (IV) Project		417000.00	
BIOTECH (XI) Project		1411000.00	
BIOTECH (XII) Project		8344000.00	
DST (SCR/KKS) Project		600000.00	
ALAKNANDA VALLEY Project		350000.00	
ISRO(APK) Project		333000.00	
ICAR (KSR) Project		411000.00	
TSBF Project		202835.00	
INDO CANADIAN Summer Prog. 2000		324060.00	
ICIMOD (SALT) Project		231000.00	
ICIMOD (PKS/NAF) Project		44000.00	
ICIMOD (PARDYP) Project		1712029.00	
ICIMOD (ISSMA) Project		69336.00	
ICIMOD (RCS) Project		85800.00	
ECO TOURISM (IDRC)Project		91330.00	**54639166.60**
Balance Carried Forward			**54639166.60**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward			**54639166.60**
Less : Tfd. To Designated Funds For :			
MOE & F : RESEARCH & DEV./OTHER EXPENSES		27500000.00	
IERP Activity		2517452.60	
ENVIS Activity		595039.00	
BIOTECH (V III) Project		475000.00	
BIOTECH (X) Project		438000.00	
WWF Consultancy(SK)		250000.00	
WWF Consultancy(NE)		55000.00	
Bio Diversity Workshop-2000		30000.00	
NBSAP(UD) Project		149700.00	
NBSAP(UP) Project		149700.00	
CSIR(AP) Project		165333.00	
IIRS(US) Project		235000.00	
NATIONAL WORKSHOP (N.E.)		90000.00	
MOE & F (SCRV) Project		30000.00	
MOE & F (SSS) Project		160000.00	
MEDICINAL PLANT WORKSHOP(UTTAR.)		25000.00	
DST (KK) Project		300000.00	
MOE & F (NDMD) Project		148000.00	
DOS-DBT Project		154450.00	
MOE & F (KBR) Project		260000.00	
MEDICINAL/AROMATIC PLANT		80000.00	
ICAR(ES) Project		400000.00	
DST Workshop		861645.00	
DST (GCSN) Project		200000.00	
ICSSR Project (PKS/AP)		51750.00	
Shivalik Consultancy		135375.00	
CSIR (SCR) Project		148160.00	
CSIR (RS) Project		113200.00	
Swajal Project		682972.00	
BIOTECH (V II) Project		392000.00	
BIOTECH (V I) Project		1074000.00	
BIOTECH (IX) Project		2146000.00	
BIOTECH (IV) Project		417000.00	
BIOTECH (XI) Project		1411000.00	
BIOTECH (XII) Project		8344000.00	
DST (SCR/KKS) Project		600000.00	
ALAKNANDA VALLEY Project		350000.00	
ISRO(APK) Project		333000.00	
ICAR (KSR) Project		411000.00	
TSBF Project		202835.00	
INDO CANADIAN Summer Prog. 2000		324060.00	
ICIMOD (SALT) Project		231000.00	
ICIMOD (PKS/NAP) Project		44000.00	
ICIMOD (PARDYP) Project		1712029.00	
ICIMOD (ISSMA) Project		69336.00	
ICIMOD (RCS) Project		85800.00	
ECO TOURISM (IDRC)Project		91330.00	**54639166.60**
BALANCE			**0.00**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
Interest From Banks			**292865.08**
Other Income :			
Interest on MCA		7140.00	
Licence Fee		83025.00	
Water Testing Fee		74400.00	
Sale of Tender form		9000.00	
Institutional Charges		595012.00	
Guest House/ Hostel Charges		38080.00	
Royalty		255.00	
Insurance Claim		45688.00	
Miscellaneous Income		16102.57	
Sale of Scrap		800.00	**869502.57**
Designated Grant Utilised For :			
MOE & F : RESEARCH & DEV./OTHER Exp.		31393236.30	
IERP Activity		2523357.00	
ENVIS Activity		651792.00	
BIOTECH (V III) Project		180853.00	
BIOTECH (X) Project		119376.00	
WWF Consultancy(SK)		200885.00	
WWF Consultancy(NE)		53734.00	
Bio Diversity Workshop-2000		30000.00	
NBSAP(UD) Project		77208.00	
CSIR(AP) Project		49584.00	
MOE & F (SCRV) Project		36775.00	
MOE & F (SSS) Project		219637.00	
DST (KK) Project		336658.00	
MOE & F (NDMD) Project		121545.00	
DOS-DBT Project		168474.00	
MOE & F (KBR) Project		280047.00	
MEDICINAL/AROMATIC PLANT		80372.00	
ICAR(ES) Project		387660.00	
DST Workshop		852345.00	
DST (GCSN) Project		170165.00	
ICSSR Project (PKS/AP)		42124.00	
Shivalik Consultancy		136051.00	
CSIR (SCR) Project		135143.00	
CSIR (RS) Project		113200.00	
Swajal Project		345172.00	
FAO Biodiversity Project		6200.00	
DST(HCR) Project		94645.00	
DST Contact Prog.		229364.00	
DOS-DBT (NE)Project		55236.00	
BIOTECH (V) Project		230544.00	
BIOTECH (III) Project		66049.00	
Agri Biodiversity Project		18989.00	
BIOTECH (V) Project Fieldstation		89408.00	
MEDI. PLANT Workshop(Uttaranchal)		25000.00	
Balance Carried Forward		**39520828.30**	**1162367.65**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward		**39520828.30**	**1162367.65**
PTCA National Symposium		1874.00	
MOE & F (US) Project		75734.00	
MOE & F (RSR) Project		91340.00	
MOE & F (RKM) Project		99696.00	
MOE & F (KSR) Project		42933.00	
BIOTECH (V II) Project		473528.00	
BIOTECH (V I) Project		907467.00	
BIOTECH (IX) Project		292731.00	
BIOTECH (IV) Project		451422.00	
BIOTECH (XI) Project		95659.00	
BIOTECH (XII) Project		22000.00	
DST (SCR/KKS) Project		4368.00	
ALAKNANDA VALLEY Project		366141.00	
ISRO(APK) Project		226860.00	
ICAR (KSR) Project		284287.00	
TSBF Project		229393.00	
INDO CANADIAN Summer Prog. 2000		300012.00	
ICIMOD (SALT) Project		447718.00	
ICIMOD (PKS/NAF) Project		98021.00	
ICIMOD (PARDYP) Project		2019665.00	
ICIMOD (FIBRE) Project		4260.00	
ICIMOD (CBD) Project		135456.00	
ICIMOD (DSR) Project		84085.00	
ICIMOD (RCS) Project		56601.00	
ECO TOURISM (IDRC)Project		91713.00	**46423792.30**
			47586159.95

B) EXPENDITURE :

Revenue Expenditure :		
MOE & F : RESEARCH & DEV./OTHER Exp.	**2**	23925382.30
IERP Activity	**3**	2407013.00
ENVIS Activity	**4**	651792.00
PTCA National Symposium	**5**	1874.00
MOE & F (US) Project	**6**	64658.00
MOE & F (SSS) Project	**7**	219637.00
MOE & F (RSR) Project	**8**	91340.00
MOE & F (RKM) Project	**9**	99696.00
MOE & F (NDMD) Project	**10**	121545.00
MOE & F (KSR) Project	**11**	42933.00
MOE & F (KBR) Project	**12**	280047.00
MOE & F (SCRV) Project	**13**	36775.00
DST Workshop	**14**	852345.00
DST Contact Prog.	**15**	229364.00
DST (KK) Project	**16**	307018.00
DST(HCR) Project	**17**	94645.00
DST (GCSN) Project	**18**	170165.00
DOS-DBT Project	**19**	168474.00
CSIR (SCR) Project	**20**	123175.00
CSIR (RS) Project	**21**	113200.00
BIOTECH (VI) Project	**22**	786156.00
BIOTECH (V) Project	**23**	230544.00
BIOTECH (IV) Project	**24**	451422.00
BIOTECH (III) Project	**25**	66049.00
Balance Carried Forward		**31535249.30**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward		**31535249.30**	
ALAKNANDA VALLEY Project	**26**	366141.00	
Agri Biodiversity Project	**27**	18989.00	
ISRO(APK) Project	**28**	226860.00	
ICAR(KSR) Project	**29**	284287.00	
ICAR(ES) Project	**30**	380308.00	
BIOTECH (V II) Project	**31**	473528.00	
BIOTECH (V III) Project	**32**	133949.00	
BIOTECH (X) Project	**33**	119376.00	
BIOTECH (IX) Project	**34**	281411.00	
BIOTECH (V) Project Fieldstation	**35**	89408.00	
BIOTECH (XII) Project	**36**	22000.00	
DOS-DBT (NE)Project	**37**	55236.00	
DST (SCR/KKS) Project	**38**	4368.00	
ICSSR Project (PKS/AP)	**39**	42124.00	
MEDICINAL/AROMATIC PLANT	**40**	80372.00	
Shivalik Consultancy	**41**	136051.00	
Swajal Project	**42**	345172.00	
WWF Consultancy(SK)	**43**	200885.00	
WWF Consultancy(NE)	**44**	53734.00	
Bio Diversity Workshop-2000	**45**	30000.00	
NBSAP(UD) Project	**46**	77208.00	
CSIR(AP) Project	**47**	49584.00	
MEDI. PLANT Workshop(Uttaranchal)	**48**	24957.00	
TSBF Project	**49**	229393.00	
INDO CANADIAN Summer Prog. 2000	**50**	300012.00	
ICIMOD (SALT) Project	**51**	447718.00	
ICIMOD (PKS/NAF) Project	**52**	98021.00	
ECO TOURISM (IDRC)Project	**53**	91713.00	
ICIMOD (PARDYP) Project	**54**	1915265.00	
ICIMOD (DSR) Project	**55**	84085.00	
ICIMOD (FIBRE) Project	**56**	4260.00	
ICIMOD (RCS) Project	**57**	56601.00	**38258265.30**
Amount transferred to Fixed Assets Fund (Capital Expenditure)	**58**		
MOE & F -RESEARCH & DEVELOPMENT			
Library		3812372.00	
Scientific Equipments		2083416.00	
Office Equipment		323019.00	
Furniture & Fixture		1365391.00	**7584198.00**
Balance Carried Forward			**45842463.30**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward			**45842463.30**
Scientific Equipments:			
ICIMOD (PARDYP) Project		104400.00	
BIOTECH (VI) Project		121311.00	
DST (KK) Project		29640.00	
CSIR(SCR) Project		11968.00	
FAO Biodiversity Project		6200.00	
ICAR(ES) Project		7352.00	
BIOTECH (VIII) Project		46904.00	
MOE&F (US) Project		11076.00	
BIOTECH (IX) Project		11320.00	
BIOTECT (XI) Project		95659.00	**445830.00**
Refund of unspent Grant			
ICIMOD(CBD - UD) Project		135456.00	
MED. PLANT WORKSHOP(Uttaranchal)		43.00	**135499.00**
TOTAL EXPENDITURE RS.. (B)			**46423792.30**
SURPLUS (A - B)			**1162367.65**
EXCESS OF INCOME OVER EXPENDITURE (TFD.TO GENERAL FUND A/C)			
TOTAL RS...			**47586159.95**

AUDITOR'S REPORT
As per our separate report of even date annexed

FOR A.K.KASHYAP & CO.,
CHARTERED ACCOUNTANTS

DR. L.M.S. PALNI
(Director)

DR. U. DHAR
(D.D.Officer)

(ASHOK KASHYAP)
FCA PARTNER

HARISH CHANDRA
(Finance Officer)

DATED : 11th JUNE, 2001.
PLACE : DEHRA DUN

M/S A.K.KASHYAP & CO
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672966, 672836
FAX : (0135) 655634

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
RECEIPT :			
Opening Balance :	59		**22968029.67**
Grant In Aid For :			
MOE & F : RESEARCH & DEV./OTHER EXPENSES		27500000.00	
IERP Activity		2517452.60	
ENVIS Activity		595039.00	
NATIONAL WORKSHOP (N.E.)		90000.00	
MOE & F (SSS) Project		160000.00	
MOE & F (NDMD) Project		148000.00	
MOE & F (KBR) Project		260000.00	
DST (GCSN) Project		200000.00	
CSIR (SCR) Project		148160.00	
CSIR (RS) Project		113200.00	
BIOTECH (V II) Project		392000.00	
BIOTECH (V I) Project		1074000.00	
BIOTECH (IV) Project		417000.00	
ALAKNANDA VALLEY Project		350000.00	
ISRO(APK) Project		333000.00	
ICAR(KSR) Project		411000.00	
BIOTECH (VIII) Project		475000.00	
DST (KK) Project		300000.00	
DOS-DBT Project		154450.00	
ICAR(ES) Project		400000.00	
DST Workshop		861645.00	
ICSSR Project (PKS/AP)		51750.00	
MEDICINAL/AROMATIC PLANT		80000.00	
SHIVALIK CONSULTANCY		135375.00	
SWAJAL PROJECT		682972.00	
MOE&F (SCRV) Project		30000.00	
WWF Consultancy (SK)		250000.00	
WWF Consultancy (NE)		55000.00	
BIOTECH (X) Project		438000.00	
BIODIVERSITY WORKSHOP-2000		30000.00	
BIOTECH (IX)Project		2146000.00	
NBSAP (U D)Project		149700.00	
NBSAP (U P)Project		149700.00	
C S I R (A P)Project		165333.00	
I I R S (U S)Project		235000.00	
BIOTECH (XI)Project		1411000.00	
BIOTECH (XII)Project		8344000.00	
MEDI. PLANT WORKSHOP (Uttranchal)		25000.00	
DST (SCR/KKS)Project		600000.00	
			51878776.60
Interest From Bank :			
Institute		292865.08	
Endowment Fund		465885.00	**758750.08**
Retitrement Gratuity			**17050.00**
CAUTION MONEY			**7100.00**
Balance Carried Forward			**75629706.35**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward			**75629706.35**
Addition to Provident Fund			
Subscription		655209.00	
Voluntary Contribution		626820.00	
Institute's Contribution		655209.00	
Transfers from other deptt.		93991.00	
Interest received & accrued		1116091.00	**3147320.00**
Other Income :			
Interest on MCA		7140.00	
Licence Fee		83025.00	
Water Testing Fee		74400.00	
Sale of Tender form		9000.00	
Institutional Charges		593012.00	
Guest House/ Hostel Charges		38080.00	
Royalty		255.00	
Insurance Claim		45688.00	
Miscellaneous Income		16102.57	
Sale of Scrap		800.00	**869502.57**
TOTAL RECEIPTS RS..			**79646528.92**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
PAYMENT :			
Project Payment For :			
Project Expenditure (Revenue)			
MOE & F : RESEARCH & DEV./OTHER Exp.		23957463.30	
IERP Activity		2407013.00	
ENVIS Activity		651792.00	
PTCA National Symposium		1874.00	
MOE & F (US) Project		64658.00	
MOE&F (SSS) Project		219637.00	
MOE & F (RSR) Project		91340.00	
MOE & F (RKM) Project		99696.00	
MOE&F (NDMD) Project		121545.00	
MOE & F (KSR) Project		42933.00	
MOE & F (KBR) Project		280047.00	
MOE & F (SCRV) Project		36775.00	
DST WORKSHOP		852345.00	
DST Contact Programme		229364.00	
DST (KK) Project		307018.00	
DST(HCR) Project		94645.00	
DST (GCSN) Project		170165.00	
DOS-DBT Project		168474.00	
CSIR(SCR) Project		123175.00	
CSIR(RS) Project		113200.00	
BIOTECH (VI) Project		786156.00	
BIOTECH (V) Project		230544.00	
BIOTECH (IV) Project		451422.00	
BIOTECH (III) Project		66049.00	
ALAKNANDA VALLEY Project		366141.00	
Agri Biodiversity Project		18989.00	
ISRO(APK) Project		226860.00	
ICAR(KSR) Project		284287.00	
ICAR(ES) Project		380308.00	
BIOTECH (VII) Project		473528.00	
BIOTECH (VIII) Project		133949.00	
BIOTECH (X) Project		119376.00	
BIOTECH (IX) Project		281411.00	
BIOTECH (V) : Fieldstation		89408.00	
BIOTECH (XII) Project		22000.00	
DOS - DBT (NE) Project		55236.00	
DST (SCR/KKS) Project		4368.00	
ICSSR (PKS/AP) Project		42124.00	
MEDICINAL/ AEROMATIC PLANT Project		80372.00	
SHIVALIK CONSULTANCY Project		136051.00	
SWAJAL Project		345172.00	
WWF CONSULTANCY (SK) Project		200885.00	
WWF CONSULTANCY (NE) Project		53734.00	
BIODIVERSITY WORKSHOP-2000		30000.00	
NBSAP (UD) Project		77208.00	
C S I R (AP) Project		49584.00	
MEDI. PLANT WORKSHOP (Uttranchal)		24957.00	**35063278.30**
Capital Expenditure :	**58**		
MOE & F : RESEARCH & DEVELOPMENT			
Library		3812372.00	
Scientific Equipments		2083416.00	
Office Equipment		323019.00	
Furniture & Fixture		1365391.00	**7584198.00**
Balance Carried Forward			**42647476.30**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31st MARCH 2001

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward			**42647476.30**
Scientific Equipments:			
BIOTECH (VI) Project		121311.00	
DST (KK) Project		29640.00	
CSIR(SCR) Project		11968.00	
FAO Biodiversity Project		6200.00	
ICAR(ES) Project		7352.00	
BIOTECH (VIII) Project		46904.00	
MOE&F (US) Project		11076.00	
BIOTECH (IX) Project		11320.00	
BIOTECT (XI) Project		95659.00	**341430.00**
Provident Fund:Final Settlement/Transfers			**792900.00**
SECURITY DEPOSIT			**8130.00**
CAUTION MONEY REFUNDED			**7000.00**
E M D Refunded			**26560.00**
Adv. Dr. H C Rekhari			**500.00**
Refund of unspent grant			
Medi. Plant Workshop(Uttaranchal)			**43.00**
Closing Balances:	**60**		**35822489.62**
TOTAL PAYMENTS RS...			**79646528.92**

AUDITOR'S REPORT
As per our separate report of even date annexed'

FOR A.K.KASHYAP & CO.,
CHARTERED ACCOUNTANTS

DR. L.M.S. PALNI
(Director)

DR. U. DHAR
(D.D.Officer)

(ASHOK KASHYAP)
FCA PARTNER

HARISH CHANDRA
(Finance Officer)

DATED : 11th JUNE, 2001.
PLACE : DEHRA DUN

M/S A.K.KASHYAP & CO
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672966, 672836
FAX : (0135) 655634

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
SCHEDULE OF FIXED ASSETS AS ON 31st MARCH 2001

ANNEXURE '58'

PARTICULARS	COST AS ON 1/4/00	ADDITION DURING THE YEAR	COST OF SALES/TFD. DURING THE YEAR	TOTAL
Land :	**75639.23**	**0.00**	**0.00**	**75639.23**
Building	**2749848.00**	**0.00**	**0.00**	**2749848.00**
Furniture & Fixture: (Details)	**10048122.40**	**1365391.00**	**0.00**	**11413513.40**
Institute	10030515.40	1365391.00	0.00	11395906.40
ICIMOD SALT	11000.00	0.00	0.00	11000.00
ICIMOD ISSMA	6607.00	0.00	0.00	6607.00
Scientific Equipments : (Details)	**56948799.11**	**2529246.00**	**0.00**	**59478045.11**
Institute	42199618.19	2083416.00	0.00	44283034.19
DST (RSR)	7415.00	0.00	0.00	7415.00
BIOTECH-I	1840346.00	0.00	0.00	1840346.00
BIOTECH-II	4029751.00	0.00	0.00	4029751.00
BIOTECH-III	2129381.00	0.00	0.00	2129381.00
UNDP (HAIGAD)	70960.00	0.00	0.00	70960.00
CSIR (RCS)	137948.00	0.00	0.00	137948.00
DST (SKB)	808564.00	0.00	0.00	808564.00
FAO-BIO-DIVERSITY	126592.00	6200.00	0.00	132792.00
ICAR (ES)	167155.00	7352.00	0.00	174507.00
ENVIS	242380.00	0.00	0.00	242380.00
NWDPRA	64858.00	0.00	0.00	64858.00
IEG PROJECT	52465.00	0.00	0.00	52465.00
DST (SKN)	323172.00	0.00	0.00	323172.00
BIOTECH (V)	46119.00	0.00	0.00	46119.00
WWF (CBD)	7700.00	0.00	0.00	7700.00
HAIGAD II	115438.00	0.00	0.00	115438.00
NORAD	1921158.00	0.00	0.00	1921158.00
ICIMOD (SALT)	216447.92	0.00	0.00	216447.92
INDO CANADIAN	180076.00	0.00	0.00	180076.00
ICIMOD ISSMA	67161.00	0.00	0.00	67161.00
ECO-TOURISM	75738.00	0.00	0.00	75738.00
MACARTHER UNESCO	63450.00	0.00	0.00	63450.00
ICIMOD (PARDYP)	88530.00	104400.00	0.00	192930.00
ICIMOD (CBD)	52801.00	0.00	0.00	52801.00
ICIMOD (FIBRE)	216882.00	0.00	0.00	216882.00
MRE	2450.00	0.00	0.00	2450.00
ICIMOD-GIS EQUIPMEN	148800.00	0.00	0.00	148800.00
BIOTECH (IV)	244811.00	0.00	0.00	244811.00

M/S A.K.KASHYAP & CO
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672966, 672836
FAX : (0135) 655634

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
SCHEDULE OF FIXED ASSETS AS ON 31st MARCH 2001

ANNEXURE '58' Contd...

PARTICULARS	COST AS ON 1/4/00	ADDITIONS DURING THE YEAR	COST OF SALES/TFD. DURING THE YEAR	TOTAL
C S I R (SCR)	495371.00	11968.00	0.00	507339.00
D S T (KK)	311526.00	29640.00	0.00	341166.00
I S R O (APK)	94829.00	0.00	0.00	94829.00
M O E & F (NDMD)	148900.00	0.00	0.00	148900.00
BIOTECH (VI)	201675.00	121311.00	0.00	322986.00
D S T (GCSN)	48331.00	0.00	0.00	48331.00
BIOTECH (VIII)		46904.00	0.00	46904.00
M O E & F (U S)		11076.00	0.00	11076.00
BIOTECH (IX)		11320.00	0.00	11320.00
BIOTECH (XI)		95659.00	0.00	95659.00
Office Equipments :	**4555233.35**	**323019.00**	**0.00**	**4878252.35**
Institute		206675.00		206675.00
I E R P		116344.00		116344.00
Fire Fighting Equipme	**60962.00**	**0.00**	**0.00**	**60962.00**
Library :	**26683057.50**	**3812372.00**	**0.00**	**30495429.50**
Vehicles :	**4015099.25**	**0.00**	**0.00**	**4015099.25**
(Details)				
Institute	2931435.30	0.00	0.00	2931435.30
ICIMOD SALT	279224.00	0.00	0.00	279224.00
TSBF	280475.00	0.00	0.00	280475.00
MACARTHER UNESCO	290375.00	0.00	0.00	290375.00
ICIMOD	233589.95	0.00	0.00	233589.95
Glass/Net House :	**3568581.00**	**0.00**	**0.00**	**3568581.00**
(Details)				
Institute	1517793.00	0.00	0.00	1517793.00
BIOTECH (III)	2050788.00	0.00	0.00	2050788.00
TOTAL RS..	**108705341.84**	**8030028.00**	**0.00**	**116735369.84**

M/S A.K.KASHYAP & CO
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672966, 672836
FAX : (0135) 655634

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

ANNEXURE '59'

PARTICULARS	ANN	AMOUNT	AMOUNT
OPENING Balances (IC A/C) :			
Cash & Bank Balances :			
Cash in Hand :			
Almora:		9480.55	
Srinagar		200.64	
Sikkim		2762.02	
Kullu		1170.17	**13613.38**
Cash at Bank :			
CBI Kosi A/c No.CD-14		1236939.00	
SBI Almora A/c No.22752		719481.15	
SBI Almora A/c No.23884		29999.15	
SBI Tadong A/c No.CA/4/65		78884.00	
SBI Kullu A/c No.50201/7		1542.01	
SBI Itanagar A/c C&I3/14705		193207.61	
SBI Srinagar A/c No.3/615		263211.14	
SBI Almora P.F.A/c No.22021		10853.40	**2534117.46**
Advances			
House Building Advance		1728914.00	
Motorcycle/Car Advance		813125.00	
Festival Advance		16500.00	
Provident Fund Advance		234964.00	
G.S.L.I.		224.90	
C.P.F.		36.00	
Units of Institute :			
Garhwal Unit		17447.43	**2811211.33**
Fixed Deposits :			
With SBI Endowment Fund :		4570315.00	
Intt.Acc.on FDR (Endowment Fund A/C		126638.00	
SBI Provident Fund		6825024.00	
CBI Provident Fund		1761416.00	
Intt.Acc.on FDR (P.F.A/C)		971771.00	
F.D.R. (Margin Money L/C A/c)		79500.00	
F.D.R. GENERAL FUND		3000000.00	**17334664.00**
Balance Carried Forward			**22693606.17**

M/S A.K.KASHYAP & CO
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672966, 672836
FAX : (0135) 655634

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

ANNEXURE '59' Contd..

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward			**22693606.17**
Due Staff/Others (IC A/c)			
Klenzaids Con.Controls (P) Ltd., (BIOTECH I)		56880.00	
Director- IARI		26.50	
A.S.Parihar		389.00	
B.P.Kothyari		6000.00	
R.K.Nanda & Sons		28517.00	
Pertech Computers		2000.00	
Employment News		15050.00	
Sigma Aidrich Chemicals		10590.00	
Siltap Chemicals Ltd. (BIOTECH III)		20064.00	
N.R.S.A.Hyderabad		74800.00	
Klenzaids Con.Controls (P) Ltd.		57175.00	
Suraj Lal		432.00	**271923.50**
F.C.Inter A/c			**2500.00**
Opening Balance(I/C)			**22968029.67**
Opening Balance(F/C)			
Cash & Bank Balances :			
Cash In Hand		11993.00	
With SBI A/c No.20910		1211231.12	**1223224.12**
Advances :			
N.E.UNIT (SALT)		12324.00	
E.T.& T.N.DELHI		2880.00	
SIKKIM UNIT (ECO TOURISM)		23772.00	
N.R.S.A.HYDERABAD (PARDYP)		14500.00	
N.R.S.A.HYDERABAD (CBD)		11000.00	**64476.00**
Opening Balance(F/C)			**1287700.12**
TOTAL RS...			**24255729.79**

M/S A.K.KASHYAP & CO
CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD
DEHRA DUN-248001
PHONE : (OFF.) 652346, 655634
(RES.) 672966, 672836
FAX : (0135) 655634

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
CLOSING BALANCE AS ON 31st MARCH 2001

ANNEXURE '60'

PARTICULARS	ANN	AMOUNT	AMOUNT
Closing Balances (IC A/C) :			
Cash & Bank Balances :			
Cash in Hand :			
Almora:		5763.05	
Srinagar		186.64	
Sikkim		707.60	
Kullu		3863.17	**10520.46**
Cash at Bank :			
CBI Kosi A/c No.CD-14		7989773.74	
SBI Almora A/c No.22752		2568076.03	
SBI Almora A/c No.23884		31208.15	
SBI Tadong A/c No.CA/4/65		2203160.42	
SBI Kullu A/c No.50201/7		479134.01	
SBI Itanagar A/c C&I3/14705		787962.61	
SBI Srinagar A/c No.3/615		130837.14	
SBI Almora P.F.A/c No.22021		62140.40	**14252292.50**
Advances			
House Building Advance		2326873.00	
Motorcycle/Car Advance		668672.00	
Festival Advance		19800.00	
Provident Fund Advance		328143.00	
G.S.L.I.		(117.34)	
C.P.F.		36.00	
Units of Institute :			
Sikkim Unit		46082.00	
H.P. Unit		2320.00	**3391808.66**
Fixed Deposits :			
With SBI Endowment Fund :		4570315.00	
Intt.Acc.on FDR (Endowment Fund		591314.00	
SBI Provident Fund		7075024.00	
CBI Provident Fund		2611416.00	
Intt.Acc.on FDR (P.F.A/C)		2081725.00	
F.D.R. (Margin Money L/C A/c)			
DST (HCR)		95000.00	
DST (KK)		176000.00	
ISRO (APK)		39000.00	
BIOTECH (IX)		390000.00	
INSTITUTE		359979.00	**17989773.00**
Balance Carried Forward			**35644394.62**

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
CLOSING BALANCE AS ON 31st MARCH 2001

ANNEXURE '60' Contd..

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward			**35644394.62**
Due Staff/Others (IC A/c)			
Allen Press Inc.		7711.00	
Hardely Brother's		1877.00	
A.S.Parihar		389.00	
Post Master G P O Almora		12653.00	
N.R.S.A.Hyderabad(SK)		90000.00	
Employment News		15050.00	
Sigma Aidrich Chemicals		10590.00	
Siltap Chemicals Ltd. (BIOTECH III)		408.00	
N.R.S.A.Hyderabad		8400.00	
R K Nanda & Sons		28517.00	**175595.00**
F.C.Inter A/c			**2500.00**
Closing Balance(I/C)			**35822489.62**
Closing Balance (F/C A/C)			
Cash & Bank Balances :			
Cash In Hand		679.00	
With SBI A/c No.20910		334555.12	**335234.12**
Advances :			
N.E.UNIT (SALT)		168261.00	
(RCS)		29222.00	
(ICIMOD PKS/NAF)		10000.00	
E.T.& N.T.DELHI		2880.00	
SIKKIM UNIT (ECO TOURISM)		23389.00	
N.R.S.A.HYDERABAD (PARDYP)		14500.00	
H.P. UNIT (PKS/NAF)		(2320.00)	**245932.00**
Closing Balance(F/C)			**581166.12**
TOTAL RS...			**36403655.74**

INSTITUTE FACULTY

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

ABBREVIATIONS USED

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

SUPPORTING STAFF

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

HEAD QUARTERS
KATARMAL, ALMORA

PH: 05962-41041/41015
FAX : 05962-31507 Att. GBPIHED

SIKKIM UNIT
TADONG, SIKKIM

PH : 03592-31673
FAX : 03592-31090

NORTH EAST UNIT
VIVEK VIHAR, ITANAGAR

PH : 0360-211773
FAX : 0360-211773

HIMACHAL UNIT
MOHAL, KULLU

PH : 01902-25329
FAX : 01902-22720

GARHWAL UNIT
UPPER BHAKTIYANA, SRINAGAR, GARHWAL

PH: 01388-52603
FAX : 01388-52424, 53199

Photo by: B. S. Chauhan Bhyundar, Chamoli

Printed at SHIVA OFFSET PRESS, D.DUN PH : 91 135 655748