ANNUAL REPORT

1999-2000

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 Members of Parliament
Nominated by Government of India
New Delhi

Ministers-in-charge, Environment
Governments 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

Directors 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 M.C. Thakur
"Arohi" Environment & Nature
Conservation
The Mall, Himachal Pradesh,
Manali 175 131

Dr Gautam Vohra
Chairman
Development Research & Action Group,
75 Paschimi Marg, Vasant Vihar
New Delhi 110 057

Vice Chancellor
Kumaun University, Nainital, UA

Member Secretary

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

GOVERNING BODY

Chairman

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

Shri Vinod Vaish, IAS
Special 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 Scintific 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
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

Shri R. Mathur, IAS
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 M.C. Thakur
"Arohi" Environment & Nature
Conservation, The Mall, Himachal
Pradesh Manali-175 131

Dr Gautam Vohra
Chairman
Development Research & Action Group
75, Paschimi Marg, Vasant Vihar
New Delhi - 110 057

Member Secretary

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

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
Dy.Director General (NRM)
Indian Council of Agricultural Research
Krishi Bhawan, New Delhi - 110001

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

Er D.S. Tolia
Scott Willson Kirk Patrick & Co. Ltd.
599 J, IIIrd Floor Vishnu Tower
Balaji Colony Tirupati-517502

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 Mehrauli Road
New Delhi-110 016

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

Dr R.K. Rai
Joint Director (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, UA.

PROJECT EVALUATION COMMITTEE

Chairman

Prof. L.R. Verma
Vice Chancellor
Dr Y.S. Parmar University of
Horticulture & Forests
Nauni, Solan 173 230, H.P.

Members

Dr. R.P. Awasthi
Director, ICAR Research Complex for
N.E. Region, Umroi Road, Bara Pani
Pin 793 103 (Meghalaya)

Prof. C.L. Acharya
Deptt. of Soil Science
H.P. Agriculture University
Palampur, H.P.

Dr R.D. Singh
Scientist, CSIR Complex
Palampur 176 061, H.P.

Dr S.N. Hegde
State Forest Research Institute
Van Vihar, P.B. No. 159
Itanagar 791 111, Arunachal Pradesh

Dr D.S. Bhakuni
Central Drug Research Institute
Chattar Manzil, Lucknow (U.P.)

Dr A.R. Nautiyal
HAPPRC, HNB Garhwal University
Srinagar, Garhwal, UA.

Prof. S.C. Dey
Dept. of Zoology
Gauhati University
P.O. Bopinath Bardoloi Nagar
Guwahati 781 014 (Assam)

Prof. M.K. Bhasin
Deptt. of Anthropology
University Delhi
Delhi-110 007

Sri S.C. Sharma
Scientist
Indian Council of Forestry Research
and Education, P.O. New Forest
Dehra Dun 248 006 UA.

Nominee of Secretary
Ministry of Environment & Forests
Paryavaran Bhawan
CGO Complex, Lodi Road
New Deli 110 003

Member Secretary

Nominee of Director
Govind Ballabh Pant Himalaya
Paryavaran Evam Vikas Sansthan
Kosi-Katarmal, Almora 263 643,
UA.

ANNUAL REPORT

1999-2000

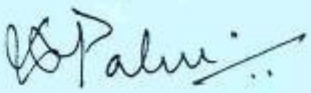
G B Pant Institute of Himalayan Environment & Development
(An Autonomous Institute of Ministry of Environment and Forests, Govt. of India)
Kosi-Katarmal, Almora - 263 643, UA, India

CONTENTS

Director's Foreword

Dr. L.M.S. Palni

The reporting year 1999-2000 was particularly important for the Institute for a number of reasons. Inauguration of the Himachal Unit Complex of the Institute at Mohal, Kullu and the laying of the foundation stone of the Sikkim Unit at Pangthang were major events. The Annual Day function and the G.B. Pant Memorial Lecture, IXth in the series, by Professor H.Y. Mohan Ram on 20th February 2000 were other notable events. Formal initiation of a new core programme "Indigenous Knowledge Systems" should pave the way for documentation (and evaluation) of this fast depleting rich knowledge base; it also assumes significance in the wake of IPRs. Three of the Institute scientists were awarded Vishisht Vaigyanik Puraskar of the Ministry of Environment & Forests, and one colleague was honoured with the Indian National Science Academy's Young Scientist award. Several important publications were released during the year, notably studies relating to "Valuation of Water" and "Van Rawats : A Tribe in Peril". The scientific contributions have been published in high impact journals and well received by the peers globally. Recognizing the need for bridging the vital gap between technology developers and the actual users in the villages, an attempt has been made to initiate a rural technology park at the Katarmal Campus of the Institute, and at Pangthang. Demonstration-cum-training site for contour hedge-row farming technology has been established at Doimukh through the NE Unit at Itanagar. The Institute has been consciously developing and nurturing an ethos of applied, action oriented research to fulfill and to respond to the societal needs. At the policy level inputs have been provided and guidelines have been prepared on three selected mountain specific issues namely rain water harvesting, green roads concept and location planning in hill towns. The Institute also hosted a seminar on "High Altitude Biology" organized by the Indian National Science Academy and the INSA Council Meeting. A National Symposium on the "Role of Plant Tissue Culture in Biodiversity Conservation and Economic Development" was also organized by the Institute. "Environmental Planning and Sustainable Development - Opportunities and Challenges" was jointly organized by the Institute, Wadia Institute of Himalayan Geology and the Govt. of Arunachal Pradesh. The guidance and support received from the Science Advisory Committee, Governing Body and the G.B. Pant Society during the year are gratefully acknowledged. Comments and critique on the progress of work presented in this report, by anyone and everyone, interested in the welfare of the Himalaya and its inhabitants would be highly appreciated.



MAJOR ACHIEVEMENTS

- Based on the experiences of various field trials a Rural Technology Park has been set up in the Institute Campus at Katarmal, and a Contour Hedge row Farming Technology demonstration cum training site has been set up at Doimukh in Arunachal Pradesh.

- Guidelines for (i) Location Planning and Site Selection for Residential Buildings, Tourist/Commercial complex in Hill towns, (ii) Rain Water Harvesting for Irrigation and Domestic Use, and (iii) Road Sector in the Indian Himalayan Region (Green Roads Concept) have been prepared.

- Documentation of ecology, value and rights relating to water resources in Kumaun, and watershed based water management plan has been suggested.

- IX G.B. Pant Memorial Lecture entitled "Plant resources of the Indian Himalayan region: some points for action" - delivered by Prof. H.Y. Mohan Ram on 20 February 2000 at Gangtok.

- A new core programme "Indigeous Knowledge Systems" started functioning to fill an important niche in the Himalayan region.

- The Himachal Unit Complex of the Institute at Mohal, Kullu (H.P.) was inaugurated in April, 1999, and the foundation stone of the Sikkim Unit Complex of the Institute was laid at Panthang, near Gangtok in June 1999 by Shri Suresh P. Prabhu, Union Minister of Environment and Forests, Government of India.

- Continuous GPS reference station has been set up in the Institute campus and a detailed initial report has been compiled.

Executive Summary
Research and Development Activities

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 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. Main thrust of all these programmes has been on extensive use of biological measures through agroforestry models, mountain risk engineering (MRE) techniques, and propagation of multi purpose tree species. In-situ water harvesting is demonstrated using low cost poly lined tanks at all sites. Study of traditional system of irrigation water management and soil conserving farming systems 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 plant distribution ceremony was organized at Badrinath. Use of latest technique of Global Positioning System (GPS) has been initiated for quantification of tectonic deformation fields in Kumaun Himalaya and a continuous reference GPS station has been set up at Institute campus for future studies. A hydro-meteorological station has also 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 studied. 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 agrobio-diversity management strategies by Tolchha community were studied in detail over the last few years and the activity is at the concluding stage. The natural resource inventories in Hawalbagh block and Nanda Devi Biosphere Reserve for effective development/ management planning and recommending sustainable livelihood options were continued. 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 where farmers/ local officials were provided information kits and on field training during the year.

Conservation of Biological Diversity:

Recognizing the importance of Himalayan Medicinal Plants (MPs), the core group Conservation of Biological Diversity conducted a detailed study on pharmaceutically important MPs. An approach on setting conservation priorities, considering the perception of two distinct stakeholders i.e., the users (industry) and the biologists, was developed. Considering sensitivity of the group, attempts were made to authenticate ground information. In this context, detailed investigations were conducted on distribution and diversity patterns of MPs in Askot Wildlife Sanctuary. Studies on Biosphere Reserves (Nanda Devi and Kanchendzonga), subtropical/temperate and timberline zone were initiated to develop strong database on sensitive habitats and biota and to strengthen *in situ*

conservation. The economic benefits and conservation linkages of eco-tourism were analysed through a case study in Sikkim Himalaya. Development of propagation packages for important species strengthened the establishment of *ex situ* genebanks. The results of systematic studies were disseminated through VI training workshop (November 1999). The workshop specifically focused on imparting training to students and teachers on "Role of plant tissue culture in biodiversity conservation". Moreover, being identified as lead institution for co-ordinating R&D activities in selected Himalayan Biosphere Reserves the outreach of the Institute has expanded in biodiversity related aspects.

Ecological Economics and Environmental Impact Analysis:

Considering the increased quantum of vehicular pollution and solid wastes on account of increased tourism in the Himalayan region, the core undertook studies on monitoring of air quality and characterisation of solid waste in Kullu-Manali region in Himachal Pradesh. The priorities for tribal development in the Central Himalayan region has emphasised the studies on problems and prospects of Rajis, Bhotias and Jaunsaris tribes. Vegetable cultivation on commercial scale in Khairna valley of Kumaon Himalaya, has brought 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 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 developments have taken place for their performance evaluation. The core therefore undertook activities on their evaluation 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 along with 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 species of Himalayan region are in progress. This includes, 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 considerably improved the living standard of few sections of the villagers.

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/nursery beds at 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 Institute's Annual Report 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 high altitude societies still continuing and preserving some of their traditional knowledge systems, it was decided to document their indigenous practices of natural resource management. The traditional practice of wool dyeing from 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 are also being analysed before they get phased out. These activities are still in resource inventory stages and the analysis of information will start in the next year or so.

1. INTRODUCTION

The reporting year 1999-2000 is the eleventh 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 endeavouring 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. Indigenous Knowledge Systems is the new core programme started to address the issues of mountain cultural heritage and traditional knowledge systems, which play significant role in the sustainable use, management and conservation of resources. 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 1999-2000 on various ongoing and newly initiated projects and brief account of 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 Environment and Forests, Shri Suresh P. Prabhu inaugurated the Himachal Unit Complex of the Institute at Mohal, Kullu (H.P.) on 2nd April 1999. Shri Maheshwar Singh, Member of Parliament (Kullu), Shri Roop Singh, Minister of Forests, Shri Karan Singh, Minister of Education, Govt. of Himachal Pradesh, and Shri Vinod Vaish, IAS, Special Secretary, Ministry of Environment and Forests, Government of India attended the function along with other dignitaries and officials of state and central government organizations. Shri Suresh P. Prabhu, while addressing the audience, expressed concern over environmental degradation in the Himalaya. He emphasized the need to strengthen tourism development in the Kullu valley. Hon'ble Union Minister of Environment and Forests, Shri Suresh P. Prabhu, in the presence of Shri Pawan Chamling, Chief Minister of Sikkim laid the foundation stone for Sikkim Unit Complex of this Institute at Panthang about 12 km away from Gangtok on June 2, 1999. Shri R.B. Subba, Minister of forests, and Shri T.T. Bhutia, Minister of Irrigation, Government of Sikkim also attended the function.

The Institute hosted National Seminar on "High Altitude Biology" organized by Indian National Science Academy (INSA) on May 15, 1999. The seminar was presided over by Professor G. Mehta, FNA, President INSA and Director Indian Institute of Science, Bangalore. The seminar was attended by eminent scientists and prominent academics from all over the country.

A National Symposium on the Role of Plant Tissue Culture in Biodiversity Conservation and Economic Development and the XXII meeting of the Plant Tissue Culture Association (India) was organized by the Institute from June 7-9, 1999. The seminar was inaugurated by Dr. Manju Sharma, Secretary, Department of Biotechno-logy, New Delhi. In her keynote address on "Biodiversity conservation and socio-economic

development - role and relevance of biotechnology", she stressed on the need of concerted efforts in R & D for commercialization of products and processes utilizing the existing rich natural resources of the country. The seminar was attended by eminent scientists from all over the country.

The Institute celebrated its Annual Day Function at Gangtok in the Sikkim unit on February 20, 2000. His Excellency Chaudhary Randhir Singh, Hon'ble Governor of Sikkim was the Chief Guest, and Shri K.T. Gyaltshen, Hon'ble Minister for Tourism, Govt. of Sikkim presided over the function. Other dignitaries included Professor H.Y. Mohan Ram, FNA; Shri Vinod Vaish, IAS, Special Sceretary, Ministry of Environment and Forests, Government of India; Shri Sonam Wangdi, IAS, Chief Secretary Governmant of Sikkim, Members of Governing Body and Science Advisory Committee. A large number of scientists and academics, officers of Government of Sikkim, senior citizens and local people attended the function. The highlight of the function was IX G.B. Pant Memorial Lecture entitled "Plant resources of the Indian Himalayan region : some point for action" delivered by Prof. H.Y. Mohan Ram. He dwelt on the availability of a variety of plant resources in the Himalaya, and suggested that the prosperity of the country depends on the judicious harnessing of its natural resources through the application of skills and value addition. He highlighted the potentiality and use of bamboos and rattans for the economic development of the region, and suggested strategies for augmenting production. Later, two publications of the Institute "Water in Kumaon : ecology, value and rights", and "Van Rawats : A tribe in peril" were released on this occasion.

3. RESEARCH AND DEVELOPMENT PROGRAMMES

In order to achieve the sustainable development of the Indian Himalaya, research and development programmes of the Institute are based on a 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 progress made in various projects during the year have been placed under appropriate core programmes in the text. The project implementation sites are carefully selected keeping in view the heterogeneous heritage of the Himalaya along with specific needs and aspirations of the local inhabitants. All activities are need based, target oriented and time bound; efforts are made to provide practicable solutions rather than theoretical prescriptions. To meet the targets, and accomplish the objectives well equipped laboratories and computer facilities have been established. Rigorous data collection, development modification and demonstration of science and technology inputs, including technology packages of the Institute, are underlying elements of all project activities. While a number of projects were completed during the year, a few new projects were also initiated; most projects are now in their third or fourth year of operation. Highlights of the progress made during the year 1998-99, along with a brief, conceptual background, specific objectives and major achievements are summarized for individual projects. Brief summaries of projects completed during the year are placed in the text and detailed findings will be made available subsequently.

3.1. LAND AND WATER RESOURCE MANAGEMENT

land and water are the two basic resources on which the survival of mankind depends. In the Himalaya management of these important natural resources is a difficult and complex problem. The Himalayan region is characterized by sparse population, undulating terrain, tiny and scattered land holdings. The cultivation is done on slopes with shallow and gravely soil, scanty or no irrigation as the agriculture is largely rainfed, with agro-pastoral economy, etc. In the last few years, institute is engaged in the study of some of these basic characteristics and problems related to its present utilization patterns. Following research programmes were under progress during the year.

Documentation of resource utilization patterns in the two micro-watersheds of Garhwal Himalaya with baseline data collection related to soil and water. Data compilation on Govt. managed schemes to study the existing irrigation systems and rural water supply and selection of sites for field studies. Demonstration of agroforestry model in Mamlay (Sikkim) watershed was started as Phase II of the completed activity. Detailed mapping of changes in land use patterns using IRS data has been initiated.

3.1.1 Integrated Watershed Management: A Case Study in Sikkim Himalaya

Background

The second phase of the project has been initiated in the year 1994 as a follow up action with a view to develop a model at the farm level for demonstration and to continue data acquisition for long-term studies. Based on the results of first phase various initiatives in the form of development of technology packages, such as intensification of traditional crops, strengthening of fodder components and biocomposting have been introduced. Environmental impact assessment of construction of a motorable road within the watershed is being carried out.

Objectives

1. Estimation of runoff and erosion in the improved cropping practices. In addition, soil, water and nutrient conservation under different cropping systems will also be studied.
2. Use of Nitrogen accretion in upland farming systems.
3. Study of the role of bund species on conservation and their competition with crops, and identification of ecologically and economically useful agroforestry trees for the region.

Results and Achievements

1. Agroforestry model developed was monitored at two different sites, viz. at Chhamgaun for temperate region and at Debrong for subtropical region. Stress on natural resources at the watershed level have made visible impacts such as reduced soil fertility, water scarcity during the lean period, limitation on the availability of fodder, fuel and other products from the forests. Technology packages on the propagation of bamboos, improvisation of traditional large cardamom curing kiln for reducing the firewood requirement and improving the final product on large cardamom capsule were developed.
2. Technological intervention for integrated landslide/gully erosion control on an upland farm at Upper Kamrang village of the watershed has begun to show stable and sound ecological conditions. Since this has been achieved by a combination of bio-engineering and engineering methods, the monitoring of experimental effectiveness is underway on a long term basis. In view of the ecological and environmental approach of rehabilitation of the site, an economic analysis based on cash flow method was undertaken for the base year till year 1.
3. EIA and Ecological Economics aspects of Namchi-Vok motorable road within the watershed was carried out. It was found that the materials excavated were slided or thrown down the slope causing damage to standing crops as well as accumulation of harmful debris in farm-lands. This road shall benefit the population of 5000. For understanding the villagers' perception of environmental, ecological and economic acceptance, a face to face survey on contingent valuation method (CVM) approach was undertaken on the whole, 65 % of affirmative and 35 % negative responses to economic and ecological compensation weighed heavily against 52 % of affirmative and 48 % negative responses to adverse environmental impact of road construction. This pointed to a higher priority attached by the villagers to ecological and economic prospects and their willingness to pay directly or indirectly.

3.1.2. Integrated Watershed Management: Case Studies in Garhwal Himalaya

(Summary of the completed project)

Background

A watershed is a natural hydrological unit draining the run-off water to a common point. The quantity and quality of the water is an index of the amount and intensity of precipitation and the nature of watershed management (WM). WM is defined as a process of guiding and co-ordinating use of land and water resources to provide environmental services and goods, without adversely affecting resources upstream or downstream. This can be achieved by a judicious mix of both technical and institutional support, credit, infrastructure development, etc. to integrate the watershed with mainstream economy.

Objectives

1. To generate baseline data on hydrometeorology of two micro-watersheds having different land uses and to understand watershed-level hydrological processes, which control soil and water loss.
2. Performance evaluation of engineering and vegetative measures in community wastelands for conservation of soil and water resources and to provide biomass resources to the watershed people.

Results and Achievements

1. This study was conducted during 1994-99 in two micro-watersheds (WS) situated in middle montane belt (altitude 1100-1900 masl) of Garhwal Himalaya. The WS (area » 300 ha) vary considerably with regard to land use. Both the WS shared similar atmospheric temperature, rainfall, evaporation and other climatic conditions. The per capita biomass energy consumption for human and livestock population were almost the same for these WS. The human and livestock population densities for Dugar Gad were 3.1 and 6.3 animal units (AU) and for Srikot Gad 1.8 and 3.8 (AU), respectively. Each unit of agronomic yield entails an expenditure of 9 units of biomass energy from the surrounding forests. About two-thirds of the annual food requirement is met from purchase in the nearby market.
2. About one-third of the existing land under rainfed cultivation in Dugar Gad (44.2 ha) could be suitably brought under irrigation. The crop yield could be increased two fold, provided Dugar Gad stream water is used for canal irrigation.
3. A comparison of the assessment of soil and water conservation in Srikot Gad WS and Dugar Gad WS revealed that annual streamflow was more (33.9%) of rainfall in Duar Gad than Srikot Gad (22.4%). However, with respect to total water yield Dugar Gad WS produced about two times more water compared to Srikot Gad WS. Peak streamflow in Dugar Gad occurred in August, which was delayed by about one month in Srikot Gad.

3.1.3 Management of Irrigation Systems and Rural Water Supply in the Himalaya

Background

In the Central Himalaya, the problems of irrigation water management becomes more serious due to severe water scarcity. Attempts have been made to study the collective nature of action in hill irrigation and its organisational patterns. However, these were primarily limited to the successful irrigation systems to develop guidelines for new schemes. This study proposes to analyse both successful and unsuccessful experiences in traditional and modern 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.

Results and Achievements

1. In traditional community managed systems, length of canal required to irrigate one ha land (termed as canal ratio or CR) ranged between 0.049 to 0.356 km/ha. Different canal ratio is found for different cropping seasons. High canal ratio is a typical characteristic of hill irrigation systems. It is directly responsible for higher cost of construction and maintenance of hill systems than irrigation systems in the plains.
2. Community irrigation systems have very high irrigation intensity. Maximum irrigation intensity was 195.96 per cent for the Barsil canal system for both cropping seasons of the year (97.62 per cent for rabi and 98.33 per cent for kharif).

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

Background

Most of the traditional soil and water conservation measures are low cost mechanical measures such as terrace bunding, brushwood structures, slope reduction by making bench terraces, etc. In some cases biological measures are also used through agro-forestry practices. An attempt is made for quantitative and qualitative assessment of traditional and modern conservation practices to suggest the most appropriate technology for different regions of Himalaya.

Objectives

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

Results and Achievements

1. Performance of low cost bioengineering measures for

controlling man induced soil erosion was assessed using erosion plots (20 x 5 m). Similar plots were established for assessment of soil loss from different landuses.

2. To study the soil loss and runoff pattern on a watershed scale a study was initiated in Nanakoshi watershed (area 534.78 ha) in Almora district. The watershed has 41.33 % area under forest, 34.06 % under cultivable waste and 20.51 % under cultivation. The maximum winter stream discharge was 0.32495 m^3/sec with suspended sediment of 0.119 g/l. The maximum suspended sediments was 0.2790 gm/l in January mainly due to high rainfall. The data for other seasons is being collected.

3.1.5. Mountain Risk Engineering in the Indian Himalayan Region

(Summary of the completed project)

Background

In view of the accelerated soil erosion rates and mass wasting processes and the growing concern for effective stabilisation of hill slope instability across the Himalayan region, a consensus has developed for co-ordinated efforts that helped in the development of the concept of Mountain Risk Engineering (MRE). MRE is being practised in mountainous regions of various counties for few years now. With this background, initiatives were taken in 1998-99 to form a multidisciplinary team for testing of framework of MRE along with development of suitable approach to be adopted for local community participation in the stabilisation work.

Objectives

1. To stabilise identified small to medium hill slope instabilities adopting principles and practices of MRE.

Results and Achievements

The hill slope stabilization works were carried out in two villages (i.e., Joshiyana and Khoont) of Kumaun Himalaya. As per norms of MRE, a total of 11 small to medium hill slope instabilities were identified and detailed geologic, land-use, soil type and social assessment were done for developing treatment plan. These sites were subsequently stabilised adopting various practices with emphasis on low cost biological and physical measures. Apart from hill slope stabilization, one of the major achievements of this programme was moderate to high peoples' participation in the various developmental works. In addition, rate analysis norms have been developed for various low cost physical and biological measures and identification of suitable bio-engineering treatments for the region along with suitable plants species and their functions in slope stabilisation.

3.1.6. Badrivan Restoration Programme

Background

The cultural, mythological, historical and scientific evidences indicate that the Badrinath Dham shrine had dense vegetation/forest around it in the past. However, at present there is hardly any trace of forest around this shrine. In recent past, some government and non-government organizations 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) 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 (the ancient sacred forest of Badrinath) at Badrinath in Chamoli Garhwal.

Results and Achievements

1. Hanumanchatti nursery (2,500 m amsl) was maintained and strengthened successfully during the year (i.e. from April 1999 to November 1999). Out of 57,630 seedlings/cuttings of various trees/shrubs, which were available in Hanumanchatti nursery up to November 1998, only 36,545 seedlings/cuttings of 14 high altitude trees/shrubs survived at the nursery in Hanumanchatti (12 kms before Badrinath). 12,188 seedlings/ cuttings of various high altitude trees/shrubs were distributed, free of cost, to various NGOs/ Govt. organisations/ Army regiments, local people and villagers of Auth, Bamani,

Benakuli, Dhantoli, Hanumanchatti, Indradhara, Khiron and Mana for plantation.

2. Observations on germination potential of seeds of 19 plant species at Mana nursery (3,133m) and of 20 species at Kosi nursery (1,120m) were also recorded. In addition to the above, seed germination potential of 17 high altitude trees/shrubs was recorded under laboratory condition at Katarmal Campus of the Institute in the months of April and May 1999.

3. On the request of the local inhabitants of Badrinath valley, Plant Distribution Ceremony (third of its kind) was organised on 12th September 1999 at Badrinath. One hundred and fifty (150) well established and hardened seedlings of Deodar (*Cedrus deodara*) and Kail (*Pinus excelsa*) were distributed, free of cost, among the local inhabitants, priests (purohits) and saints of Badrinath shrine for plantation purpose in and around their habitation (Fig. 1).

3.1.7 People And Resource Dynamics In Mountain Watersheds Of Hindu-Kush Himalaya (PARDYP)

Background

PARDYP is a regional collaborative programme involving local, national and international partners each contributing to the project objectives in their respective areas of comparative advantage. After 3 years of PARDYP, in addition to the rehabilitation project, considerable knowledge has been gained to identify physical problems in Natural Resource Management (NRM) The real question for phase II is now 'how' to turn this knowledge and understanding into directly relevant workable and appropriate programmes for the communities. In phase I, small but sound beginnings have been made in understanding how scientists work with the communities, how groups are formed and how best the project can approach the "research for development" philosophy.

Fig. 1. Ritual distribution of tree seedlings at Hanumanchatti in Chamoli Garhwal

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 increase household and community benefits.

Results and Achievements

1. Watershed received 99.52 cm precipitation during 1999 (Table 1), which was significantly lower than that of 1998 (169.49 cm). Out of 99.52 cm precipitation, only 72.09 cm was effective (causing soil erosion). Maximum soil loss was recorded from grazed pine forest (4.139 t/ha/year) followed by Tea-plantation area, degraded land and agricultural land.
2. Based on primary survey and PRA exercise micro-plan for 4 villages within the study watershed (Thakala, Doba Malla, Patli and Bimola) have been prepared and are being finalized with the help of line agencies.
3. Improved variety of Finger Millet (VL- 149) was treated with *Azatobacter chroococcum* A_{43} strain in farmers' field and recorded 38% increase in grain yield over control. *A. chroococcum* W_5 strain yielded 20% increase in tomato, 22.5% in capsicum and 16.5% in brinjal production.

Table. 1: A Comparative account of Hydro - meteorological observations for the year 1998 and 1999 in Beta Gad Watershed

Parameters	*1998*	*1999*
Annual Mean Rainfall (Average of 5 stations -cm)	169.49	99.52
Monsoon Rainfall (Average of 5 stations -cm)	106.81 (63.02%)	84.64 (85.04)
Mean Monthly Temperatures(°C)	4.72-27.41 max: 37.43 min: -0.81	8.68-23.39 max: 37.03 min: -1.22
Mean Monthly Relative Humidity(%)	64.9-96.0	46.39-90.37
Evaporation (mm) - 24hr	3.09-11.31	3.41-14.35
Annual total Runoff (cm)	85.17	43.56
Annual Runoff Coefficient	0.5	0.43
Maximum Sunshine Hours	266.59 (May)	247.9 (March)

3.1.8. Hydrometry and estimation of sediment load of Gangotri glacier in Garhwal Himalaya (Uttaranchal)

Background

The Gangotri glacier, located in Uttarkasi district of Garhwal Himalaya is one of the biggest glaciers in Himalaya. It is 26 Km long and its width varies from 0.5 to 2.5 km respectively. Numerous small sized glaciers join the main Gangorti glacier from all sides and from the Gangotri group of glacier, and the water of Bhagirathi rivers is used for generation of hydropower. The rate of flow of water and sediment is of great importance for operation and maintenance of such schemes.

Objectives

1. To collect hydrometeorological data of Gangotri glacier and study of the relationship between discharge variations and meteoro-logical parameters.
2. To measure the melt water discharge and quantum of suspended sediment load of the glacier and their relationship during the melt water season and to assess the rate of erosion of the glacier through suspended sediment load.
3. To evaluate the sediments source area, production mechanism and transport pathways of the suspended and dissolved load of the glacier.

Results and Achievements

1. In case of Gangotri glacier, measurements of glacier melt water discharge were carried out to co-relate it with suspended sediments and to get total quantum of sediment load. Discharge data of Gangotri glacier collected for the season (April to Oct.1999) and it showed great variations.
2. Glacial melt water streams carry high sediment load both as suspended sediment and bed load in response to the large supply of sediments to the streams by glacial processes. During the 1999 ablation season, large variations in suspended sediment (SS) concen-tration was also observed in melt water of Gangotri glacier (Fig. 2).

3.1.9. Hydro-Ecological Linkages of Carbon Dynamics in Relation to Land Use/Cover Change in a Himalayan Watershed (Sikkim)

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. 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. This study on hydrology and carbon dynamics in a series of transformed land-uses will be studied in a watershed in Sikkim Himalaya.

Fig. 2. Location of hydrometry station at Gomukh, Gangotri glacier

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 change combustion emission and agricultural change emissions will be estimated.
3. Hydrological studies such as overland flow, soil erosion, carbon loss through soil erosion, sediment concentration in stream water, and discharge will be carried out on land-use basis.

Results and Achievements

1. Different land-uses/covers are identified and sites demarcated for detailed study. The hydro-meteorological stations were established at two sites representing sub-tropical and temperate conditions. Relative humidity varied from 66% in temperate region to 78% in sub-tropical region. Photosynthetic active radiation (PAR) recorded during 10.30 to 12.00 hours in different land-uses/covers.
2. Land-use/cover area of the entire watershed was quantified using satellite imagery (1:50000 scale), IRS, LISS-III, FCC, band 2,3,4 for the year 1997. About 33% of the watershed area comes under intensive cultivation practices, followed by 28% under open mixed forest with agroforestry practices, 15% under open mixed forest (reserved), 6% scrub land, 6% rock outcrops, 5% dense mixed forest (reserved) and 6% under other categories.
3. Soil organic carbon and microbial carbon were estimated in parent soil from all land-use/covers. The organic carbon was highest (4.3%) in the dense mixed temperate natural forest and lowest (0.89%) in the sub-tropical wasteland. The organic carbon loss through eroded soil was highest (3.99%) in the open mixed temperate natural forest and lowest (0.97%) in the sub-tropical open cropped area.

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

Background

The Himalayan mountains, stretching for over 2500 Km. in a remarkable uniform arc from Nargaparbat in the West to Namcha Barwa in the east, has been formed over the past 45 million years by sustained compression provided by the indenting Indian plate. This process continues apace even today, perpetually subjecting the Himalayan region to threats of natural hazards, notably earthquakes and landslides. A high precision Global Positioning System (GPS) was accordingly installed in the campus of the GBPIHED, at Katarmal, which 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 landslope 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 upto the Indo-Tibetan border (Untadhura, Kingribingri/ Lipulekh).

Results and Achievements

1. Determining the south-north gradient of strain accumulation rates right through and across the great Himalaya (from Almora to Milam), Significant results so far obtained from the continuously operating GBP-GPS and the regional GPS campaigns around it, are: a) precise coordinates of the GBP-GPS site and its velocity with respect to a similar station in the campus of the Indian Institute of Science, Bangalore and b) the velocity vectors at Chaukori, Munsiari and Burphu (Fig. 3).

2. The baseline distance between GBP-GPS station (Fig. 4) and IISC Bangalore is 1845789.8015 metres with an accuracy of 3.7 mm in the north, 8 mm in the east and 1.05 cm in the vertical.

3. Baseline variations (annual velocity of convergence of the GBP- GPS station w.r.t. IISC) is less than 5 mm/yr, indicating that the Lesser Kumaun Himalaya is currently locked with the Indian plate.

4. The convergence of the Trans-Himalayan region in Kumaun with

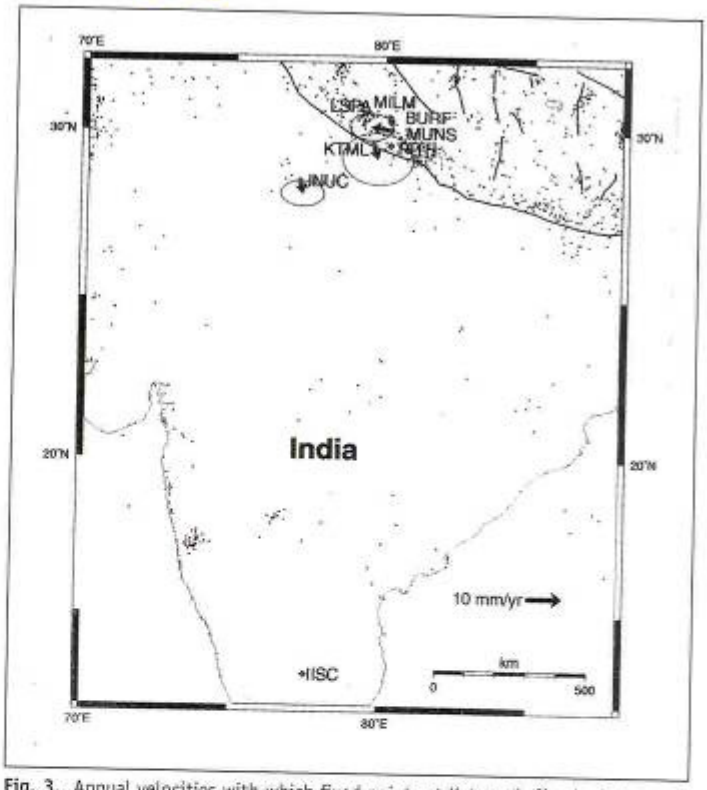


Fig. 3. Annual velocities with which fixed points at Katarmal, Chaukori, Munsiari and Burphu move with respect to IISC, Bangalore.

the Indian shield is about 10-15 mm/yr, indicating that this is the area where a seisimic displacement is taking place piling up stress at the back of the great Himalaya, in preparation for the next major earthquake.

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

Background

Ecology and management of soil in agro- ecosystems have generated considerable interest during recent years. Tillage can have a marked influence on soil physical properties. Reduced tillage systems are increasingly recognised as essential to long-term maintenance of soil susceptible to erosion. At the time of seedbed preparation cropfields are tilled twice and massive quantity of organic manure is applied. These practices invite recurring losses to topsoil, water and nutrients under the influence of monsoon rains. It will be also important to investigate the soil, nutrients and water losses from the traditional agriculture, which may alone outweigh the gains due to crop yield. These interrelated areas make the basis of this research project.

Objectives

1. To consider soil physico-chemical properties, soil moisture, crop yield, weed potential, nutrient release pattern of mulch material at different time of mulch application and frequency of tilling.
2. To compare the results with those obtained under conventional practices of cropfield manuring and tilling followed in this region.
3. To determine the practice(s) of crop cultivation favouring soil, water and nutrient conservation.

Results and Achievements

1. Abandoned cropfields of Dobh-Srikot village (altitude 1200 masl) in Pauri district of Garhwal Himalaya were selected to carry out this project. At the start of the experiment in October 1999, soil bulk density and water holding capacity was found 0.058 gm cm^{-3} and 17.7%, respectively.
2. A total of 36 experimental plots (area 10 m^2 each) were created and tilling (zero, once and twice) and mulch (Oak, Pine and Lantana leaf litter) treatments were given before sowing wheat crop. Runoff collectors were fixed with each of the plots to determine water, soil and nutrient loss.

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

Background

Due to multitude of natural processes and human activities, the ecology of the Himalayan region has deteriorated. Deforestation, landslides, increasing human and livestock population, developmental activities have created significant loss to the natural resources. This requires assessment of the ecological set-up, stratification and mapping of forests based on topography, climate, biotic pressure etc. In this regard remote sensing (RS) in conjunction with Geographic Information System (GIS) has emerged as a powerful tool for understanding ecosystem dynamics and environmental hazards for a better and sustainable resource use. In keeping of the above, Space Applications Centre (SAC), Ahmedabad and GBPIHED have initiated a collaborative project in the Alaknanda river catchment.

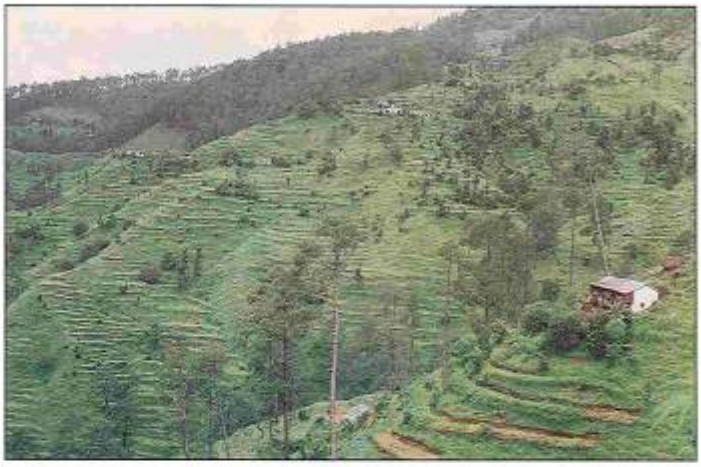
Objectives

1. Identification of areas most vulnerable/susceptible to landslide hazard zonation and their vegetation dynamics.
2. Identification of degraded watersheds for conservation measures.
3. Development of management model for optimal resource use (fuelwood and fodder).

Results and Achievements

1. Base maps for land use and land cover, forest types, geomorphology, geology, lineament; drainage, sub watershed boundary, etc., have been prepared.
2. New roads constructed in the Alaknanda valley after 1968 (given in Survey of India Toposheet) have been transferred to the maps.
3. Resource-use (fuelwood and fodder) survey in 40 randomly selected villages in the study area was done and database was prepared fitting to GIS environment.
4. Ground truth data collected for landslides and vegetation types were transferred to the maps.
5. Detailed study of Chamoli earthquake of March 1999 and hazard zonation along road section from Chamoli to Tapovan was carried out.

3.2. SUSTAINABLE DEVELOPMENT OF RURAL ECOSYSTEM



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 participation in natural resource management, prospects of commercial 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.

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

(a) Natural Resource Management for Sustainable Development

Background

This project was initiated in 1992-93 for understanding the site-specific requirements of different watersheds across the Himalaya in terms of developing and demonstrating the utilization potential of local resources for sustainable rural development based on participatory approaches.

Objectives

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

Results and Achievements

1. In an effort to categorize the different indigenous land-use system, to assess bamboo and cane resources utilization pattern and to study the conservation status of various bamboo and cane species in north-easten India, seven villages of Tangsa tribe in Changlang district and three villages of Adi (Abor-Minyong) tribe of Bilat circle, in Pasighat of Arunachal Pradesh were studied. The seven villages studied mainly comprised of Lungchang (one of the largest sub-tribe) and the Jugli. The Tangsas have about 12 land-use systems. Bamboo is indispensable for the tribal people in their day to day life, viz. for shelter, food, furniture, handicrafts, medicine and ethno-religious purposes. Bamboo requirement for housing, craft, fencing and religious uses of the village is almost entirely met from the individual plantations. For the requirement of cane the villagers have to depend on the reserve forest. In very rare cases are the bamboos brought and sold within a village. Bamboos for the fencing of jhum lands, home, horticultural garden and bamboo plantation comes from the village forest. Arunachal Pradesh has the richest diversity in bamboo, harbouring about 14 genera and 45 species.
2. Some extensively used bamboos of Abor-Minyong are Dibang (*Bambusa tulda*), Epo (*Dendrocalamus hamiltonii*), Todor (*Pseudostachyum polymorphum*), (*Bambusa nutans Roxb.*), Homeng (*Bambusa pallida*), Surung (*Dendrocalamus giganteus*), Madang (*Cephalostachyum pergracile*), and Tabum (*Bambusa khasiana*) each having its own characteristics. Besides these, varieties of wild species of bamboo, known as Homeng and Ea found in abundance in jungles. All cultivated bamboo gardens (Dubom ko among), the homestead land (Toko garden) and adjoining home gardens (Ekum bari), granaries and forest plantations (Agike) are privately owned. Each household uses 3-4 kg dry bamboo shoot annually. When a house has to be rebuilt (after every 5 to 6 years), the requirement of mature bamboo culms is of 450, which may be procured from size of about one hectare area. A diversion of a part of the well managed bamboo resource towards income generation activities like bamboo ply production and bamboo craft products with improved technologies and improved marketing facilities could provide the area with a much needed economic alternative.
3. In order to understand the linkages between agriculture, ecosystem and environment, the Nyishis (Daflas), in Papum Pare district of Arunachal Pradesh were studied focusing on demographic and economic profile, indigenous land use pattern, crops and cropping pattern and input output of important crops, and forest resource utilization. Each Nyishis family had an average of 2.64 ha irrigated land, within 3-5 km from the village. The average paddy production was recorded as 32 q/ha. The wet paddy cultivation is done on shared basis, and usually half of produce is given to the hired (Adhi) labours. On an average each household maintains 3 animals, composing oxen, bulls & pigs. Each family also maintains over 40 poultry birds. The annual labour input per household varies from 400-700 man-days, which is mainly for agriculture (200-350 man days), collection of forest produces (200-250 days) and other works (30-70 man days).

(b) Land use models for Himalaya

Background

Agroforestry, in its true form or in modified forms, is argued to be a sound land management option meeting both environmental and developmental imperatives in the hills, particularly on the slopes. Agriculture, forests and animal husbandry are inter-linked across the Himalaya. However, the nature and magnitude of these linkages vary. Agriculture in the Himalaya continues to be of subsistence type and productive potential of cropland depends upon the organic inputs derived directly from the forests in the form of litter or indirectly through animal dung. Alternatively the resources could be generated on farm through contour farming.

Objectives

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

Results and Achievements

1. In case of UP Himalaya, total annual litterfall was observed highest for *Ficus glomerata* (243 g/m²), followed by *Boehmeria rugulosa* (231 g/m²), *Alnus nepalensis* (229 g/m²), *Dalbergia sissoo* (125 g/m²), *Albizia lebbek* (117 g/m²), and *Ficus roxburghii* (85 g/m²). Of the different components of litter (leaf, twig, floral and fruit parts), leaf litter, contributed more than 70% to the total annual litter fall for all the species. The rate of litter decomposition was observed higher for nitrogen fixing species as compared to non-nitrogen fixing species. Concentration of N and P increased with the increasing weight loss of the leaf litter in all the species though magnitude of increase varied between the species (Table 2). However, in the initial stage of decomposition, concentration of N and P showed little decrease in *Albizia lebbek, Alnus nepalensis* and *Ficus glomerata*.
2. In Himachal Pradesh, experiments on decomposition of organic material (*Pinus wallichiana* litter) was carried out under 2 major food crops of the Kullu valley at 2 locations (Rolgi 2200m and Tichi 1600m altitude) to see the impact of decomposing pine leaf litter on maize and wheat through litter bag method. On an average, decomposition rates under wheat were higher than decomposition rates under maize crop at both the sites (Fig.5). Impact of releasing nutrients from decomposing leaves on growth and crop yield showed that crop growth and yield was higher with pine litter than the crop without pine litter. However, under maize crop this impact was much pronounced than wheat crop. This was also found that impact of releasing nutrients on growth and yield was more at lower elevation (Tichi) than higher elevation at Rolgi.

In Arunachal Pradesh, the natural resource utilization patterns of the Apatanis was investigated focusing on their different landuse practices, species diversity in each sub-component and their resource management strategy. Each household has bamboo farming (Bije), vegetable and fruit gardens (Balu) and individual or clan forests (Sansung). The Apatanis, unlike their neighbours and most other communities of Northeastern India, practise wet cultivation instead of shifting cultivation. Soil physico-chemical analyses like moisture content, pH, conductivity and bulk density under different landuse practices were determined during the study period for soil profiles of 0-15 cm and 15-30 cm.

Table 2. Initial nutrient concentration (%) of confined leaf litter of various multipurpose tree species.

Species	*C*	*N*	*P*	*K*	*Ca*	*Mg*
Albizia lebbek	36.10	2.62	0.147	0.60	1.44	0.57
Alnus nepalensis	31.25	2.51	0.127	0.60	1.26	0.36
Boehmeria rugulosa	35.10	1.16	0.180	0.92	2.10	0.60
Dalbergia sissoo	31.50	2.19	0.180	1.12	1.51	0.40
Ficus glomerata	35.56	1.97	0.165	1.10	1.60	0.53
Ficus roxburghii	32.67	0.96	0.132	0.98	1.23	0.62

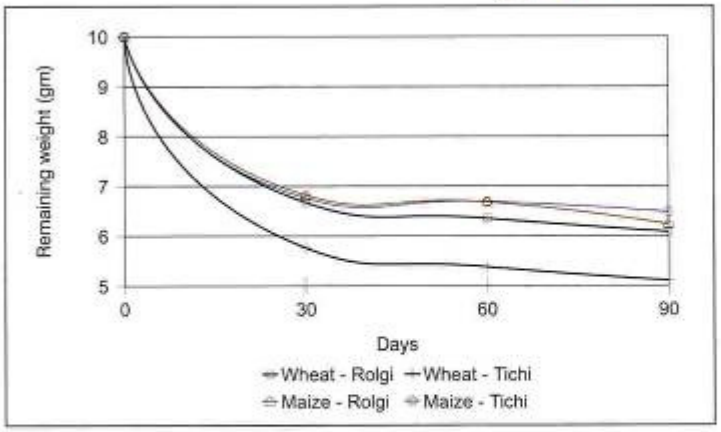


Fig. 5. Remaining weight of litter in litter bags under wheat and maize crops in Kullu Valley, N.W. Himalaya

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

(Summary of Completed Project)

Background

Reconciling economic development with biodiversity conservation has become most important in sustainable development, particularly in remote rural areas of the Himalaya where biodiversity is concentrated and where poverty tends to be pervasive. Facing a range of developmental crisis with limited public funds, most of the region/area has invested little in biodiversity conservation as is the case of Nanda Devi Biosphere Reserve. As a result, fragile and unique ecosystems are being degraded or converted to agricultural use on a large scale. As the habitats are destroyed, many a plant species are facing danger of extinction.

Objectives

1. To design, develop, and field test natural resource management models
2. To study qualitative and quantitative changes of resources
3. To study socio-economic impacts of various programs on the development of the rural system

Results and Achievements

1. A wide altitudinal variation and geographical setting of the NDBR facilitated influx of many taxa and promoted endemism. Traditional resource use and management systems developed by the local communities here were aimed at sustainable supply of natural resources. However, in recent times, road construction, penetration of market forces and monetary consideration led to commercial exploitation of the natural resource base in many locations and has brought cultural changes among the natives.
2. Restriction of free access to reserve forests/delimiting local people to the Panchayat (community) and civil forests has led to alienation of local communities from the reserve forests, unsustainable exploitation of reserve forests by outsiders whose prime objective was to maximize profit rather than to maintain sustainable yields, intensification of forest resource use around settlements and the inability of government agencies to ensure desirable balance between exploitation and regeneration. Although commercial exploitation of NTFP from the area has been banned since 1982, yet extraction continues, so also illegal poaching of wildlife.
3. Based on dominant top canopy tree species, seven forest types could be identified in the reserve. In 2000-3000 m elevation zone, five forest types (*Pinus wallichiana* forest, *P. wallichiana-Abies pindrow* mixed forest, *Cedrus deodara* forest, Abies pindrow-*Quercus spp.* mixed forest, and *Abies pindrow* forest) and in 3000-3500 m elevation zone, two forest types could be identified (*Taxus baccata* forest patches distributed across 3000-3500 m elevation and *Betula utilis* in 3200-3500 m zone).

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

Background

Agroecosystems are essentially

man-made ecosystems and reflect evolution of human culture. Traditional agroecosystems of the Nanda Devi Biosphere Reserve are closely interlinked with the livestock, forest and rangelands.. During recent past as a result of rapid socio-economic and cultural changes and various environmental perturbations, the agrobiodiversity of buffer zone agroecosystem of NDBR has eroded steadily and significantly. The loss of agrobiodiversity or maintenance of monoculture led to an increase in ecological vulnerability and unsustainability.

Objectives

The following two objectives were addressed during the reporting period.

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

Results and Achievements

1. The total energy input was recorded maximum for *Eleusine coracana* in monocropping at lower region followed by *Amaranthus spp.* and *Fagopyrum esculentum* at middle region whereas minimum for *Hordeum hemalayense* at higher region. At higher region, *Fagopyrum tataricum* (in pure form) required maximum energy input than the other crops. Among the mixed crops, mixed cropping of *Solanum tuberosum* and *Phaseolus vulgaris* at all the agro-climatic regions involved highest energy input than the other combinations.
2. Combination of crops common at all the elevational zones, exhibited maximum energy and monetary output at higher elevational zone than the middle and lower elevational zones, except in the case of *Triticum aestivum, Hordeum himalayense, Hordeum vulgare* and *Brassica compestris*, which showed a reverse trend (Fig. 6).
3. The monetary efficiency ratio was obtained highest for the mixed cropping of *S. tuberosum* and *P. vulgaris* cultivated at all the agro-climatic zones.
4. However, among the crops cultivated in irrigated land, in pure or mixed form, *S. tuberosum* exhibited the maximum energy and monetary efficiency ratio than the other crops when grain/tuber yield was considered alone.

3.2.4. An Assessment of Agricultural Production and Strategy for Sustainable development of Bioresources

Background

The ever increasing population of human and livestock in the rural Himalaya, has made it imperative to assess the production of bioresources such as agriculture, 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 was studied in detail in order to assess the production of bioresources. The entire block has been divided into three altitudinal zones (i.e., less then 1400m, 1400-1600m and more than 1600m), and a total of 40 villages were studied.

Objectives

1 To study the population profile of different geo-environmental zones.

2 To study the population dependency on agriculture.

3 To quantify the agricultural production in the existing conditions.

Fig. 6: Traditional agricultural systems of Himalaya

Results and Achievements

1 In the first zone the population growth rate was low as compared to other zones. It may be because of migration due to continuous decreasing land holdings size and better connectivity (Fig. 7). The second zone covered the maximum area, therefore, with maximum human and livestock pressure; as a result the population growth in this zone was higher than the first zone.

2 In the third zone there was higher population growth, effecting in land based multifunctional activities (cultivation of cash crops, food crops, horticulture, livestock, etc.). The land holding size here was also higher than the first zone. The total persons engaged in agricultural activities were continuously decreasing in all the three zones and Women workers were mainly engaged in agricultural activities (Table. 3).

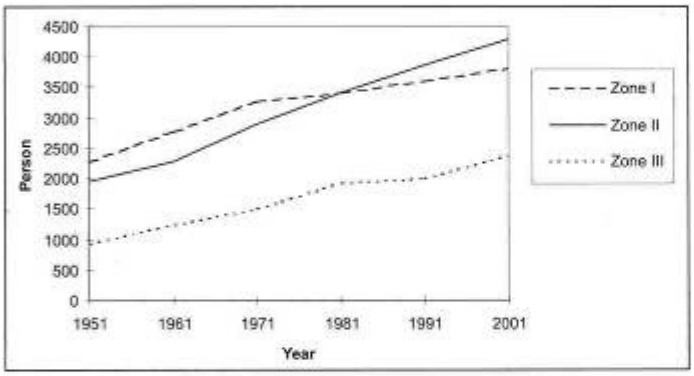


Fig. 7. Population growth in Hawalbagh Block

Table 3. Per cent of cultivator to the total main workers

		Total	*Census years (% of Cultivators to the main workers*				
Zone	Persons	workers	1961	1971	1981	1991	1999
I	Total	100	93.6	86.1	75.3	82.8	58.3
	Male	100	85.5	73.6	60.8	69.7	18.6
	Female	100	98.9	98.3	97.7	97.7	89.7
II	Total	100	88.9	82.0	54.0	48.3	47.2
	Male	100	73.2	67.7	29.7	32.8	11.6
	Female	100	99.6	98.2	97.9	91.5	73.2
III	Total	100	89.2	91.5	68.4	62.6	64.6
	Male	100	73.8	83.2	59.0	34.7	16.9
	Female	100	98.9	99.7	99.2	97.7	100

Sources: Since 1961 to 1991 district Census Handbooks and for the year 1999 field survey

3.2.5. Farmers Field School-Cum-Training Programme

Background

Providing sustainable livlihood 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. Training trainers from the local inhabitants who have potentials of training others and understanding of the intricate details of scientific interventions was attempted by GBPIHED under this programme.

Objectives

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

Results and Achievements

1. A total of 60 (male and female) local farmers from different caste groups of 8 villages were invited for the training. Trainers were selected on the basis of previous training and ability to explain the technology to others. Farmers were selected on the basis of initial interest and knowledge of the subject being discussed (Fig. 8).
2. A medicinal plant cultivation technology manual was prepared based on the participatory discussions during this meeting and the previous one. While the local trainers concentrated on the traditional technologies,

Fig. 8. Participation of Farmers Training at Jyoli

scientific interventions in terms of increasing germination of seeds and establishment of cuttings, root stocks etc. was explained by the scientists. Other technologies such as improved FYM and land preparations was also discussed.

3.2.6. Management Information System (MIS) for Land use/ cover Change Analysis in relation to Conservation Oriented Land use Priorities in Nanda Devi Biosphere Reserve Buffer Zone

Background

To conserve biodiversity in the country, a network of protected areas has been set up by the Union Government. However, these area report people vs. management authority conflicts as the subsistence needs of people are over looked during the planning and implementation phase. Effective mitigation measures could be taken if the management authority have reasonably good decision support system or management information system.

Objectives

1. To prepare a management information system for land use/ cover change in buffer zone
2. To transfer such system to management authority after testing

Results and Achievements

1. Excluding Indian Topographical Sheet 62B2 all other sheets were converted to digital form and information on land use, drainage, elevation, road network etc were prepared.
2. Preliminary analyses were completed and some thematic maps were generated
3. Secondary information on demographic and socio-economic information was transferred to digital data bases

3.2.7. ENVIS Centre on Himalayan Ecology

Background

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

Objective

The ENVIS on Himalayan Ecology is the sole Centre in the entire Indian Himalaya, which is trying to integrate the available information in the ready form for the users of remotely 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 7 No.1&2 were published
2. 152 queries were handled during the year 1999 to provide query response services.
3. Databases containing bibliography, census and landuse information were expanded.
4. Attempts were made to prepare an interactive database on 78 Himalayan districts spreading in 12 states in India.

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

Background

The TSBF is a programme of collaborative research with the overall

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

Objectives

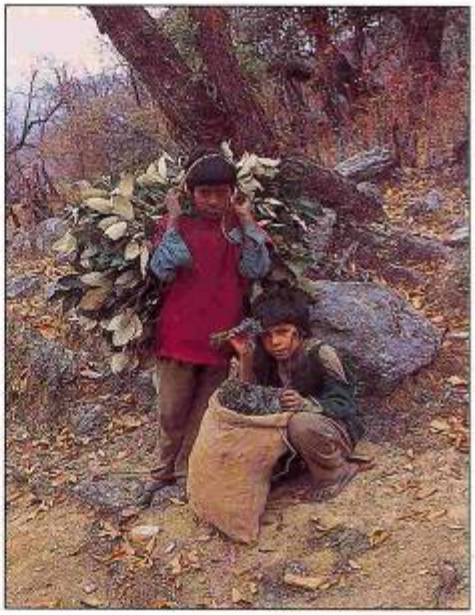
1. To conduct/encourage collaborative research with/among participating scientists
2. To coordinate research networks and projects
3. To develop test methods
4. To offer advice and assist scientists in the preparation of research proposals and obtaining funds

Results and Achievements

1. Continuation of TSBF - SARNET Abstracts & Bibliography compilation (2000)
2. Coordinating the Indian activity proposed for TSBF/UNEP project on 'Management of Agro-biodiversity for sustainable landuse and global environment benefits' (Fig. 9).

Fig. 9. Lemongrass cultivation in NE India - land use intensification has implication on agro biodiversity

3.3. CONSERVATION OF BIOLOGICAL DIVERSITY



The importance of maintaining Himalayan Biodiversity not only for the present but also for posterity is now well recognized. The core is strengthening its activities by developing both short (location specific) and long (broader spatial scale) term programmes. All activities are responsive to contemporary global thinking on the subject matter. It is in this context that the frame work of different projects are developed as per the guidelines provided by National Action Plan (NAP) and AGENDA 21 in conjunction with the Convention on Biodiversity. It aims in harnessing potential bio-resources 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 processes 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 to complement *in situ* conservation with the help of *ex situ* methods and ensure peoples' participation in biodiversity conservation.

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

Background

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

Results and Achievements

(a) Askot Wildlife Sanctuary

1. Diversity, distribution and indigenous uses of threatened medicinal plants - MPs (55 species in 48 genera and 29 families), of Askot wildlife sanctuary (AWLS) have been studied.
2. Richness of threatened MPs was highest in the zone 2801-3800m (30 spp.), followed by <1800m (26 spp.), 1801-2800m (25 spp.) and >3800m (11 spp.), zones.
3. Three species i.e. *Nardostrachys grandiflora* , *Dioscorea deltoidea* and *Picrorhiza kurrooa* (all Vulnerable) are listed in the Red Data Book of Indian Plants. Thirteen species have been categorized as Critically Rare, 7 species as Endangered, 7 species as Vulnerable and 3 species under Low-Risk-Near Threatened.

(b) Kanawar Wildlife Sanctuary (HP)

1. Following previous studies, house holds survey was conducted for monthly fodder consumption pattern in upper zone villages of KWLS. Maximum fodder consumption/HH/day is recorded for February (74.86 Kg), and minimum for August (1.0 Kg).
2. Bioresource use for primary health care in upper zone villages indicated that fifty-four taxa (50 plants and 4 mammals) are used for curing 19 common diseases. *Aconitum heterophyllum*, *Picrorhiza kurrooa* and *Dactylorhiza hatagirea* appeared as top ranking taxa, i.e. curing >47% diseases.

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

1. Upper Siraunt Gad catchment covering Kaligad, Dalmoti, Jagdeo Beats and Cantonment area in Ranikhet (Kumaun Himalaya) has been selected for detailed investigation. Thirty seven sites representing different forest habitats were surveyed for woody vegetation composition. Analysis of the data is in progress.
2. Information on fuel resource use indicated that *Pinus roxburghii*, *Myrica esculenta*, *Quercus leucotrichophora*, *Lyonia ovalifolia*, *Pyrush pashia*, *Berberis asiatica*, *Rhododendron arboreum* and *Pyracantha crenulata* are most frequently collected species. Wereas, *Grewia oppositifolia*,

Fig. 10. Timberline is a unique and sensitive biodiversity habitat in Western Himalaya

Quercus leucotrichophora, Q. glauca, Indigofera atropurpurea, Bauhinia variegata, Ficus roxburghii and *Prunus cerasoides* are highly preferred fodder species. Grasses form the major part of the fodder during rainy season. Further, analysis of useful species and their extraction trend is in progress.

(d) Studies in sensitive habitat-timberline

1. Utilizing the results of previous project "Prioritization of conservation sites in timberline zone of west Himalaya", (Sponsored by WWF India) two priority sites (viz. Pindari-Kumaun and Valley of Flowers - Garhwal) have been identified for detailed investigation and comparative analysis. Particular focus of the study is on assessment of patterns of diversity, regeneration and changes (Fig. 10).

2. Preliminary survey was conducted in Timberline zone of Valley of Flowers and adjacent areas. Preliminary data on species composition recorded from the plots (analysis under progress).

3.3.2. Bioresource Inventory of the Himalaya

Background

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

(a) Himalayan Medicinal Plants: Conservation Priorities

1. In continuation of previous attempts to prepare inventory of medicinal plants (MPs) of Indian Himalayan Region (IHR) an intensive investigation was made to develop threat perception for pharmaceutically important MPs of IHR.
2. Of the total (1748 spp) resource base very small (nearly 10%) part is being utilized by the identified companies.
3. Diversity of use in different life forms was highest for herbs (89:50.9%), followed by trees (55:31.4%) and shrubs (31: 17.7%). Across altitudinal range, richness of harvested species was maximum (61%) in sub-tropical zone and declined sharply towards the alpine zone.
4. Analysis revealed that users (industries) rely more on exclusive wild forms (64.6%) compared to wild cultivated (20%) and cultivated (15.4%) ones. Frequency of sensitivity rank (8-1, 8 being most sensitive) of MPs under different life forms is depicted (Fig. 11).

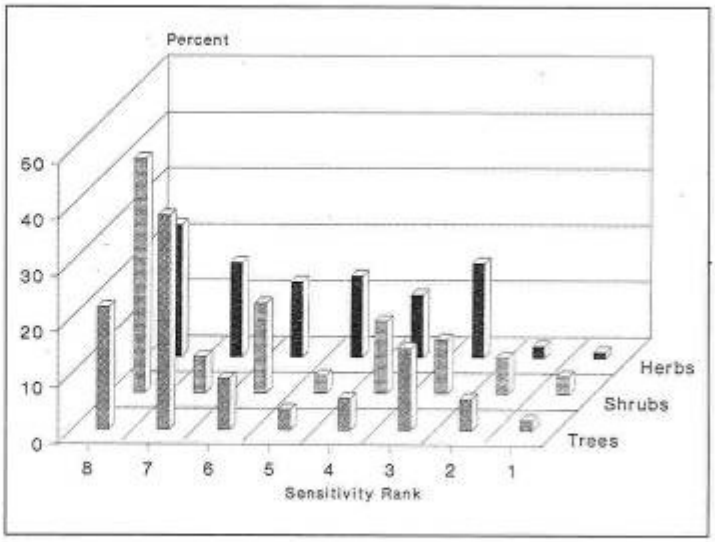


Fig. 11. Frequency of Sensitivity Rank (SR) in different life forms

(b) Essential Oil Yielding Medicinal Plants

1. Inventory of 118 species belonging to 92 genera and 45 families prepared. Apiaceae and Asteraceae (13 species each), Lamiaceae (12 spp.), Zingiberaceae (8 spp.), and Rutaceae (7 spp.) are the species rich families.
2. Along the altitudinal gradient maximum species (101) are represented in the zone <1800m, followed by 1801-2800m (58 spp), 2801-3800m (23 spp) and zone >3800m (12 spp.).
3. Across the biogeographic provinces, west Himalaya (74 spp) was most species rich followed by trans, north-west (60 spp.), central (47 spp.) and east Himalaya (42 spp.). Fifty three species were found to have specific uses in individual biogeographic province (i.e., west 20: spp.; trans, north west: 14 spp.; central: 10 spp. and east: 9 spp.).

3.3.3. Establishment and Maintenance of Functional Arboreta in the Himalaya

Background

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

Objectives

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

Results and Achievements

(a) Strengthening of arboretum- Kosi-Katarmal

1. Infrastructure facilities such as shade house and extension of arboretum area for plantation was carried out, alongwith development of a demonstration plot (Fig. 12)
2. Among various species monitored for propagation responses, *Toona serrata*, *Prunus cerasoides*, *Albizzia chinensis*, *Melia azedarachta* and *Flemingia semialata* showed good results (>80%); *Terminalia chebula*, *T. bellirica*, *Mallotus philippensis* and *Elaeagnus umbellata* showed poor (<10%); and *Acer caesium*, *A. villosum* and *Meliosma pungens* showed no germination.
3. Over 8,000 seedlings were planted in the arboretum sites and Institute campus. Seedlings of various useful species were distributed to local inhabitants through various projects of the Institute. Also, over 100 seedlings of 12 species were sent to Sikkim for strengthening the Pangthang arboretum.
4. Over 20 species of medicinal plants were introduced and tested for cultivation. Among all the species, *Acorus calamus*, *Plantago lanceolata*, *Cyperus rotundus*, *Asparagus racemosus* and *Mentha piperata* showed good performance.

(b) Propagation protocols for (MPTs)

1. In view of the high socio-economic value of *Myrica esculenta* and considering its relatively poor natural

Fig. 12. Development of demonstration plots for rehabilitation of degraded lands can improve *ex-situ* conservation

regeneration, various experiments were conducted to break the dormancy, improve germination ability and reduce the mean germination time (MGT).

2. The imbibed seeds pre-chilled at 4°C for 20 days showed best (48.6%) response. Significant reduction of MGT and substantial improvement in germination (MGT 28.6%; germination 42.1%) was, however, observed for 100 ppm GA_3 (in scarified seeds) pre-treatment.

3. Effect of best pre-sowing treatments on MGT are presented (Table 4). Likewise, effect to improve percent germination and reduce MGT (best response only) are depicted (Fig. 13).

(c) Rhododendron arboretum - Sikkim Himalaya

1. Assessment surveys for the rhododendron species were conducted in Singalila National Park in Darjeeling hills, Lachen/ Lachung/ Yumthang areas in the northern parts of Sikkim and Dzongri/Barshay areas in the western parts of Sikkim.

2. Additions of following taxa was done in the arboretum (i) rhododendrons- *R. maddenii, R. vaccinioides, R. hodgsonii;* (ii) bamboo - *Thamnocalamus* sp., 1 unidentified; (iii) medicinal herbs - *Swertia chirata, Aconitum heterophyllum, Podophyllum hexandrum, Heracleum wallichii* and (iv) rare *Cephalotaxus sp.* were made. Also several native orchids (14 species, unidentified) were introduced.

3. Agroforestry species (*Ficus roxburghiana, Ficus nemoralis, Saurauia napaulensis, Symingtonia populnea, Michelia lanuginosa, Michelia excelsa, Acer pectinatum, Macaranga pustulata, Schima wallichii*) were raised in the arboretum nursery and more than two thousand saplings/ seedlings were distributed to the farmers in the locality.

Table 4: Effect of best pre-sowing treatments on Mean Germination Time (MGT)

Population	Mean time to germinate							Population Mean
	T1	T2	T3	T4	T5	T6	T7	
Kalika	53.6	34.1	41.9	32.4	30.1	26.3	35.1	36.2
Jalna	55.9	37.8	37.4	32.6	31.7	28.8	31.8	36.5
Binsar	54.2	37.0	37.7	34.4	33.0	30.8	34.0	37.3
Treatment Mean	54.5	36.3	39.0	33.1	31.6	28.6	33.6	

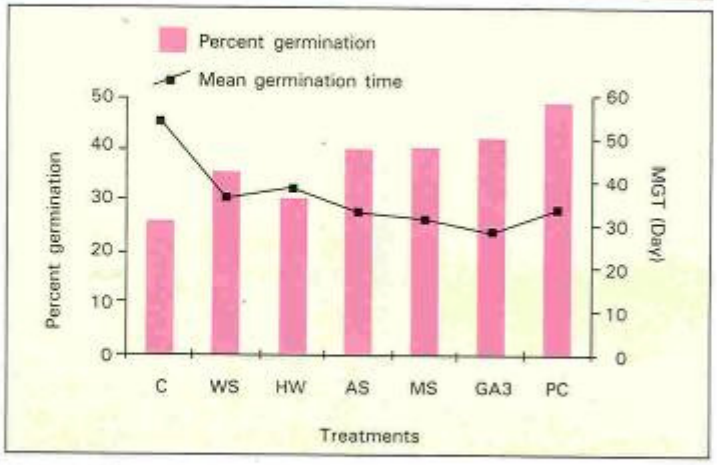


Fig. 13. Effects of various pretreatments to improve percent germination and reduce mean time to germinate

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

Background

Biodiversity conservation programs are being pursued across the Himalaya by both the Government and Non-Government agencies. Presently, such initiatives are restricted to identification of sites, surveys, inventorization of biological resources, strengthening the net work of Protected Areas, conservation of threatened species and *ex-situ* germplasm maintenance. It has been argued that conservation action needs to be promoted and implemented by bringing local people into the conservation movement and considering them as potential allies. 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 onsite training on collection, storage and propagation methods of target species focusing on teachers and students
4. Obtain and analyze response of different target groups with respect to location specific conservation option/priorities

Results and Achievements

1. Realizing that through previous training workshops (Five - between March 1995- November 1999), the target groups (students and teachers) have gained basic knowledge on various aspects of biodiversity conservation, it was decided to impart intensive training on selected themes. With this realization, for VI Training Workshop (Jagnath Inter College Saukiathal, Almora, November 18-19, 1999) 'Role of plant tissue culture in biodiversity conservation' was identified as focal theme.
2. A total 63 participants (15 teachers and 48 students) from 14 school/colleges attended the workshop. Through demonstrations and on-site training the participants were exposed to various aspects of plant tissue culture and its relevance for biodiversity conservation.
3. As a follow up of previous Workshop (GIC Narayan Nagar, November 1998), participants responses were analyzed to see the impact of training on their understanding of subject matter. A considerable improvement was apparent in both target groups (Fig. 14). As such, the improvement in students' understanding was more sharp.

3.3.5. Biodiversity Studies Using Remote Sensing in Indian Himalaya

(Summary of the completed project)

Background

Remote sensing and GIS could help in identifying the areas of high pressure and also the gradients of the disturbances across different landuse categories. In view of this, ICIMOD, Nepal and GBPIHED, India have initiated a collaborative project, which envisages to coordinate remote sensing and ground truth data for studying different aspects of biodiversity at macro, regional and micro levels.

Objectives

1. Macro level: using coarse resolution satellite data (IRS-IC, WIFS) for field work and vegetation assessment.
2. Regional level: mapping the landuse classes, habitat types and forest types using high resolution (LISS-III and LANDSAT-TM) digital/hard copy satellite data.

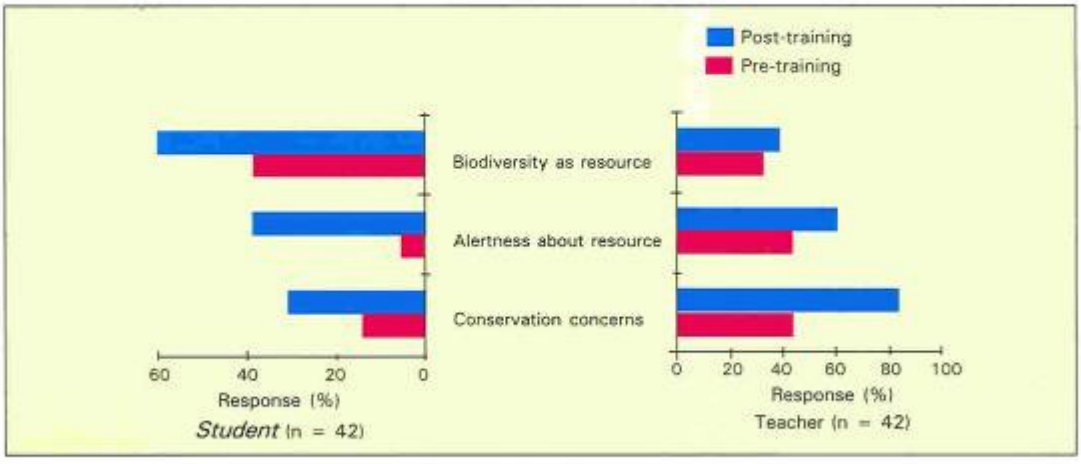


Fig. 14. Changes in participants understanding

3. Micro level: detailed mapping and classifying intensive sites (e.g. forests, land use and habitation)

Results and Achievements

The project recognized the utility of Remote Sensing for assessing the biodiversity patterns in remote Himalayan areas and considered three spatial scales for study viz. micro, regional and macro. As such, different work elements were identified to achieve specific objectives at each spatial level. After in-depth discussions over work plan among project partners it was decided to build up a strong ground truth database from intensive micro level studies following systematic data collection procedures. The envisaged objectives for intensive micro level studies were achieved as follows: (i) two extensive forest types i.e. chir-pine (*Pinus roxburghii*) and rianj-oak (*Quercus lanuginosa*) forests in Askot Wildlife Sanctuary (AWLS) of Kumaun Himalaya were studied intensively for their structural/compositional diversity patterns. Integration of ground truth data with RS data for characterizing the diversity patterns and deducting the changes over 8 years (1988 to 1996) were achieved successfully; (ii) assessment, analysis and mapping of the forest types and other land use classes in a representative area of AWLS was achieved using ground truth data, visual interpretation and digital image processing techniques.

3.3.6. 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 is required. The project was initiated to undertake studies in these directions in Nanda Devi Biosphere Reserve of West Himalaya.

Objectives

1. To delineate communities along an elevational gradient and assessing their compositional and structural patterns
2. To assess human dependence on different communities
3. To analyze changes of the vegetation
4. To identify conservation priorities and mapping

Results and Achievements

1. Human dependence study was conducted in the buffer zone villages (Chamoli district). 173 species (Trees: 19 spp., Shrubs: 24 spp., Herbs: 128 spp., Fern: 1sp. and Fungi: 1sp.) of medicinal and edible plants have been reported.
2. Maximum species are represented in the zone 2801-3800m ((137 spp.), followed by 2000-2800m (112 spp) and >3800m (69 spp.).
3. Among the medicinal and edible plants, *Berberis pseudumbellata*, *Angelica glauca*, *Pimpinella acuminata* and *Allium stracheyi* are Himalayan endemics.
4. The traditional pattern of use of medicinal and edible plants was investigated.

3.3.7. Sikkim Biodiversity and Ecotourism

Background

Tourism is rapidly becoming an important economic activity for Sikkimese people. Ecotourism, with its focus on environmentally sound practices and generating widespread economic incentives offers an opportunity for Sikkim to improve mountain livelihoods and protect its unique heritage. The Sikkim Biodiversity and Ecotourism Project is a collaborative initiative designed to conserve the biological diversity of key destinations. Working with communities, the private sector and government, the project builds upon their skills, interests and knowledge.

Objectives

1. Increasing community and private sector biodiversity conservation initiatives.
2. Increasing economic returns from community-based and travel-agent ecotourism.
3. Improving and contributing to policy-making on conservation and ecotourism.
4. Scientific and participatory monitoring of biodiversity.

Results and Achievements

1. The economic valuation of ecotourism was conducted in Yuksam-Dzongri-Goechha La corridor and Khecheopalri lake

area. Estimated willingness-to-pay for the management of trekking corridor and sacred Kheceopalri lake exhibits that the non-resident visitors (Rs. 760 and 310 per trip) had higher recreational/ conservation value than the resident visitors.

2. Hydro-ecological attributes of the land-use/cover revealed that dense forest decreased in the past few decades (96% - 1963 to 23% - 1997) with increase of open-mixed and degraded forests. Land use/cover change and pressure on the watershed forest resources have resulted in the increase of soil and nutrient deposition in the lake and bog.

3. Along the trekking corridor, out of the recorded 56 tree species in warm temperate forests, 52% species were widely used as firewood, 37% as fodder and 32 as timber. In the cool temperate-subalpine-forest, out of 32 species encountered 53% were found to be used as firewood, 31% as fodder and 31% as timber.

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

(Summary of the completed project)

Background

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

Objectives

1. to explore the biodiversity and its management in a remotely located agricultural landscape
2. to identify species rich spots of agricultural diversity in village and their role in conservation

Results and Achievements

The stability and sustainability of traditional agricultural production are based on crop diversity. There is a worldwide concern over the loss of diversity of plant genetic resources. Conserving the diversity of plants is essential to maintaining a productive and sustainable environment for agriculture and other human activities. Extensive surveys were made in each landform of tarai to the Lesser Himalayan region to identify different practices and crops cultivated in the farmer's fields. Emphasis was given to explore diversity within a crop (in the form of landraces or old varieties). Crop combinations in the crop fields varied from "monoculture" to mixed cropping. In the multiple cropping system, farmers have developed crop intensification practices by growing multiple crops to optimize yield.

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

Background

The Khangchendzonga Biosphere Reserve in Sikkim represents one of the biodiversity hot-spot in the eastern Himalayan region and acts as a natural conservation pool. This project envisages to develop a holistic understanding of the reserve particularly in view of the richness of its biodiversity components and uniqueness in socio economic attributes of the area. As such, the reserve represents great variations in elevation, climate, landscape, habitat and vegetation types. It has a rich ethno-cultural diversity and the socio-economic attributes.

Objectives

1. Assessment of landscape change.
2. Man-animal-biosphere interaction on specific places.
3. Specialized habitat monitoring for identification of keystone species with respect to habitat change.

Results and Achievements

1. Towards landscape change assessment, the biosphere reserve area mapped last year was modified as per the recent notification of KBR. As per the notification KBR has been declared with an area of 2619.92 km^2 with four different buffer zones. The ecological zones marked based on altitudinal gradients is under inventorying of flora, fauna and human dimensions.
2. Livelihood of people in the surrounding areas of KBR is at subsistence level. There are three major options namely traditional farming, pastoralism and tourism. Traditional farming and pastoralism is common for ethnics living in the fringes of the KBR.

3. Tourism involved use of large scale firewood by support staff and large number of pack animals while on the mountain treks. Monitoring of the natural resources in the tourist trek and mountaineering training area has been initiated.
4. The current buffer area demarcated is being evaluated and some areas in the expanded core are already having socio-economic activities that may have to be reconsidered for converting into buffer areas.

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

Background

The Central Government has constituted a National Expert Advisory Group to advice and oversee implementation of various research projects in designated and potential sites. 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 Government has designated Lead/Coordinating Institution for each existing Biosphere Reserves 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 has been identified as a Lead/Coordinating Institution for Nanda Devi, Manas, Dibru-Saikhowa and Dehang-Debang.

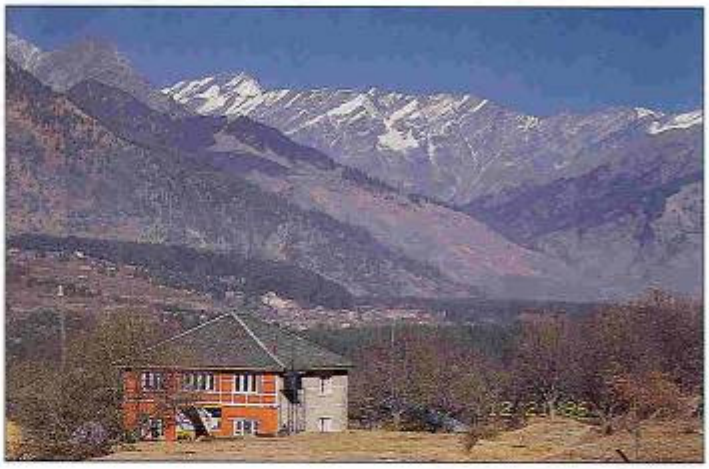
Objectives

1. Collection, synthesis and dissemination of research based information in respect of Biosphere Reserves from all sources
2. Publications of compendium of upto date information and bringing biannual publication aimed at educating stakeholders

Results and Achievements

1. Literature survey was carried out and the published papers/articles and technical reports, etc. were collected, compiled, synthesized and documented on various aspects of Nanda Devi, Manas, Dibru-Saikhowa and Dehang-Debang BRs. Research papers were also invited to update the information 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. The compilation, synthesis and documentation of information lead to the publication of Himalayan Biosphere Reserves Biannual Bulletin. The bulletin includes research papers, abstracts, project and Ph.D. summaries, news items, memorial, bibliography, list of projects and instructions to author for submitting research papers/articles.

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.

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 tourism activities in the valley and formulating a sustainable tourism plan. In earlier phases assessments were made regarding accommodation and tourists' flows by different means of transportation. Later, it was noted that Kullu valley is facing infrastructural constraints. As a result, solid waste is becoming a major problem. During 1994-95, recommendations regarding waste management and other amenities were finalised on the occasion of Kullu Dussehra and submitted to district administration. An impact of this study was again tested after 5 years during Kullu Dusshera of 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 at household level in waste management.

Objectives

1. To conduct solid waste characterisation survey from remaining point sources (hotels, hospitals) and non-point sources (tiny spots around Manali) which could not be covered in earlier studies.
2. To find solid waste management options for each category of waste coming from different sources of its generation.

Results and Achievements

1. Nearly 34% hotels representing from every category (star equivalent, other hotels-ordinary and deluxe, and guest houses and paying guest houses) were taken into account for solid waste characterisation study in Kullu and Manali. Two hundred and eighty seven samples (1 ft^3) in Manali from 128 hotels and 140 samples from 29 hotels in Kullu were segregated into different waste compositions and later grouped into three broad categories based on time taking duration of decomposition.
2. Readily biodegradable wastes (RBW) are the wastes that decompose rapidly under normal conditions. Leftover foods, vegetable rinds and peels of fruits and mixed organic wastes are the principal compositions found in hotel wastes at Kullu and Manali.
3. On average, more than 79% wastes at Manali and 66% at Kullu belonged to RBW. Of the total RBW, vegetable rinds and leftover foods at both of the locations follow fruit waste (Fig. 15). This share is again increased up to about 85% at Manali and 77% at Kullu when biodegradable wastes (BW) is added with RBW from decomposing point of view

3.4.2. Ambient Air Quality Monitoring in Kullu Valley

Background

Initially, a project on bio-geochemical cycles was conceptualised in 1993-94 in collaboration with Indian Institute of Tropical Meteorology, Pune to study biochemical cycles in Himalayan ecosystem. The present area-Kullu valley is an important tourist destination in western Himalaya where this study was started primarily with the measurements of total suspended particulate (TSP) matter during 1994-95 and 1995-96 at Mohal (1100m), Manali (1829m) and Kothi (2530m) in Kullu valley. The overall objective for keeping in shifting these TSP monitoring sites around Manali and Kullu is to get complete background concentration of particulate matter.

Objectives

1. Assessment of background concentrations of air pollutants.

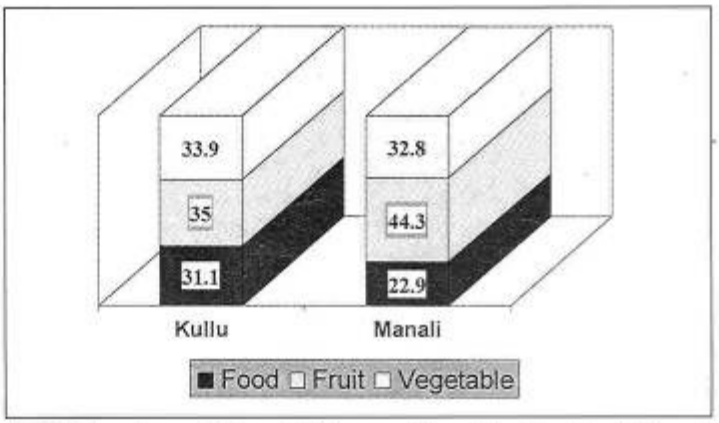


Fig. 15. Percentage variations in RBW compositions in hotel waste at Kullu and Manali

2. Atmospheric chemical transformations in the Himalayan ecosystems.

Results and Achievements

1. Total suspended particulate (TSP) concentration at Mohal (Kullu) and Jagatsukh (Manali) were monitored semi-monthly for eight hours for a sample by High Volume Sampler (HVS-APM 415). The TSP variations ranged from 92.5 (August) to 125.7 mg/m^3 (April) at Mohal and 44.5 (December) to 117.85 mg/m^3 (April) at Jagatsukh. Both of these locations have crossed its permissible level (100 mg/m^3) during summer when vehicular emissions and biomass burning due to high tourist influx remain high (Fig. 16).

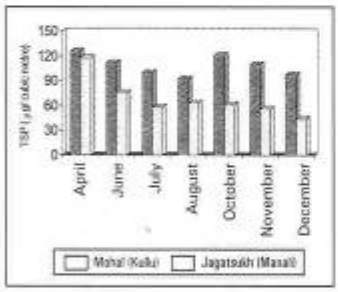


Fig. 16. Variation monitored at Mohal and Jagastsukh in Kullu Valley

2. The concentration of Aitken Nuclei (A.N.) at Mohal varied from 1000 to 8300/cm^3 with an average of 4352/cm^3, whereas it varied at Kothi from 280 to 4500/cm^3 with an average of 1392/cm^3. The lower concentrations of A.N. at Kothi than at Mohal indicate less pollution at Kothi rather than at Mohal (Fig. 17).

3. The concentration of surface ozone (O_3) at Mohal varied from 3 to 36 parts per billion (ppb) with an average of 16.7 ppb. Whereas at Kothi it varied from 24 to 40 ppb with an average of 32.7 ppb.

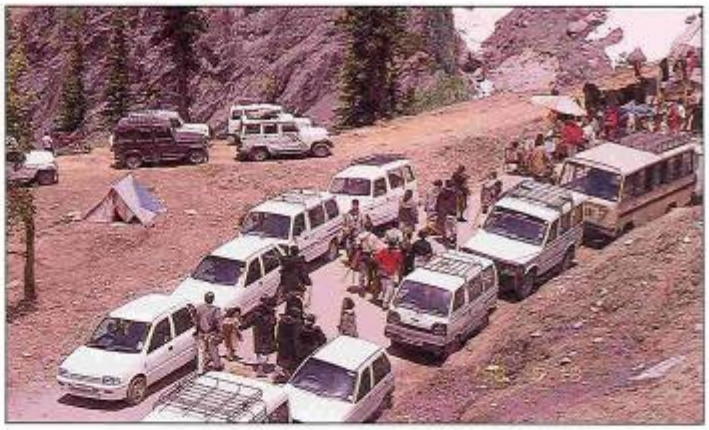


Fig. 17. Prime cause of air pollution

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

Background

This study was carried out in the central Himalayan region of India covering two tribal communities viz., the Jaunsaries and the Bhotias. In brief, it aimed at addressing the imaginary & realistic goals of sustainable development, i.e., is sustainable development in tribal areas merely a subject of argument or an objective to achieve?

Objectives

1. To study the integrated nature of tribal culture, and its influences on resource use & management,
2. To understand the concept development from tribals' perception,
3. To trace the linkages between culture & development, and
4. To identify markers for sustainable development and nature of variation of these markers in different tribal communities and thereby to trace the differential development.

Results and Achievements

1. Sound database has been created on physical environment, demography, socio-cultural milieu, economic structure, political structure, village institutions, and knowledge, attitude & perception on environmental conservation and development initiatives. The Jaunsaris are agriculturists and a conservative tribal community with unique cultural practices like polyandry.
2. Here an effort is being made to characterize the differential trends of socio-economic and demographic development among these two tribes. With exception to altitudinal variation, the

Central Himalayan region of India is governed by, more or less, a set of similar Geo-physical and environmental conditions. However, discernible differences in socio-economic and demographic developments (Table 5) are found in these tribal communities, which are effected by economy and culture.

Table 5. Differential development among the Jaunsari and Bhotia tribal communities

Demographic features	*Jaunsaries*	*Bhotias*
Joint families (%)	84.3	49.8
Nuclear families (%)	15.7	50.2
Average family size	10.39	6.12
Families with female heads (%)	2.69	13.7
Literacy (%)	40.40	63.17
Sex ratio	884	1006
Female literacy (%)	22.5	45.90
Mean age at first marriage of females	13.23	17.32
Mean age at first pregnancy	14.27	18.91
Average number of pregnancies	4.16	3.75
Crude birth rate	60.51	53.22
Total fertility rate	5.83	5.01
Crude death rate	15.21	14.38
Infant mortality rate	187	165

3. It makes imperative that policies and programs to be undertaken for development of tribal people must understand the nature of economy and culture of the community.

3.4.4. The socio-economic and developmental problems and prospects of Rajis (Van Rawats) tribe of Central Himalaya.

(Summary of the completed project)

Background

This study was undertaken on the socio-economic, demographic and developmental problems of the Raji tribe, a primitive and underdeveloped tribal community of Central Himalayan region of India. Rajis, numerically small with a population of 530, is in a phase of transition undergoing changes in prospect of culture, tradition and livelihood pattern. The study also aimed at developing appropriate strategy for the development of the tribe based on existing resource base, ecology and culture.

Objectives

1. To have a complete census of the total population
2. To understand the demographic behaviour
3. To find out socio-economic realities in quantified terms
4. To quantify the level of changes those have occurred under developmental and technological interventions.

Results and Achievements

The Rajis are one of the most under-developed tribal communities of the Central Himalayan region of India. They are facing numerous problems today, in addition to loss of their identity and self-image. The tribe has a declining growth rate in contrast to the high fertility behaviour. The Crude Death Rate of the tribe was about 29 against India's 10.2 and the Infant Mortality Rate was about 192 against India's 91. High Infant Mortality Rate (IMR), Crude Death Rate (CBR) and shorter life span of the females were some factors responsible for decline in population growth rate. The tribe had a low sex ratio (818 females for 1000 males) and it was acute for the population above the age of fifty. Development, in this tribal community, was not appropriate and sustainable for a variety of reasons. The strategy for the development of this tribe 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.

3.4.5. 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. 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. Four villages, so far, have been investigated in Khairna Valley of Kumaun hills of Central Himalayan region of India region. The four villages were selected keeping in view their multi-caste composition, distance from road head, altitude, etc. All the four villages were multi-caste villages, situated within 0-5 km from the road varying in altitudes from 1200 to 1550 m.
2. As many as 130 respondents, out of which 51.22 per cent were from scheduled castes, were covered in the study. Altitudinal effect on fertility was observed, as the total number of conceptions per a mother was 3.41 in Atavirta, the village located at an altitude above 1500 m against that of 3.96 in Jourasi, the village located at the lowest altitude of 1260 m.
3. The effects of literacy on total number of conceptions for mother was very significant. The number of conceptions and well as surviving children for mother was gradually lesser with increase in level of literacy (Table 6).

Table 6. Total numbers of conceptions and surviving children per mother in various literacy groups of respondents

Levels of literacy	*Total respondents*	*Number of conceptions per mother*	*Number of surviving Children per mother*
Illiterate	68	4.29	3.72
0-3 standard	5	4.20	4.20
4-5 standard	32	3.06	2.59
6-8 standard	13	2.69	2.53
9-12 standard	9	1.78	1.67
Graduates & above	3	1.33	1.33
All levels	130	3.58	3.15

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

Background

Given the type of prevailing climatic conditions in the region, certain areas offer adequate scope for both season and off-season vegetable cultivation, which appear to be economically rewarding, in addition to meeting vegetable requirement of the people and thus providing rich minerals and vitamins to the consumers. The change in land use, cropping pattern, socio-economy and environment, which must have occurred, is totally unknown. It is, therefore, important to carry out overall impact analysis of the situation to quantify the positive and negative changes. With this background, a study is being conducted in the Khairna valley having long-term objectives.

Objectives

1. Identifying 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. The settlements in the valley are located within an altitudinal range of 900-2200m asl. Khairna town, a small market centre and

situated about 30 km from Nainital on Haldwani-Almora-Ranikhet motor road, provides necessary facilities to local peoples for transporting and marketing their products to markets like Haldwani, Almora, Ranikhet, Nainital, etc. Though, the settlements have diversified crop mix, all have adopted one or another vegetable crop as their economic base. As many as 19 settlements (about 10% of total settlements), were identified and selected for survey depending upon their accessibility, and altitudinal variation .

2. A total of 425 households from 8 settlements out of selected 19 having a population of 3039 are so far covered in the survey. Main workers constituted 50.15% of the total workers and out of them 75.52 % are engaged in agriculture. Among the agricultural workers, male and female composed 41.88% and 58.12%, respectively.

3. Out of about 217.84 ha of cultivated land, only 24.75% is irrigated. More than half of the cultivated land, i.e., 59.65% is owned by Rajputs. Farmers growing vegetable are 83.76% of total farmers. Average yield of tomato, chilly, cauliflower, potato, bean, capsicum and pea was 100.297 q/ha, 56.083 q/ha, 134.390 q/ha, 66.308 q/ha, 77.167 q/ha, 80.772 q/ha and 64.654 q/ha, respectively.

3.4.7. Performance evaluation of bioengineering treatments for mitigating landslide hazards

Background

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

Objectives

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

Results and Achievements

1. The MRE sites at village Joshiyana and Khoont rehabilitated in 1998 were taken up as study sites. During the field visits it is noted that all of the physical structures excepting one (water collection chamber) are intact and performing their expected duties. The visual observations indicated that the performance of bioengineering works is just satisfactory. It is further noted that the bioengineering works have performed relatively better at village Khoont sites as compared to village Joshiyana sites. This was evident from the survival rate, mortality of various species at different sites recorded for various plant species with average mortality of ~52 per cent at Khoont as against ~78 per cent at Joshiyana (Fig. 18).
2. In order to assess the perception of local inhabitants about principles and practices of MRE, a questionnaire was developed and random survey of 88 and 37 residents of Khoont and Joshiyana village respectively were carried out after one year of implementation of MRE treatments. Together with their background pertaining to gender

Fig. 18. Same site after two years of bioengineering treatment

and literacy, the results were analyzed. Table 7 indicates the perception of people about the various treatments for the MRE field sites and a general glance indicates that people are in favour of MRE.

3. The significance test of responses indicated that the responses for these three questions (1, 7b&c) differ significantly at 5% level of significance village wise. To further understand the specific reasons for variation in responses, village wise responses were categorized under different themes of male versus female, land holding actually affected versus not affected and literate versus illiterate.

Table 7. Peoples' perception about role of MRE and bioengineering at field sites after one year of programme.

	Question	*Response*					
		JOSHIYANA			KHOONT		
		Y[1]	N[2]	C[3]	Y[1]	N[2]	C[3]
1.	Previous experience / exposure of participation in similar activities?	2	35	0	37	51	0
2.	Did you or your immediate family member participate in MRE activities?	22	15	0	38	50	0
3.	Was your land holding also affected?	24	13	0	35	53	0
4.	Do you think concept of MRE should be adopted for hill slope stabilisation?	36	1	0	87	0	1
5.	Your perception of relative importance of following components of MRE						
	a. Only physical structures	0	37	0	11	74	3
	b. Only bioengineering works	1	36	0	11	74	3
	c. Combination of physical and bioengineering	36	1	0	85	0	3
6.	Do you think MRE treatments are performing satisfactorily -						
	a. Physical structures	27	6	4	53	13	22
	b. Bioengineering works	8	22	7	47	13	28
	c. Combination of physical & bioengineering	14	15	8	51	10	27
7.	Practical utility of MRE treatments in -						
	a. Landslide stabilization	36	1	0	87	0	1
	b. Source of fuel / fodder	37	0	0	77	5	6
	c. Income generation	29	5	3	73	3	12
	d. Rehabilitation of the area	32	4	1	73	3	12
	e. Regeneration of natural plant species	34	0	3	77	2	9
8.	Do you think concept and practices of MRE should be replicated?	37	0	0	87	0	1
9.	Do you think MRE treatments are cost effective -						
	a. Physical structures	14	17	6	42	15	31
	b. Bioengineering works	14	17	6	24	18	46
	c. Combination of physical and bioengineering	14	16	7	39	14	35
10.	Do you think approach of MRE is better than that of Line Departments?	22	2	13	52	15	21
11.	Do you think that local inhabitants should be involved in -						
	a. Deciding the programme outline?	30	6	1	61	22	5
	b. Execution of the programme?	30	6	1	55	25	8

Note: [1] - Yes, [2] - No and [3] - Can't say

3.4.8. 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.

Results and Achievements

1. As per the project thrust on MRE evaluations, an important infrastructure like road is selected for investigation. After reconnaissance surveys along different road alignments, a priority was set in terms of volume of traffic, economic/ commercial activities, village/ town settlements and connectivity of important locations.
2. These investigation routes have about 10 active landslides of significantly large dimensions in addition to a number of medium and small landslips, erosion, debris flow and road subsidence sites.
3. Towards Remote Sensing analysis, visual and - digital image processing is underway. Hand held Global Positioning System (GPS) campaigns were undertaken to locate the routes on geo-referenced satellite scenes.
4. Ground Truth Radiometer (GTR) operating in IRS 1C LISSIII compatible visible to near-infrared bands (B2: 520-590 nm, B3: 620-690 nm, and B4: 770-860 nm) has provided spectral reflectance of exposed rock portions. The graph in the Fig. 19, shows spectral reflectance curves of some of the landslide sites.

3.4.9. Impact of Hill Slope Instabilities along Road Network

Please see section on quick appraisal studies.

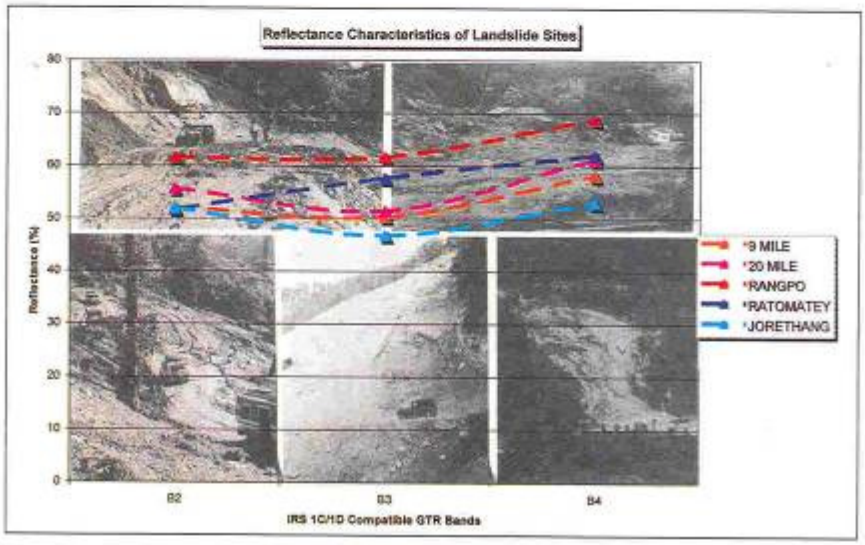


Fig. 19. Reflectance characterization of landslide sites

3.5. ENVIRONMENTAL PHYSIO-LOGY AND BIOTECHNOLOGY

Plants being the primary producers, a thorough understanding of the factors which 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. Microorganisms obtained from various experiments are being maintained using appropriate methods. Nitrogen accretion studies and phosphorus 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, 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, biofencing, protected cultivation, etc. were conducted for betterment of rural people.

3.5.1. Rhizosphere microbiology of Himalayan plants

Background

Plant growth promoting rhizobacteria improve plant growth by colonizing the rhizosphere or rhizoplane or both. The beneficial effects on plant growth due to inoculation of these bacteria have been reported through various mechanisms viz. (i) biological nitrogen fixation, (ii) production of antibiotics and siderophores, (iii) secretion of growth promoting substances including phytohormones, and (iv) solubilization of rock phosphates. The microbial community in an established tree rhizosphere should be more specific owing to the prolonged length of time occupied by the plant species, and due to the interaction amongst various microbial communities. Therefore, identification of existing microbial communities in soil, studying plant-microbe and microbe-microbe interactions, and isolation and selection of beneficial microbes would be highly relevant. The selected beneficial isolates can be developed as inoculants for better plant performance at higher elevations.

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. Microorganisms, isolated from higher altitudes and possessing beneficial properties in terms of disease control and growth promotion have been screened. The selected microorganisms (species of *Bacillus*, *Pseudomonas* and *Trichoderma*) are being tested using appropriate carrier, in view of developing inoculants for colder regions (Fig. 20).
2. Microbial inoculations have been successfully applied for controlling wilt in conifers at nursery stage. Seedlings of conifers and oak are being raised using 'rhizosphere soil' as well as 'microbial inoculants', in view of plantations at degraded sites.
3. Bacterial inoculants have been developed for tea plantations and are in use in tissue culture, cutting and seed raised tea.
4. Microorganisms are being maintained in the culture collection.

Fig. 20. Fungal diversity in *Cedrus-Taxus* forest

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/waste land, 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 & Achievements

1. In vitro propagation protocol for *Rosa damascena* and two orchids namely, *Cymbidium* sp. and *Rhynchostalis retusa* have been developed. About 60% survival has been observed in *R. damascena*.
2. Protocol for in-vitro propagation of *Thamnocalamus spathiflorus* (Trin.) Munro, an evergreen temperate bamboo has been developed (Fig. 21). Following the transfer of in vitro propagated plants into earthen pots and grown under outdoor conditions, gas and water vapour exchange rates were measured at different light levels and compared with seedlings of the same age.
3. In order to identify elite and suitable clones for large scale propagation, plant parts of *Taxus baccata* subsp. *wallichiana* collected from various locations/ populations have been evaluated for taxol and baccatin III contents. Maximum taxol detected in the bark and needle samples were 0.0473% (Jageshwar) and 0.0066% (Khati), respectively. On the other hand maximum baccatin III content found in the bark and needle samples were 0.0066% (Jageshwar) and 0.0030% (Jageshwar), respectively.

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

Background

Rising concentration of atmospheric CO_2 has become a serious global problem because in addition to its effect on growth, physiology and photosynthesis of plants, CO_2 is the most important greenhouse gas that contributes to planet's warming, which is predicted to be greater than at anytime in the last 100,000 years. In this context short-term effects of elevated CO_2 at varying temperature and light level on photosynthetic characteristics in plants from different vegetational zones of Central Himalaya were studied. Since leaf nutrients are of vital importance for the process of photosynthesis and biomass accumulation in plants, and vary along the altitudinal gradient, it is also appropriate to assess how plants with different leaf nutrient status respond to elevated CO_2 at varying temperature and light levels.

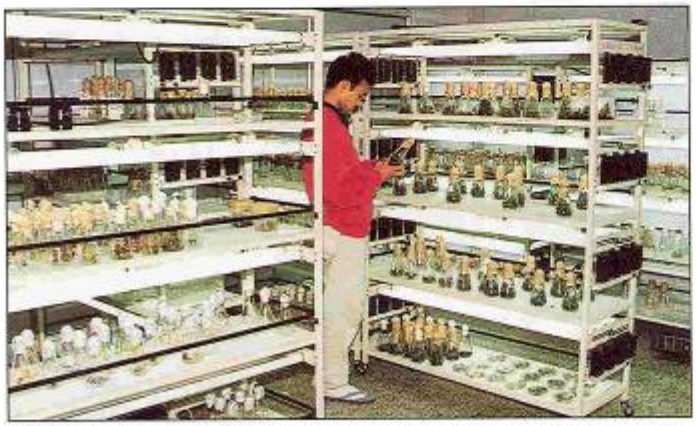


Fig. 21. Routine examination of plant tissue cultures of various Himalayan species grown under controlled conditions in a culture room

Objectives

1. To examine short-term effect of rising CO_2 concentration on physiological attributes of plants.
2. To study the combined effect of rising CO_2 and other environmental factors on photosynthetic characteristics of plants.

Results and Achievements

1. Himalayan vegetation has physiological capacity to exploit high CO_2 concentration. However, species belonging to different vegetational zones differed in the degree of responsiveness.
2. Temperate plants showed higher concentrations of nitrogen, phosphorus and potassium as compared to tropical and alpine plants, suggesting a correlation between the extent of enhancement of photosynthesis due to elevated CO_2 and leaf nutrient status.
3. Total chlorophyll content was also higher in temperate plants than those from tropical and alpine zones.
4. Seasonal and diurnal variation in the atmospheric concentration of carbon dioxide is shown in (Fig. 22). CO_2 concentration was found maximum during the morning and minimum during the afternoon hours. While differences in CO_2 concentrations between morning and evening hours were maximum

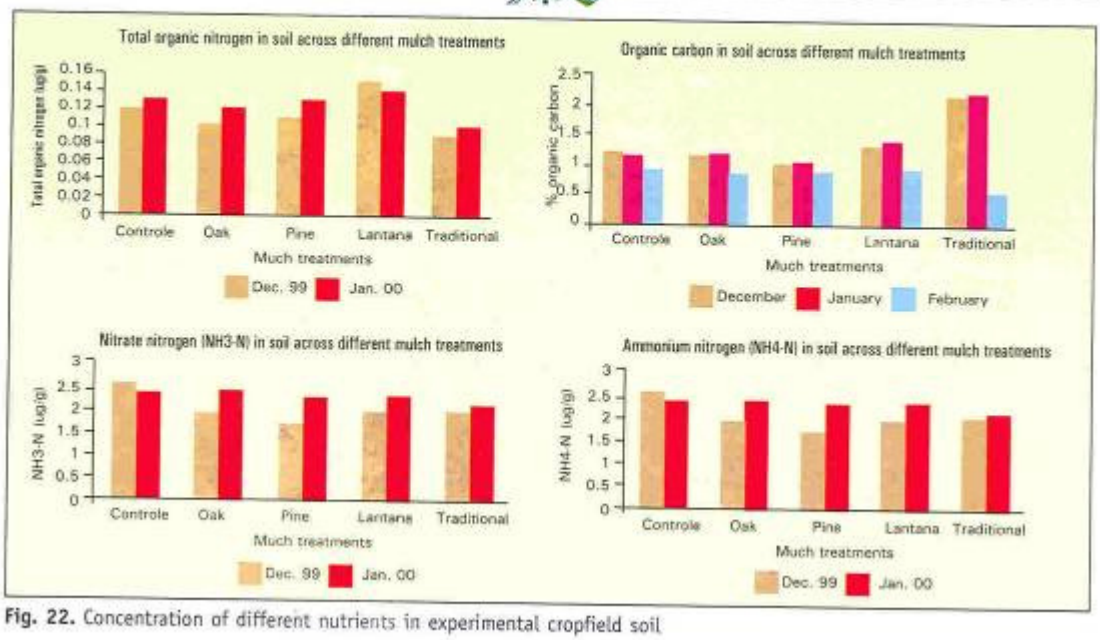


Fig. 22. Concentration of different nutrients in experimental cropfield soil

during July-August, differences became less pronounced during autumn and winter months.

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.

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

In view of the medicinal importance of *Taxus baccata*, phenological studies were taken up to learn about the life cycle events and to understand the best time of harvesting for taxol extraction. These studies were carried out at Jageshwar in the Kumaun Himalaya.

1. Extension of vegetative bud, needle and shoots starts from July end and continues up to the first week of April (following year); there was no significant difference between male and female trees. Life span of needles normally extends up to five years.
2. In the current years shoots, growth in diameter was much rapid up to June but afterwards it was gradual; a slight shrinkage during the winter season was observed. The pattern of diameter growth was similar in older shoots but the rate was relatively lesser.
3. While male cones were visible between July and August, the female cones become visible only during the first week of April of the second year. Seed maturation occurs during September and October of the second year.
4. Shoot biomass of lateral and sub-lateral branches of male or female trees was also determined. Although the values were lower for sub-lateral shoots as

compared to lateral shoots, the difference between male and female trees were not significant.

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.

Results and Achievements

1. In vitro protocols for maggar bamboo (*Dendrocalamus hamiltonii*), dev-ringal (*Thamnocalamus spathiflorus*), tea (*Camellia sinensis*) and Himalayan oaks (*Quercus leucotrichophora florisunda* and *Q. glauca*) have been developed (Fig. 23).
2. In vitro raised plants of tea, maggar bamboo, dev-ringal and oak(s) have been transferred to the field.
3. A simple polypit technology (pit in the ground covered with polythene at the top) was developed for accelerating optimal-growth of tree seedlings all through the year, particularly during the winter months. This condition greatly enhanced growth and substantially reduced nursery time (Fig. 24).
4. Selected antagonistic bacteria are being successfully used for hardening of tissue culture raised tea plants during lab to land transfer.
5. Healthy seedlings of species of *Cedrus* and *Quercus* were raised using rhizosphere soil as a source of inoculum.

Fig. 23. Somatic embryogenesis in Quercus leucotrichophora, a step during *in vitro* propagation

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 project envisages to fill the above gap. The work emphasizes to test the following two hypotheses related to the mechanisms on ecosystem biogeo-chemistry 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 pools, and (2) soil acidification due to rapid accumulation of nutrient cations in biomass may cause soil exchange complex to become more dominated by H^+. *Alnus* has a symbiosis with *Frankia* and is efficient in N_2-fixation. Large cardamom (*Amomum subulatum*), the most important

Fig. 24. Determination of leaf area index using a plant canopy analyzer

perennial cash crop of the Sikkim Himalaya, 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. Soil total-P in the different ages of *Alnus-cardamom* agroforestry and the mix-tree systems varied significantly between stands, seasons and soil types. Total-P values ranged from 0.50-1.18 mg/g soil in *Alnus* stands and 0.85-1.08 mg/g soil in mix tree species stands. Mix-tree cardamom agroforestry system (5.6-32 mg/g soil) showed lower available-P than *Alnus* cardamom stands.
2. Microbial-P biomass values varied significantly between stands, seasons and soil types. Across the sites mean annual microbial-P biomass ranged from 17-74 mg/g soil in *Alnus* stands and 13-38 mg/g soil in Mix-tree stand. The oxalate concentration in the different ages of *Alnus*-cardamom system varied significantly between stands, seasons and soil types (Fig. 25).
3. Pooled data of microbial-P biomass and available-P from all ages of *Alnus* stand showed higher values when compared with non-N_2-fixing mixed tree stand. N_2-fixing *Alnus*-cardamom stand was more dynamic in terms of microbial-P and available-P.

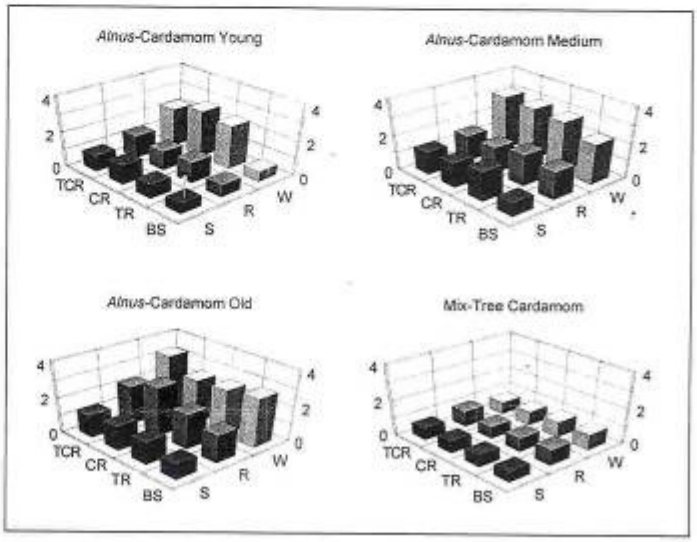


Fig. 25. Seasonal variation in oxalate (mg/soil) between soil types (rhizospheric and bulk) of different age *Alnus*-cardamom and Mix-Tree Cardamom stands. W=winter, S = spring, R=rainy; BS=bulk soil, TR=tree rhizosphere, CR=cardamom rhizosphere, and TCR=tree + cardamom rhizosphere

3.5.7. Farmers Centered Agricultural Resource Management (FARM) Programme: Khulgad Watershed (Mountain site in India)

(Summary of Completed Project)

Background

Like in other parts of the Himalayan region majority of population (about 70%) of U.P. Himalaya is engaged in agricultural and allied activities. However, due to limited irrigation, marginal and scattered landholdings, lack of technical know-how, lower crop productivity, etc. agriculture does not provide income generating opportunity to the farmers. As a result substantial number of able bodied men migrate to other parts of the country in the lookout for employment opportunities. In the above context, the work was sponsored by Soil Conservation section of the *Krishi Nideshalaya* for Hill through Soil Conservation Department Almora, under the Farmer's Centered Agricultural Resource Management (FARM) Programme of FAO through the Ministry of Agriculture, Govt. of India for developing a sustainable and realistic, eco-friendly alternate model for sustainable development of the region.

Objectives

1. To demonstrate simple, cheap and replicable technologies in the watershed.
2. To improve the quality of life of the people living in the area through efficient management of resources and to sustain optimum yield over a period of time.
3. Documentation of the existing germplasm and conservation practices.

Results and Achievements

This model has been designed and developed with the aim of bringing change, over a period of time, leading to improvement in the economic status of the inhabitants, generation of employment, reduction of environ-mental degradation and promotion of sustainable use of resources. Only limited activities could be carried out due to lack of sufficient time. However, most of the technologies have been provided to the farmers and general awareness has been increased. Training, interaction and demonstration of various eco-friendly techniques have enhanced the level of awareness considerably among the village folk. The majority of cultivators living in the watershed and surrounding area have shown interest in the adaptation of demonstrated technologies. A large number of households are continuously demanding plant material/saplings of superior quality, polythene for polyhouses and polypits, bio-composting pits, and seeds of high yielding varieties of vegetables, etc (Fig. 26).

Fig. 26. Field plantation of broom grass, an important fodder and soil binding species

3.5.8. Productivity, energetics and maintenance of soil fertility in Agroforestry Systems of Sikkim

Background

In Sikkim, there are mainly three types of agroforestry systems, i.e. (i) large cardamom based, (ii) mandarin orange based, and (iii) fodder-fuel tree based. Large cardamom (*Amomum subulatum*) is the most important perennial cash crop of the Sikkim Himalayan region that is cultivated in 26000 ha of Sikkim and Darjeeling between 600-2000 m elevation. 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. Large cardamon agronomic yield was highly dependent on climate and rainfall. It was highest at the 20-year stand that ranged from 400 to 700 kg/ha and the lowest at the 5-year stand. On the basis of agronomic yield *Alnus*-cardamom plantations were doing well up to little more than 20 years age. Net energy fixation increased with plantation age to peak at 15-years stand thereafter decreased with age (Table 8).
2. Soil pH of the upper soil horizon was always smaller than the lower soil layer. It was highest in 5-year stand and decreased with age thereby causing acidity.
3. Soil organic carbon accretion in the age sequence of *Alnus*-cardamom agroforestry ranged between 85 Kg/ha in 5-year (lowest) to 116 mg/ha in 15-year (highest) plantation stand.
4. A marked seasonality in the rate of nitrification was observed and nitrate level was recorded maximum in the winter season with a substantial decrease in rainy and spring seasons after 14 days in situ field incubation. Net nitrification rates varied significantly between seasons and stand ages and ranged between 7-22 mg/g, 4-10 mg/g and 2-4 mg/g during winter, spring and rainy seasons, respectively.

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

Background

The Department of Biotechnology (DBT) sponsored a multi-institutional project on bioprospecting of biological wealth, concerned with application of conventional, molecular and flow cytogenetics approaches to fingerprint chromosomes for systematic, analytical and transparent investment in conservation and sustainable use of biodiversity programmes of high priority endangered species like *Valeriana jatamansi, Rheum emodi, Gentiana kuroo, Coptis teeta, Aconitum species, 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 in Solan (H.P.) and another at GBPIHED, Kosi-Katarmal, Almora.

Objectives

1. Plant collection, herbarium vouchers, initial field notes and ethnobotanical data.
2. Storage of DNA rich materials.
3. Preliminary cytological studies.

Table 8. Energy storage, fixation, allocation, heat sink realease and exit, and net ecosystem increment in an age series of *Alnus*-cardamom plantation stands.

Particulars	*Plantation age (year)*					
	5	10	15	20	30	40
Energy storage ($x10^6$ KJ ha^{-1})	1053	1435	2341	2288	2291	2635
Net energy fixation (x 10^6 KJ ha^{-1})	322	389	444	305	261	154
Energy allocation in agronomic yield (x 10^6 KJ ha^{-1} $year^{-1}$)	2.19	4.47	6.02	7.05	3.40	0.78
Heat sink (x 10^6 KJ ha^{-1} $Year^{-1}$)	171	228	299	259	226	116
Energy release and exit (x 10^6 KJ ha^{-1} $year^{-1}$)	171	284	355	277	248	144
Net ecosystem energy increment (x 10^6 KJ ha^{-1} $year^{-1}$)	150	105	89	27	12	9

4. Breeding systems and phytochemical work

Results and Achievements

1. In continuation to the ongoing programme on germplasm collection, additional plant material of target species was collected during this year from alpine and subalpine regions of Kumaun and Garhwal Himalaya.
2. In vitro propagation protocols have been developed for large scale multiplication of *P. hexandrum*, *Podophyllum kurrooa* and *Aconitum balfourii*.
3. Vegetative propagation methods have been developed for *P. hexandrum*, *A. balfourii* and *P. kurrooa*.
4. Basic chromosome counts were made for *A. violaceum*.
5. Podophyllotoxin analysis showed marked variation (0.05 to 2%, on % dry wt. basis) among various population of *P. hexandrum* collected from different locations in Kumaun and Garhwal Himalaya.

3.5.10. Standardization of Hardening System for Transfer and Establishment of Planting Material of Selected Multipurpose Trees for the Waste and Marginal Lands of Central sub Himalayan Hills

Background

Hardening of *in-vitro* raised plants and their subsequent performance in the field condition are the most important factors determining the success of *in-vitro* protocols. The study aims to optimize the hardening process of selected multipurpose trees (MPTs) and also standardize their performance in field conditions. This will not only help the mountain people to augment their day to day requirements of fuel wood and fodder but also, importantly, explore possibilities of income generation. Besides the advantage of increasing productivity, the study will also popularize the techniques among rural mountain inhabitants.

Objectives

1. To monitor the survival and growth performance of *in-vitro* raised plantlets during hardening process.
2. To establishing *in-vitro* raised high yielding superior plant material initially in experimental plots in arboretum.
3. To scale up production of plant material developed through *in-vitro* and conventional means.

Results and Achievements

1. Experiments were conducted during multiplication and rooting stage to enhance the *ex-vitro* survival percentage of the *Sapium sebiferum*. Intervention of sucrose concentration in the medium increased *in-vitro* as well as *ex-vitro* survival.
2. Experiment was conducted to compare the percent survival and growth performance of in vitro with conventionally (*ex-vitro*) raised (through seed) plantlets of *Sapium sebiferum*. One year observation revealed that during the first part of the experiment (up to October), the *ex-vitro* raised plantlets performed better in terms of plant height and leaf number.
3. To standardize the suitable ex vitro condition for micropropagated plants, twenty four fully acclimatized plantlets (three month old) were kept under three different environmental conditions (i.e., nursery, shade house and glass house) for one year. Plantlets showed relatively better growth performance in glass house condition compared to nursery and shade house condition.
4. Plants obtained through various experiments were established in experimental plots in Arboretum for monitoring further growth performance. By adopting various methods for optimization of the best condition for maximum survival percentage and growth of plantlets, 250 *in-vitro* raised high yielding plant material of *Sapium sebiferum* and 80 plantlets of *Bauhinia vahlii* were produced. These plantlets are ready for the plantation in the marginal lands.

3.5.11. 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, analyse inter-population variability and evolve conventional and *in-vitro* methods of propagation of selected (i.e., *Angelica glauca*, *Swertia angustifolia*, *Arnebia benthamii* and *Saussurea obvallata*) species in west Himalaya.

Objectives

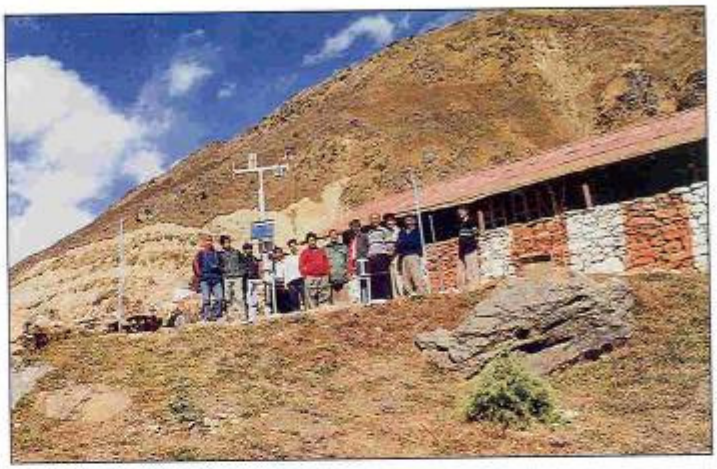
1. To quantify and assess population size of selected species in natural habitat
2. To analyze morphogenetic variability in selected species
3. To identify constraints in conventional methods of propagation
4. To develop *in-vitro* propagation protocols in selected species particularly those of narrow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

Results and Achievements

1. Over forty percent of potential high altitude sites in Kumaun and Garhwal have been covered to identify the locations of three target species. Four populations of *Arnebia benthamii* (1- Kumaun and 3 - Garhwal), Six of *Angelica glauca* (4 - Kumaun and 2 - Garhwal) and five of *Saussurea obvallata* (2 - Kumaun and 3 - Garhwal) were identified. Also, 4 populations of *Swertia angustifolia*, in relatively lower altitudes of Kumaun have been located.
2. Assessment of populations for availability and morphological variability is under progress.
3. Studies in genetic variability have been initiated in *Swertia angustifolia* and *Saussurea obvallata* using SDS - PAGE and isozyme analysis.

Experiments for micropropagation of selected species are under progress.

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' perception of environment and development activities are considered important for involving them in the effective management of natural resources. The Core (INHI) of the Institute serves as a nodal point for networking with associated Institutions/Universities/NGOs/Voluntary agencies working on problems relevant to the Indian Himalayan region. Based on the recommendations of the Project Evaluation Committees 12 projects were sanctioned and funded during the year. Environmental awareness on various aspects of the Himalayan environment and development was created among the people/organizations/ NGOs during the year by organising various meetings with the people/ organizations, etc.

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

Based on the recommendations of the Project Evaluation Committee(s), following seven projects (four to NGOs, two to Universities and one to Govt. Institution/Autonomous Organization) were sanctioned and funded during the year 1999-2000.

1. Development of ecologically sound integrated techniques for the management of tea pests in H.P. by Dr. N.P. Kashyap, Department of Entomology, H.P. Krishi Vishvavidyalaya, Palampur, H.P. [Total outlay : Rs. 3,32,315/-].

2. Inventory, biodiversity value, status and strategies for conservation of sacred groves of Manipur by Dr. M.L. Khan, Department of Forestry, North Eastern Regional Institute of Science & Technology, Nirjuli, Arunachal Pradesh. [Total outlay : Rs. 4,63,560/-].

3. Participatory action plan for ecodevelopment : Convergence of services approach for income generation by Dr. C. Shastri, Himalayan Action Research Centre (HARC), Indira Nagar, New Forest, Dehradun, U.P. [Total outlay : Rs. 1,87,000/-].

4. Investigation on water pollution in Kosi catchment area, Almora by Dr. R.D. Khulbe, Central Himalayan Environment Association (CHEA), Nainital, U.P. [Total outlay:Rs. 4,85,240/-].

5. Sustainable development approach for trekking tourism promotion in Chamoli district of Garhwal Himalaya by Dr. S.C. Bagri, Department of Tourism and Hoteliering, HNB Garhwal University, Srinagar, U.P. [Total outlay : Rs. 3,56,845/-].

6. Promotion of fish rearing in outer Himalayan villages : Technology transfer to bring economic development and generate employment for women by Dr. A.S. Rautela, Society for Environment and Employment Development (SEED), Kotdwara, U.P. [Total outlay : Rs. 4,59,000/-].

7. Resource assessment and biodiversity characteristics of fish fauna of the Bhagirathi and Yamuna catchment system with in Garhwal Himalaya by Dr. B.D. Joshi, Indian Academy of Environmental Sciences (IAES), Hardwar, U.P. [Total outlay : Rs. 4,47,879/-].

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

1. Twenty seven (27) fresh project proposals, which were received in IERP format during the year for funding, were screened carefully and subsequently processed/referred for preliminary evaluation to the subject experts. Four fresh project proposals were also returned directly to the PIs for necessary action. In addition to the above, follow-up action on the recommendations/decisions of the ninth (IX) PEC meeting, which was held at the Headquarters of the Institute on 12 March 1999, was also completed during the year.

2. Funds for thirty (30) ongoing/completed projects were released during the year after careful examination of the Utilization Certificates and Statement of Expenditures. First instalment of grant of seven (7) newly sanctioned projects was also released during the year.

3. Annual Progress Reports (APRs) of seventeen (17) on-going projects were processed for evaluation and referred to the subject experts. Subsequently, the comments of the subject experts (as obtained in most of the cases) were communicated to the concerned PIs for follow-up action. Progress of one field oriented project was also monitored by an expert committee and the observations were sent to the concerned PI for further necessary action.

4. Final Technical Reports (FTRs) of twelve (12) projects 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. The executive summaries of all the 12 completed projects were submitted to the SIC, ENVIS for the favour of publication in the ENVIS Bulletin of the Institute. During the year, five (5) executive summaries were published by the ENVIS Centre of the Institute in its ENVIS Bulletin [No. 7(1) and 7(2)] and subsequently the issues of the bulletin were distributed to the various organisations/user agencies.

5. Follow-up action on almost one hundred and seven (107) project files (old/fresh/on-going, etc.)

was initiated/completed during the year. Financial targets/ objectives set for the IERP were also achieved successfully during the year 1999-2000. Out of Rs. 40,92,092=86, only 86 paise remained unspent as on 31 March 2000.

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 R&D activities and afforestation programmes of the Institute. Out of 4,300 seedlings/ cuttings of various trees/shrubs, which were available in Central nursery up to 31 March 1999, only 3,000 seedlings/cuttings of 16 trees/ shrubs survived at the nursery (1,120m amsl) in Kosi up to 31 March 2000. During the year, seeds of ten (10) promising mountain trees (namely, *Aesculus indica, Alnus nepalensis, Dalbergia sissoo, Ehretia laevis, Emblica officinalis, Grewia oppositifolia, Leucaena leucocephala, Quercus leucotricophora, Quercus semecarpifolia* and *Thuja orientalis*) were collected in large quantities from time to time and subsequently sown in the nursery beds/seedlings trays/polybags at the nursery. Almost 1,200 cuttings of four (4) promising mountain 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, eighteen thousand and four hundred (18,400) seedlings of 20 promising mountain trees/shrubs (namely, *Aesculus indica, Alnus nepalensis, Bauhinia variegata, Celtis australis, Cupressus torulosa, Ehretia laevis, Emblica officinalis, Grevillea robusta, Grewia oppositifolia, Jacranda mimosifolia, Leucaena leucocephala, Ligustrum nepalense, Melia azedarch, Prunus cerasoides, Quercus floribunda, Quercus glauca, Quercus leucotricophora, Sapindus mukorossi, Thuja orientalis* and *Toona ciliata*) were also raised in the nursery during the year. Out of the raised cuttings/ seedlings (i.e. 19,600), two thousand and five hundred five (2,505) seedlings/cuttings of various species were did not survive up to 31 March 2000 at the nursery. During the year, eight hundred and sixty (860) seedlings/cuttings of 15 trees/shrubs were distributed, free of cost, to the farmers, rural women, students and NGOs for plantation purpose in mid altitude areas. However, four thousand and three hundred twenty (4,320) seedlings/cuttings of 13 trees/shrubs were used directly for plantation purpose by the Institute in and around of its old and new premises. The nursery at the Kosi campus of the headquarters was also remained income generating during the year by the sale of one hundred (100) seedlings/cuttings of 7 promising mountain trees/shrubs. As on 31 March 2000, fourteen thousand and eight hundred fifteen (14,815) seedlings/cuttings of 24 species were available in the Central Nursery.

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 (eighth of its kind) on nursery development, tree plantation techniques and natural resource conservation and management was organized from March 28 to 30, 2000 at Shama village (District - Bageshwar) of Uttar Pradesh. The target groups included farmers, rural women, students, ex-service army personnel and NGOs. Fifty two (52) participants from Bageshwar district attended this short term on-site training programme. The participants were trained by the staff and identified resource persons. Training material was also distributed to the trainees by the staff. Demostrations of different technologies during the occasion of the above mentioned training programme were highly appreciated by the participants. In addition to the above, two on-site training programmes, specifically for farmers and rural women, on farm based techniques (polyhouses, polypits, biocompost, biofertilizer and water harvesting, etc.) were also organized from 12th to 13th November 1999 at Bagri village and from 15th to 16th November 1999 at Doba village of Bageshwar district. Fifty six (56) farmers including rural women were trained during the occasion of these two short term training programmes. The techniques demonstrated by the staff at the above mentioned places/sites are now being adapted/adopted by the farmers of nearby villages for their economic upliftement. Visits of a group of farmers from Laubanj and Shauli villages to Doba and Majherchaura villages of Bageshwar district were also arranged on 21-22 September 1999 to facilitate on exchanging their views and experiences on the aspects of indigenous practices, natural resource conservation and management, water harvesting and conflicts resolution systems etc (Fig 27).

3.6.4. Dissemination of Information through Networking

This activity envisages to disseminate R&D inputs of the

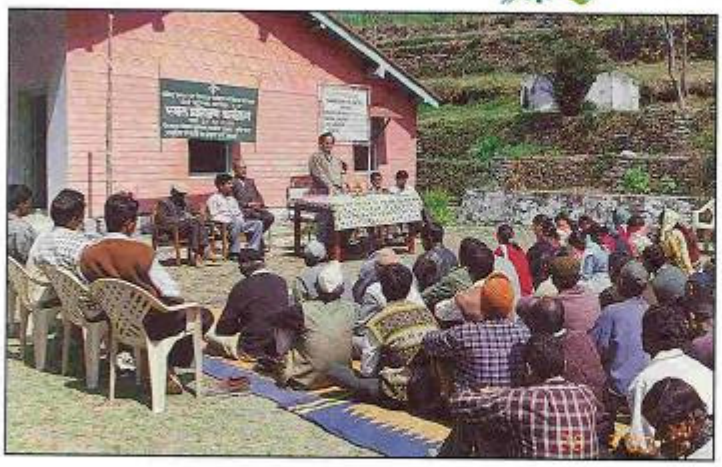
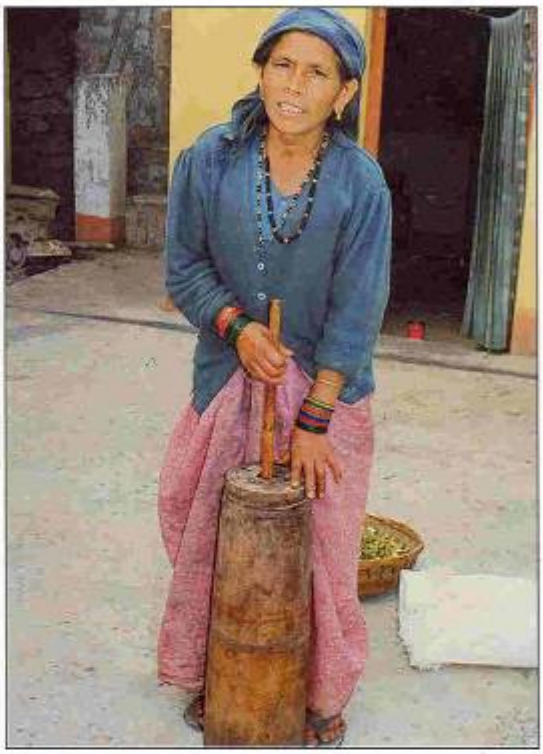


Fig. 27. Environmental awareness training programme

Institute, through its regular in-house publications [namely, Hima-Paryavaran (a biannual newsletter) and Institute Annual Report], to the various academic/scientific/Govt. departments, NGOs and individuals working on the various aspects of mountain environment and development. During the year, three volumes of Hima-Paryavaran [10(2), 1998; 11(1), 1999 and 11(2), 1999] and Institute's Annual Report (1997-98) were distributed to almost 597 individuals/subject experts working on various aspects of mountain environment and development at various academic and scientific institutions including government departments and NGOs, etc. Institute's folders /leaflets/annual day lectures/other publications were also distributed during the year to almost 2,050 individuals at the occasion of various workshops/ seminars/ meetings.

3.7. INDIGENOUS KNOWLEDGE SYSTEMS



Mountain cultural heritage and traditional knowledge systems play significant role in sustainable use, management and conservation of resources. Re-strengthening 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.

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

Background

Native people inhabiting 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, 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 Achievements

1. Wool and woolen products form an integral part of high altitude society, and various indigenous practices associated with the woolen products have been documented. The traditional techniques of wool shearing, cleaning, spinning, processing and dyeing have been documented (Fig. 28).

Fig. 28. Indigenous method of wool processing and dyeing

2. The traditional knowledge of wool dyeing using natural vegetation as colouring agent was quite common in the high altitude Bhotiya community. But, the readily availability and regular supply of synthetic dyes in the markets of Munsyari had introduced the use of synthetic dyes. It was found that due to the economic reasons, synthetic dyes had taken the market of wool dyeing, and had almost replaced the use of natural dyes in the Munsyari region of Pithoragarh district.
3. The study has documented the indigenous methods of making colourful dyes for colouring of their traditionally processed wool (Fig. 29), which involves the use of various plants parts of different species ranging from herbs to large trees to make the base colours.

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,

Fig. 29. Traditional method of making woolen garments

varied topography, and 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 and explained.

Objective

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

Results and Achievements

1. This activity has been just initiated, and documentation and survey works are in progress in the Central Himalayan region.
2. In the rainfed conditions of Kumaun region, farmers practice a fallow system to increase fertility of soil. In this system a cropfield yields three crops in two years. After harvesting crops of rainy season, cropfield remains fallow during winter season and subsequently crops of next rainy season are being cultivated. Various attributes of this fallow system are under observation (Fig. 30).

Fig. 30. Traditional use of solar energy for vegetable drying

QUICK APPRAISAL STUDIES

Impact of Hill Slope Instabilities along Road Network

Background

The constraints of difficult terrain, physiographic features, climatic variability and natural calamities in the form of landslides, earthquakes, cloud bursts, etc., pose threats to the road network of the Himalayan region. The severity could be judged from the fact that: (i) Annually Rs. 350 million are lost due to failure of transport and communication network. (ii) More than 50 per cent of landslides are due to road construction alone. (iii) The incidence of landslide increases by 25 to 345 times due to road construction activity. (iv) Each kilometre of road requires displacement of 40 to 80 thousand cubic metre of debris.

Objectives

1. To record the incidences of hill slope instabilities along road segments,
2. To identify the causative factors of these instabilities and document the remedial measures adopted from time to time, and
3. To suggest suitable remedial measures.

Results and Achievements

1. In Kumaun region comprising of districts Almora, Pithoragarh and Nainital districts of Uttar Pradesh, extensive survey along the road network has been carried out. The region, accounts almost for all type of physiographic, geologic, climatic and ecologic variations found in the region. Road segments of 2 kilometres length were identified in various altitude zone along the roads network of the region for various kinds of alignment, viz. ridge, valley and along the slope. To study the incidences of hill slope instabilities, their causative factors, etc., field surveys were conducted.
2. Table 9 provides a summary of important findings of the field survey regarding the average number of unstable sites, non-functional culverts, subsidence sites, etc. The information has

been categorised according to alignment of the road segment. It is, generally believed that ridge alignment has advantages over other alignments and this can be seen that at least from hill slope instabilities point of view, ridge alignment is preferable.

Table 9. Hill slope instabilities along road network of Kumaun region

	Road segment	*ALIGNMENT*		
		Along the slope	Ridge	Valley
1	Number of road surveyed	10	7	4
2	Length of road surveyed, km	28	20	18
3	Elevation range, m above msl	1230-1980	1410-2225	1150-1400
4	Average number of land slips per km, upstream of road	1.32	0.47	2.35
5	Average number of road side cutting / subsidence sites, per km	0.24	0.11	0.39
6	Average number of unstable slope, per km	1.56	0.58	2.74
7	Average slope at unstable site	54°	59°	58°
8	Average number of natural cross drainage works, per km	3.1	2.4	3.5
9	Average number of culverts, per km	4.35	4.86	4.18
10	Average number of culverts (non-functional), per km	0.63	1.02	0.45
11	Average number of culverts closed/ choked, per km	0.22	0.47	0.56
12	Av. No. of sites where slope is unstable below culvert, per km	3.28	3.66	3.63
13	Average number of passing places, per km (only in single lane)	4.53	4.68	4.47

4. MISCELLANEOUS ITEMS

4.1. Addition to the Library

With an addition of 862 books during the financial year 1999-2000, the total number of books available in the Library, is 9820. A total of 139 periodicals (Foreign/Indian) are being received in the library including some periodicals subscribed by the ENVIS Centre on Himalayan Ecology at the Institute. Library databases have been updated by using the Network Version of the Software PALMS (Prasad Automated Library Management Systems) and Computerized Current Awareness Services (CAS) Selective Dissemination of Information (SDI) Services are being provided. Library has also started Abstracting Services by using the Abstract Module of the PALMS. Thirteenth and Fourteenth volumes of Published Research Papers, Popular Articles, and Books have been compiled and Bibliography (1989-99) has been updated. New Arrivals and Articles Alert Services are being provided regularly. Library is also receiving some books from some national and international organizations as complimentary/ gratis or exchange.

4.2 Membership of Professional Societies/Committees

Member, Central Himalayan Environment Association (**S.K. Nandi & S.C. Joshi**)

Member, Commonwealth Forestry Association, U.K. (**R.K. Maikhuri & G.C.S. Negi**)

Member, Ecological Society of America, USA (**S.C. Rai & S. Sharma**)

Member, Environmental Protection Society, Darjeeling (**Uma Shankar**)

Member, Himalayan Phytochemical Association, H.P. (**H.K. Badola**)

Member, International Association of Landscape Ecology (**S. Sharma**)

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

Member, International Association of Plant Tissue Culture and Biotechnology (**L.M.S. Palni & Anil Kumar**)

Life Member, National Institute of Ecology, New Delhi (**P.P. Dhyani & A.P. Krishna**)

Life Member, Indian Anthropological Association (**P.K. Samal & N.A. Farooquee**)

Life Member, Indian Fern Society (**S.S. Samant**)

Life Member, Indian Association of Soil & Water Conservationists (**Uma Shankar**)

Life Member, Indian Institute of Public Administration, New Delhi (**U. Dhar**)

Life Member, Indian Science Congress Association (**Anita Pandey, P.K. Samal & S.C. Joshi**)

Life Member, Indian Society of Ecological Economics, N. Delhi. (**D.K. Agrawal & A.P. Krishna**)

Life Member, Indian Society for Human Ecology (**P.K. Samal & N.A. Farooquee**)

Member, International Society of Plant Morphologists, Delhi (**H.K. Badola**)

Life Member, Indian Society of Seed Technology, New Delhi (**R.S. Rawal**)

Life Member, Indian Academy of Social sciences (**D.S. Rawat**)

Life Member, Sikkim Science Society (**Anita Pandey & S. Sharma**)

Life Member, Society for Biological Chemists-India (**S.K. Nandi & Anil Kumar**)

Life Member, Society of Ethnobotanists (**S.S. Samant**)

Life Member, U.P. Association for the Science & Technology Advancement (**S.K. Nandi**)

Member, The Medplan Conservation Society, Bangalore (**H.K. Badola & Uma Shankar**)

4.3 Award/Honour

Vishist Vaigyanik Puraskars for the year 1996-97 and 1997-98 awarded by the Ministry of Environment & Forests, Govt. of India (in 1999-2000) and presented by the Hon'ble Prime Minister, Shri Atal Behari Vajpayee for outstanding research contribution (**S.K. Nandi; R.K. Maikhuri & R.C. Sundriyal**).

INSA Young Scientist Medal 1999, Indian National Science Academy, New Delhi (**Uma Shankar**)

Elected Fellow, The National Academy of Sciences, India (**Eklabya Sharma**)

Indian Council of Forestry Research & Education Cash Award (1996-97) for excellent research contribution in the area of Forest Conservation (**L.M.S. Palni, S.K. Nandi, Anita Pandey, H.C. Rikhari, S. Sharma & M. Nadeem**)

4.3.1 Referees to Journals

Nominated as Associate Editor "Tropical Ecology" a Journal of International Society of Tropical ecology w.e.f. 1999 (**U. Dhar**)

4.4.1. Scientific Papers

(I) Scientific Journals

Dhar, U. & J. Upreti (1999) In vitro regeneration of a mature leguminous liana (*Bauhinia vahlii* Wight & Arn.). *Plant Cell Report*, **18**: 664-669.

Dhar, U., Y.P.S. Pantey & A. Tewari (1999) Seed deterioration studies in Indian butter trees (*Aisandra butyracea* (Roxb.) Baehni). *Seed Sci. & Tech.*, **27**:963-968

Farooquee, Nehal A. & S. Sharma. (1999) Development and the marginalization of traditional knowledge and societies in high hills of Central Himalaya. *Journal of Human Ecology*, 10 (5&6) : 407 – 413.

Farooquee, Nehal A. & K.S. Rao. (1999) Conservation and utilization of indigenous cattle and livestock among the transhumant pastoralists of Kumaun Himalaya (India). *Journal of Environmental Systems*, 27(4) : 311-323.

Jain, A., S.C. Rai, J. Pal, & E. Sharma (1999) Hydrology and nutrient dynamics of a sacred lake in Sikkim Himalaya. *Hydrobiologia*, 416: 13-22

Kumar, K & G.S. Satyal (1999) Cost analysis of losses caused by the Malpa landslide in Kumaun Himalaya; A basic framework for risk assessment, *Current Science*, 77 (8) : 1023 -1028.

Kumar, A., A. Sood, **Palni, L.M.S.** & Gupta, A.K. (1999). In vitro propagation of *Gladiolus hybridus* Hort: Synergistic effect of heat shock and sucrose on morphogenesis. *Plant Cell, Tissue and Organ Culture*, 57: 105-112.

Kuniyal, J.C. & A.P. Jain (1999). Public involvement in environmental assessment of solid waste management in UP Himalayan Tourists treks, India. *Environmental & Waste Management*, 2 (4): 279-291.UK

Maikhuri, R.K., K.S. Rao, K.G. Saxena & **R.L. Semwal** (1999). Traditional crops in the Central Himalaya. *Plant Genetic Resources Newsletter (IPGR)*, 120: 1-7.

Maikhuri, R.K., K.S. Rao, K.G. Saxena & **R.L. Semwal** (1999). Traditional crops-diversity based nutrition and the prospects for sustainable rural development in the Central Himalaya. *Himalayan Paryavaran*, 6: 36-42.

Maikhuri, R.K., R.L. Semwal, K.S. Rao, K. Singh & K.G. Saxena (2000). Growth and ecological impacts of traditional agroforestry tree species in Central Himalaya, India. *Agroforestry Systesms* 48: 257-272.

Nadeem M., L.M.S. Palni, A.N. Purohit, **H. Pandey, & S.K. Nandi** (2000) Propagation and conservation of *Podophyllum hexandrum* Royle: an important medicinal herb. *Biological Conservation*, 92:121-129

Pandey A., A. Durgapal , M. Joshi and **L.M.S. Palni** (1999) Influence of *Pseudomonas corrugata* inoculation on root colonization and growth promotion of two important hill crops. *Microbiological Research*, 154, 259-266.

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.

Rao, K.S., R.K. Maikhuri, & K.G. Saxena (1999). Participatory approach to rehabilitation of degraded forest lands: a case study in high altitude village of Indian Himalaya. *International Tree Crops Journal*. 10: 1-17.

Samal, P.K., R. Fernando and **D.S. Rawat** (2000). Influences of economy and culture in development among mountain tribes of Indian Central Himalaya. *International Journal of Sustainable Development & World Ecology*, 7 (2000): 41-49.

Samal, P.K., Y.S. Topal, & Pushpa Pant (1999). Socio-econmic and Demographic Behaviour of Van Rajis: A Primitive and Nomadic Tribe in Central Himalayan region of India. *Man In India*, 79 (3&4): 241-252.

Saran, S., S. Sharma & P.S. Roy (2000) Extraction and refinement of landuse/ landcover information from sattelite digital data using Fast Fourier Transformation in spatial frequency domain. *Current Science*, 78 (1) : 87-90.

Sharma, S., H.C. Rikhari & L.M.S. Palni (1999) Conservation of natural resources through religion : a case study from Central Himalaya. *Society and Natural Resources*, 12 : 599-612.

Siril, E.A. and P.P. Dhyani (1999) Analysis of genetic stability of in-vitro raised *Sapium sebiferum* plants using isozyme expression. *Physiol. Mol. Bio. Plants*, 5 : 73-76.

Sundriyal, M., R.C. Sundriyal, E. Sharma & A.N. Purohit (1999). Wild edibles and other useful plants from the Sikkim Himalaya, India. *Oecologia Montana* 6: 1-14.

(II) Chapters in books/ Proceedings

Agrawal D.K. & **H.C. Rikhari** (1999). Bioengineering Techniques for Slope Stabilisation and their Performance Evaluation - The State of Art. In : *Final Report of the Task Force of Department of Science and Technology on Geotechnical Investigations of Landslides.*

Joshi, S.C. & L.M.S. Palni (1999). Combined effects of low temperature and dew formation on CO_2 assimilation and relative water content of two evergreen plants. *Proceedings of National Symposium on Plant Physiology and Biochemistry in Relation to Agriculture and Environment*, pp 12.

Joshi, S.C. (1999). Influence of growth regulators and phenols on the IAA-catabolic enzymes of normal and gall tissues of *Cinnamomum tamala* Fr. Nees in culture. *Proceedings of National Symposium on Role of Plant Tissue Culture in Biodiversity Conservation and Economic Development*, pp 72.

Joshi, V., A. Naithani & **G.C.S. Negi** (1998). Study of landslides caused by natural and anthropogenic reasons in Garhwal Himalaya. *Proceedings of National Conference on Disaster and Technology*. Manipal Institute of Technology, Manipal, pp. 48-54.

Kimothi, M.M., J.K. Garg, V. Joshi & A. Naithani (1999). *Chamoli earthquake and its impact assessment using IRS 1C/1D data.* Space Applications Centre, Ahmedabad. SAC/RESA/FLPG-ED/05/1999. 22 p.

Kimothi, M.M., J.K. Garg, V. Joshi, R.L. Semwal, R. Pahari & N. Juyal (1999). *Slope activation and its impact on the Madhamaheshwar and Kaliganga sub-watersheds, Okhimath using IRS-IC/1D data.* Space Applications Centre, Ahmedabad. SAC/RESA/FLPG-FED/SR/04/1999. 42 p.

Kumar, K. & G.S. Satyal (1999) Chemistry of Drinking Water Resources in Almora District of Kumaun Himalaya, India. Proceedings of National Conference on Water Quality Management. New Delhi pp. 10-27.

Kumar, K. & **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.

Krishna, A.P. (2000). *Land/Use/Cover Status Assessment Using Remote Sensing (RS) and Geographical Information System (GIS) Approach*. In: Natural Resources' Conservation and Management for Mountain Development (Eds. S C Tiwari and P P Dabral), International Book Distributors, Dehradun. pp. 195-211.

Krishna, A.P. (2000). *Landslide hazard, vulnerability and risk assessment in parts of the Sikkim Himalaya – a GIS based approach.* In: Proc. of International Workshop-cum-Training Programme on Landslide Hazard & Risk Assessment and Damage Control for Sustainable Development.UNDP Umbrella Programme, N. Delhi. pp. 162-168.

Krishna, A.P. (1999). *Snow cover and glacier assessments in parts of the Sikkim Himalaya by remote sensing and GIS*, In: Proc. NSSW'99 National Snow Science Workshop (October 28-30, 1999) at SASE (DRDO, GOI), Manali. pp. 33-40.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao & K.G. Saxena (2000). Garhwal Himalaya: Nanda Devi Biosphere Buffer Zone – Socio-ecological profile. In: P.S. Ramakrishnan, U. Chandrashekara, C. Elouard, C.Z. Guilmota, R.K. Maikhuri, K.S. Rao, S. Sankar and K.G. Saxena (eds.). *Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, pp 219-226.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao & K.G. Saxena (2000). Garhwal Himalaya: Nanda Devi Biosphere Buffer Zone – Traditional agroecosystems. In: P.S. Ramakrishnan, U. Chandrashekara, C. Elouard, C.Z. Guilmota, R.K. Maikhuri, K.S. Rao, S. Sankar and K.G. Saxena (eds.). *Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, pp 227-238.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao & K.G.

Saxena (2000). Garhwal Himalaya: Nanda Devi Biosphere Buffer Zone – Animal husbandry. In: P.S. Ramakrishnan, U. Chandrashekara, C. Elouard, C.Z. Guilmota, R.K. Maikhuri, K.S. Rao, S. Sankar and K.G. Saxena (eds.). *Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, pp 240-252.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao & K.G. Saxena (2000). Garhwal Himalaya: Nanda Devi Biosphere Buffer Zone – Forest ecosystems. In: P.S. Ramakrishnan, U. Chandrashekara, C. Elouard, C.Z. Guilmota, R.K. Maikhuri, K.S. Rao, S. Sankar and K.G. Saxena (eds.). *Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, pp 253-264.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao & K.G. Saxena (2000). Garhwal Himalaya: Nanda Devi Biosphere Buffer Zone – Village ecosystems. In: P.S. Ramakrishnan, U. Chandrashekara, C. Elouard, C.Z. Guilmota, R.K. Maikhuri, K.S. Rao, S. Sankar and K.G. Saxena (eds.). *Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, pp 265-298.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao & K.G. Saxena (2000). Garhwal Himalaya: Nanda Devi Biosphere Buffer Zone – Reserve-people conflicts. In: P.S. Ramakrishnan, U. Chandrashekara, C. Elouard, C.Z. Guilmota, R.K. Maikhuri, K.S. Rao, S. Sankar and K.G. Saxena (eds.). *Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, pp 299-309.

Maikhuri, R.K., S. Nautiyal, U. Rana, S. Tiwari, K.S. Rao & K.G. Saxena (2000). Garhwal Himalaya: Nanda Devi Biosphere Buffer Zone – Ecosystem rehabilitation and conflict resolution. In: P.S. Ramakrishnan, U. Chandrashekara, C. Elouard, C.Z. Guilmota, R.K. Maikhuri, K.S. Rao, S. Sankar and K.G. Saxena (eds.). *Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, pp 310-324.

Maikhuri, R.K., R.L. Semwal, **& K.S. Rao** (1999). *Garhwal Himalaya Ke Paramparik Krishi Paristhitiki Tantra Mein Jaivik Vividhata, Sankat Aur Punarudhar: Ek Vagyanik Vivechana. Proceedings of Seminar on Uttarakhan Vikas*. Uttarakhand Seva Samiti, New Delhi, pp 22-28.

Murthy, T.V.R., M.M. Kimothi, A.S. Arya, T.S. Singh, J.K. Singh, **V. Joshi, G.C.S. Negi & R.K. Maikhuri** (2000). *Landslide hazard zonation in a part of the Alaknanda valley, Garhwal Himalaya, using remote sensing and GIS*. Space Applications Centre, Ahmedabad. RSAM/SAC/RESA/HES/SR/01/2000. 33 p.

Pandey, A. and L.M.S. Palni (1999) Rhizosphere Microbiology of Tea. In : *Global Advances in Tea Science*. (Ed.) N.K. Jain. Aravali Books International (P) Ltd. New Delhi, pp. 555-562.

Palni, L.M.S. and V. Nakamura (1999) Advances in tea biotechnology. In : *Global Advances in Tea Science*. (Ed.) N.K. Jain. Aravali Books International (P) Ltd. New Delhi, pp. 449-462.

Palni, L.M.S., H.C. Rikhari and S. Sharma (1999). Enterprise development in natural fibre based products : a study of the status and potential in the Central Himalayan region of India. MEI Case study Series No. 99/2. ICIMOD, Kathmandu, Nepal, 52 p.

Samant, S.S. (1998). Diversity, distribution and conservation of fodder resources of West Himalaya, India. In : B. Misri (Ed.). *Proceeding of the Third Meeting of Temperate Asia Pasture and Fodder Network (TPAFON)*, Pokhara, Nepal, 9-13 March, 1998, sponsored by the Food and Agriculture Organizations of the United Nations, Rome. pp. 109-128.

Sharma, E., N. Jain, S.C. Rai, and R. Lepcha, (2000) Ecotourism in Sikkim: contributions toward conservation of biodiversity resources. In: Marothia, D. (ed.), Institutional Common Pool Resources. Concept Publishing Company, New Delhi pp. 531-548

Singh, A.K. and **D.S. Rawat** (2000) Women, Water and Springs in Kumaun Himalaya. In : C.M. Agarwal (ed.) *NARI* Facets of Indian Womenhood, III : 87-93.

Sundriyal, R.C. & Jamir, Senti (1999). Appropriate technology for soil conserving farming system in north east India. In: Proceedings of the seminar on *"Watershed management in hilly areas- Problems and prospects"*, published by North Eastern Regional Institute of Water and

Land Management (NERIWALM), Tezpur, Assam. pp. 97-110.

(III) Authored/Edited Books

Kadekodi, G.K., K.S.R. Murthy & **K. Kumar** (Eds.) (2000) Water in Kumaon: ecology,value and rights, Gyanodaya Prakashan, Nainital.

Ramakrishnan, P.S., U.M Chandrashekara, C.Elouard, C. Guilmoto, R.K. Maikhuri, K.S. Rao, S. Sankar, & K.G. Saxena, (Eds.) (2000). *Mountain Biodiversity, Land Use Dynamics, and Traditional Ecological Knowledge*. Oxford & IBH Publications Ltd., New Delhi. Pp. 353.

Samal, P.K., Y.S. Topal, & **Pushpa Pant** (2000). Van Rawat : A Tribe In Peril. Gyanodaya Prakashan, Nainital. P. 132

4.4.2 Popular Articles

Agrawal D.K. (1999). Hill Slope Instabilities and Role of Mountain Risk Engineering. *ENVIS Bulletin*, 7(1):1-4.

Bernbaum, E., A.N. Purohit and P.P. Dhyani (1999) Badrinath's trees : Local forests being restored as pilgrims now plant trees as offering to God. *Hinduism Today*, May, 22-23.

Dhar, U. (1999). Making a start. *Down to Earth*, December, 55.

Dhar, U., R.S. Rawal, S. Airi, I.D. Bhatt, G. Bisht & S.S. Samant (1999). *Himalay Ki Jav Vividhata Sanrakshan Mei Janata Ki Bhagidari VI: Padap Uttak Samvardhan Ki Mahatta*, Jav Vividhata Sanrakshan Vibhag, GBPIHED, Kosi-Katarmal, Almora, p.38.

Ghosh, S., U. Rana, K.S. Rao & K.K. Sen (2000). GIS application for mountainous terrains: some considerations and options. *ENVIS Bulletin - Himalayan Environment and Development*, 8 (1): 1-8.

Joshi, V. & G.C.S. Negi (1999). Chamoli earthquake - a brief report. *Hima-Paryavaran* 11(2): 15.

Joshi, V. & R.L. Semwal (1999). Devastating calamity of Ukhimath in Garhwal Himalaya- a report. *Hima-Paryavaran* 11(2): 11-13.

Joshi, H.C., S.C. Arya & **S.S. Samant** (1999). Diversity, distribution and indigenous uses of medicinal and edible plants in a part of Nanda Devi Biosphere Reserve I. *Himalayan Biosphere Reserves (Biannual Bulletin)*, 1 (1&2): 49-65.

Kuniyal, J.C., A.S. Shannigrahi & A.P. Jain (1999) Solid Wastes Management Initiatives in Kullu-Manali Tourists' Complex (KMTC). *Hima-Paryavaran*, June 11(1): 10-11.

Maikhuri, R.K., R.L. Semwal **& K.S. Rao** (1999). Garhwal Himalaya Ke Paramparik Krishi Paristhitiki Tantra Me Jaivik Vividhata, Sankat Aur Punarudhar: Ek Vagyanik Vivechana. In: Proceeding of seminar organized by Uttarakhand Vikas Samiti, Ahmedabad, 6-7 March, 1998.

Maikhuri, R.K., K.S. Rao, S. Nautiyal, & K.G. Saxena (1999). Management planning for the Nanda Devi Biosphere Reserve. *Himalayan Biosphere Reserves*, 1(1 & 2): 73-83.

Maikhuri, R.K., S. Nautiyal, and K.S. Rao (1999). *Nanda Devi Jievamandal Arakshit Kshetr (Biosphere Reserve) Mein Oushadhiya Padapon Ki Paramparagat Krushi Takniki*. G.B. Pant Institue of Himalayan Environment and Development, Kosi-Katarmal, Almora.

Maikhuri, R.K., R.L. Semwal, **& K.S. Rao** (1999). *Garhwal Himalaya Ke Paramparik Krishi: Samasyae evam nirakaran*. Shayad Sambhavana (August), 25-30.

Momin, G.A., J.C. Kuniyal, P.S.P. Rao, P.D. Safai, K. Ali, S. Tiwari, M.S. Naik and A. G. Pillai (2000). Physical and Chemical Characteristics of Aerosols at Kullu and Manali in the Himalayan region. *IASTA Bulletin*, February, 1: 60-64.

Nandi, S.K., A. Kumar, and L.M.S. Palni (1999) Role of plant tissue culture in biodiversity conservation and economic development. *Current Science*, 77: 1229-1231.

Nautiyal, S., K.S. Negi, R.K. Maikhuri, Hemant Manral & K.S. Rao (1999). Roop Kund - Sanskrikit va Vansptik Vishleshan. Hima-Paryavaran 11(2): 24-28.

Negi, G.C.S. & K. Kumar. Reduced tillage and mulching in Himalayan cropfields for soil and water conservation. *Hima-Paryavaran* 11(2): 15-17.

Oli, B.P., B.M. Joshi & S.S. Samant (1999). An inventory of mammalian fauna of Nanda Devi, Manas, Dibru-Saikhowa, and Dehang Debang Biosphere Reserves. . *Himalayan Biosphere Reserves (Biannual Bulletin)*, 1 (1&2): 38-48.

Pant, Rekha & P.K. Samal (1999). Role of culture in sustainable living and factors for its disintegration. *ENVIS Bulletin* 7 (1):8-12.

Samant, S.S. (1999). Diversity, nativity and endemism of vascular plants in a part of Nanda Devi Biosphere Reserve in west Himalaya I. *Himalayan Biosphere Reserves (Biannual Bulletin)*, 1 (1&2): 1-28.

Semwal, R.L. & G.C.S. Negi (1999). *Madhya Himalaya mein davagni: Kaaran evam niwaran* (in Hindi). Central Himalayan Environment Association Bulletin, Naini Tal. 10:11-19.

Semwal, R.L., S. Nautiyal, K.S. Rao, R.K. Maikhuri & B.S. Bhandari (1999). Structure of forests under community conservation: A preliminary study of Jardhar village initiative in Garhwal Himalaya. *Envis Bulletin., Himalayan Ecology & Development*, G.B. Pant Institute of Himalaya Environment and Development, 7(2): 16-27.

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

National Training Programme on GIS/ RS Applications for Natural Resource Management, 12April to 7th May 1999, Almora (Convener: **K.S. Rao**)

Sloping Agricultural Land Technology, NGOs training-cum-workshop held at Midpu (Doimukh), Arunachal Pradesh, 28-30 April, 1999 (Convener : **R.C. Sundriyal**)

Farmer-to-farmer training programme on Medicinal Plant Cultivation, 24-25th May 1999, Kheljhuni village in Bhageswar District (Convener: **K.S. Rao**)

Organizational Effectiveness through Personal Transformation. 28-29th May 1999, GBPIHED, Almora. (Convener: **L.M.S. Palni**)

National Symposium on the Role of Plant Tisue Culture in Biodiversity Conservation and Economic Development, GBPIHED, Almora, 7-9 June, 1999 (Convener: **L.M.S. Palni**)

PRA training organized under PARDYP, Kausani, August 1 - 2, 1999 (Convener: **B. P. Kothyari**)

Training workshop on Jaiv Vividhata Sanrakshan Mein Janata Ki Bhagidari, GBPIHED, at Jageswar on 18th November 1999 (Convener: **U. Dhar**)

Project formulation workshop of TSBF-SARNET programme at GBPIHED, Almora 10-11th December, 1999 (Convener: **K.S. Rao**)

National Workshop on Arunachal Pradesh (Environmental Planning and Sustainable Development - Opportunities and Challenges) was organised in collaboration with Department of Planning, Government of Arunachal Pradesh and Wadia Institute of Himalayan Geology, Itanagar 16-19 December, 1999 (Convener : **L.M.S. Palni**)

4.5.1 Participation in symposia/conferences/ training courses/ workshops

Planning Workshop on PARDYP - Phase -II, Kathmandu (Nepal), May 2 - 6, 1999 (**B. P. Kothyari, S. K. Bhuchar and Y. S. Topal**).

Inception workshop on "Methodologies for assessing sustainable agricultural systems in the Hindu-Kush Himalayan region: An ecoregional framework" at ICIMOD, Kathmandu, Nepal 28-29th June 1999 (**K.S. Rao and Subrat Sharma**)

IEEE 1999 Geoscience and Remote Sensing Symposium (June 28 to July 2, 1999) and made interactive presentation entitled Geological Assessment of a Himalayan Watershed using Remote Sensing (RS) and Geographical Information System (GIS) at Hamburg, Germany (**A.P. Krishna**)

Orientation workshop on CAPARTs New Policy Guidelines and Project Planning for Technologies Relevant to North Eastern Region, Hotel Imphal, 8 July, 1999 (**R.C. Sundriyal**)

National Seminar on the Research and Development in Aromatic Plants: Current Trends in Biology, uses, production and marketing of essential oils, CIMAP Lucknow, 30-31 July 1999 (**Anil Kumar**)

First consultation-cum-orientation workshop on National Agricultural Technology Project on Plant Biodiversity at NBPGR HQ, New Delhi, 24-25th August 1999 (**K.S. Rao**)

Regional training on Landslide hazard management and control in the Hindu-Kush Himalayan region organised by ICIMOD, Kathmandu, Nepal from 12 September-2 October 1999 (**V. Joshi**).

Workshop on "Environment and Science" organised by Kumaun University at Almora Campus from September 27-30, 1999 (**D.S. Rawat**).

International Training-cum-Workshop on CO_2 Enrichment Research and Technology jointly organized by IARI and NPL at Indian Agricultural Research Institute, New Delhi, 20 September-1 October 1999 (**S.C. Joshi**).

National Workshop on Rehabilitation problem of Ukhimath Landslides Affected Villages organized by Geology Department, HNB Garhwal University, Srinagar (Garhwal) from 27-28 September, 1999 (**R.K. Maikhuri**).

International Conference on Engineering geology, hydrology and natural disaster with emphasis on Asia organized by Tribhuvan University, Kathmandu, Nepal 28-30 September 1999 (**V. Joshi**).

Country Presentation: Natural calamity or disaster of 1998-99 in U.P. Himalaya, India In ICIMOD, Kathmandu, Nepal 1 October 1999 (**V. Joshi**).

National Seminar on Human Rights organized by Department of Political Sciences, HNB Garhwal University, Srinagar (Garhwal) from 3-5 October, 1999 (**R.K. Maikhuri**).

National Workshop on Atmospheric Chemistry (NWAC-99 at Indian Institute of Tropical Meteorology, Pune), 12-14 October, 1999 (**J.C. Kuniyal**).

Chaired a session in CIDA-SICI Partnership Project Dissemination Workshop on *Urban Development and Environmental Impact*, convened by University of Delhi and Manitoba, Canada at Manali. 14 October, 1999. (**H.K. Badola**).

Geological Hazards and Environmental Training Programme (October 18 to 25, 1999) of Groupement pour le Developpment de la Teledetection Aerospatiale at Toulouse, France (**A.P. Krishna**)

Workshop on Chamoli earthquake and its impact organised by Wadia Institute of Himalayan Geology, Dehra Dun, 22-23 October 1999 (**V. Joshi**).

National Symposium on Aquatic Biodiversity and Emerging Trends in Freshwater Biology organized by Department of Zoology, HNB Garhwal University, Srinagar (Garhwal) from 22-24 October, 1999 (**R.K. Maikhuri**).

International Conference on Tropical Aquatic Ecosystems: Health, Conservation and Management. 25-30 October 1999, Nainital (**G.C.S. Negi**).

Workshop on Integrated watershed development in Ramaganga-Binau watershed, Almora District, Regional Space Application Center, UP, Lucknow and District Administration, Almora, 28th October 1999 (**K.S. Rao and Subrat Sharma**)

South Asian Conference on Education : Issues and Challenges, held at Delhi from November 14 to 18, 1999. Organised by Department of Education, University of Delhi (**Nehal A. Farooquee**)

Workshop on Delineation of Development Agenda & NGO Networking, organized by COPs-Indian Development Center, New Delhi and Sikkim Development Foundation, Gangtok and supported by National Foundation for India (NFI), New Delhi during 16-17th November 1999 at Martham Village Resort, East Sikkim (**S.C. Rai**)

Workshop on Technology Intervention in Mountain Ecosystem (TIME), organized by State Council of Science & Technology for Sikkim in collaboration with Himalayan Environmental Studies & Conservation Organization (HESCO), Dehradun, U.P. and Regional Research Laboratory, Bhubaneswar, Orissa on 20th November 1999 at Gangtok, Sikkim (**S.C. Rai & K.K. Singh**)

National Seminar on Himalayan Horticulture: HORTI-VISION 2020, Shimla, 2-4, December 1999 (**J.C. Kuniyal**).

Brain storming session on Improvement of tea through biotechnological tools, Department of Biotechnology, New Delhi, 2 December 1999 (**L.M.S. Palni & S.K. Nandi**)

TSBF-Sarnet project formulation Workshop on Management of Agrobiodiversity for Sustainable Agriculture Development at JNU organized by SES, JNU, New Delhi on 6-7 January, 2000 (**R.K. Maikhuri**).
Workshop on Role of NGOs as Partners of Financial Institutions in Sikkim, organized by SIDICO/SABCCO/SF/VHAS, Sikkim on 7th January 2000 at Gangtok, Sikkim (**E. Sharma & S.C. Rai**)

Regional Gender Training Course: Sustainable Gender in HKH, Kathmandu (Nepal), Jan 17 - 30, 2000 (**Pushpa Pant**).

Workshop on *Medicinal Plants under Vanaspati Van Society, Himachal Pradesh*, Bachat Bhawan, Kullu. 21-22 January, 2000 (**H.K. Badola**).

Conference on Aerosol Behaviour in Confined Environments (IASTA-2000), Organised by Indian Aerosol Science and Technology Association (IASTA), Environmental Assessment Division, Bhabha Atomic Research Centre, Mumbai-400 085, India, 2-3 February, 2000 (**J.C. Kuniyal**).

Training programme on Biodiversity Conservation organized by Forest Research Institute (FRI), (Indian Council of Forestry Research and

Education (ICFRE), Dehra Dun from 7-11 February, 2000 (**R.K. Maikhuri & H.K. Badola**).

Workshop as Resource Person on Sloping Agriculture Land Technology for NGOs of Northeastern states, organized by GBPIHED, Northeast Unit, Arunachal Sewa Sangh and CAPART, during 27-29th February 2000 at Itanagar, Arunachal Pradesh (**S.C. Rai, G. Sharma and J. Dhakal**)

Regional meet on role of voluntary action Social in Development, National Institute of Public Cooperation & Child Development, March 14-16, 2000, Lucknow (**P.K. Samal**)

Tenth User Interaction workshop at NRSA Hyderabad, March 15-16, 2000 (**K.S. Rao**)

PARDYP Coordinators meeting, Kathmandu (Nepal), March 22 - 24, 2000 (**B. P. Kothyari**).

Water & Erosion Studies: Basic Analysis Training, Kathmandu (Nepal), March 22 - 28, 2000 (**B. K. Ramprasad, B. K. Joshi and P. K. Verma**)

4.5.2 Meetings

Invited speaker in 2nd meeting of the Task Force of Department of Science and Technology, New Delhi on 21-22 May, 1999 on Geotechnical Investigations of Landslides (**D.K. Agrawal**)

Meeting organized by Govt. of Sikkim on 8 June 1999 on UNDP Proposal to introduce Biodiversity Strategy and Action Plan, Eco-Tourism Policy Framework, GEF Small Grants Programme, Human Development, Capacity - 21 and Micro-Hydel Develolpment in Sikkim state (**A.P. Krishna**)

Project formulation meeting on Bio-Geo Data base and Ecological Modelling for Himalaya, at Department of Science and Technology, New Delhi 21-22 June, 1999 (**K.S. Rao & R.K. Maikhari**)

1999 Open Meeting of the Human Dimensions of Global Environmental Change Research Community at Shonan Village, Japan and presented a poster/oral presentation. 24-26th June 1999 (**K.S. Rao, R.K. Maikhuri & S.C. Rai**)

Final review meeting of cooperating agencies of MacArthur Project and presented Final Technical Report at French Institute, Pondicherry, 8-10 July 1999 (**K.S. Rao**)

ICFRE-FREEP meeting on Followup on National Forest Research Plan as nodal officer at ICFRE Dehra Dun, 27th July 1999 (**K.S. Rao**)

Zonal Technical coordinators committee meeting of NATP on Plant Biodiversity at NBPGR Regional Station Bhowali 19th August 1999 (**K.S. Rao**)

Meeting on a collaborative workshop on Biodiversity of Arunachal Pradesh, organised by Planning Department, Government of Arunachal Pradesh, September 7, 1999 (**R.C. Sundriyal**)

Invited speaker in 3rd meeting of the Task Force of Department of Science and Technology, New Delhi on 20-21 September, 1999 on Geotechnical Investigations of Landslides (**D.K. Agrawal**)

Brain storming session on Research and Development Strategies for Orchid at National Research centre for Orchids, Pakyong, Sikkim, during 14th October 1999 (**S.C. Rai and K.K. Singh**)

1st meeting of High Level Committee of Ministry of Agriculture, Government of India on Assessment of Magnitude of Past Floods and Landslides in Upper Alaknanda Valley on 18 November, 1999 (**D.K. Agrawal**)

3rd meeting of Steering Committee for Integrated Development of Himalaya, Planning Commission, New Delhi on 18 November, 1999 (**D.K. Agrawal**)

Expert Committee meeting on Scientific and Technical Terminology, organised by the connection for scientific and technical termology, New Delhi on November 24-27, 1999 **(D.S. Rawat).**

Meeting on GIS Model for Watershed Management to select Pilot Watershed under Technology Extension Programme, Deptt. Of Land Resources (Ministry of Rural Development, GOI) organized by Deptt. Of Forest, Environment and Wildlife, Govt. of Sikkim on 25 November 1999 (**A.P. Krishna**)

2nd meeting of High Level Committee of Ministry of Agriculture, Government of India on Assessment of Magnitude of Past Floods and Landslides in Upper Alaknanda Valley on 12 January, 2000 (**D.K. Agrawal**)

General body meeting of *Himalayan Phytochemical Association (HIMPA)*, Baggi-Mandi, H.P. 24 January, 2000. (**H.K. Badola**).

Action plan meeting of Nanda Devi Biosphere Reserve organized by the Nanda Devi Biosphere Reserve Directorate, Gopeshwar, Chamoli on 15 February 2000 (**R.K. Maikhuri**).

National Consultative Meeting on Community Management of Natural Resources organized by IUCN, Sustainable Use Specialist Group for South Asia, at Indian National Trust for Art and Culture Heritage (INTACH), New Delhi on 26 February 2000 (**R.K. Maikhuri**).

Meeting of Regional Members of IUCN for South and South East Asia (Regional Conservation Forum-2000) on Securing Our Future in Asia: The New Century, organized by Ministry of Environment and Forest, Government of India, at New Delhi on 22-25th March 2000 (**S.C. Rai**).

4.5.3. Delivered Lectures as Resource Person

Training to Sikkim Govt. Officials on *Planning and Management of Watershed for Integrated Development* (August 17, 1999) organized by Govt. of Sikkim & Deptt. of Personnel and Training, Govt. of India and delivered lectures (**A.P. Krishna & E. Sharma**)

Lecture on EIA to forest officials at Forestry & Forest Panchayat Training Institute, Haldwani on February 04, 2000 (**P.K. Samal**)

Lecture on Simple Technologies to forest officials at Forestry & Forest Panchayat Training Institute, Haldwani on February 04, 2000 (**D.S. Rawat**)

M/S A.K. KASHYAP & CO, CHARTERED ACCOUNTANTS,
37/1, RAJPUR ROAD, DEHRA DUN-248 001
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 31-03-2000, 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 case of Balance Sheet of the State of Affairs of the above named Institute as on 31-03-2000 and
ii) In the case of Income & Expenditure Accounts of the INCOME of its accounting year ending 31-03-2000.

FOR A.K. KASHYAP & CO.,
CHARTERED ACCOUNTANTS,

-sd- (seal)
(ASHOK KASHYAP)
F.C.A. PARTNER
DATED: 21ST JULY, 2000

NOTES FORMING PART OF THE REPORT ON THE STATEMENT OF ACCOUNTS FOR THE YEAR ENDING ON 31ST MARCH, 2000 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. Interest on Fixed Deposits has been provided on accrual basis.
5. Stock/Asset registers have been maintained by the Institute for movements 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 needs 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,
-sd- (seal)
(ASHOK KASHYAP)
F.C.A. PARTNER
DATED: 21st JULY, 2000

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 2000

PARTICULARS	ANN	AMOUNT	AMOUNT
SOURCES OF FUNDS			
General Fund :			
Last Balance :		3216007.49	
Addition during the year		1175902.00	**4391909.49**
Endowment Fund :			
Last Balance:		4214385.15	
Interest Earned		512567.00	**4726952.15**
Fixed Assets Fund :			
Last Balance		98095936.84	
Addition during the year		10609405.00	**108705341.84**
Construction Fund :			
Last Balance:		184563464.00	
Addition during the Year:		17000000.00	**181563464.00**
Provident Fund :			
Last Balance		7274713.40	
Addition during the Year		2660726.00	
		9935439.40	
Less: Final Settlement/Transfer during the year		131482.00	**9803957.40**
Project Funds :	1		
MOE & F : RESEARCH & DEV./OTHER EXPENSES		1062496.90	
CONSTRUCTION WORK		48583.00	
IERP Activity		0.86	
ENVIS Activity		40319.00	
WWF (CBO) Project		(5065.00)	
UNDP (HAIGAD) Project		(28035.00)	
UNESCO (EXPERT FEE)		63300.00	
PTCA NATIONAL SYMPOSIUM		101545.00	
NATIONAL WORKSHOP (N.E.)		(57637.00)	
NEC Shillong Fund		(6981.00)	
MOE & F (US) Project		116073.00	
MOE & F (SSS) Project		76745.00	
MOE & F (RSR) Project		99145.00	
MOE & F (RKM) Project		85071.00	
MOE & F (NDMD) Project		(54941.00)	
MOE & F (KSR) Project		199668.00	
MOE & F (KBR) Project		69796.00	
MEDICINAL PLANT WORKSHOP		120193.00	
LAND USE Project		60.00	
FAO BIO DIVERSITY Project		6700.00	
DST (KK) Project		262910.00	
DST (RSR) Project		1032.00	
DST (SKN) Project		(66087.00)	
DST (HCR) Project		145316.00	
DST (GCSN) Project		76727.00	
DST (Contract Programme)		200000.00	
DOS-DBT (N E)Project		166000.00	
DOS-DBT Project		6267.00	
CSIR (HCR/GCSN) Project		2761.00	
CSIR (RCS) Project		45.00	
CSIR (SCR)		(6359.00)	
BIOTECH (V II) Project		150000.00	
BIOTECH (V I) Project		395177.00	
BIOTECH (V) Project		370982.00	
Balance Carried Forward		**3641809.76**	**309191624.88**

BALANCE SHEET AS ON 31st MARCH 2000			
PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward		**3641809.76**	**309191624.88**
BIOTECH (IV) Project		42958.00	
BIOTECH (III) Project		56167.00	
BIOTECH (I) Project		668.00	
ALAKNANDA VALLEY Project		139030.00	
AGRI BIO DIVERSITY Project		18951.00	
ISRO(APK) Project		46495.00	
IEG Project		147.00	
ICAR(KSR) Project		43016.00	
ICAR (ES) Project		(22495.00)	
TSBF Project		121611.00	
MACARTHER UNESCO Project		0.86	
ICIMOD REH.Project		43151.05	
ICIMOD (SALT) Project		463044.21	
ICIMOD (PKS/NAF) Project		85800.00	
ICIMOD (PARDYP) Project		317821.00	
ICIMOD (FIBRE) Project		(13462.00)	
ICIMOD (CBD) Project		146456.00	
ICIMOD (LAND SLIDE) Project		19521.00	
ICIMOD (DSR) Project		56666.00	
INDO CANADIAN Summer Programme		5491.00	
ECO TOURISM (IDRC)Project		39160.00	**5251006.88**
Other Liabilities :			
Advance K.S.Rao		1990.00	
Advance H.C.Rekhari		500.00	
Security Payable		450.00	
Salary Payable		5466.70	
Medical Claim Payable		230.00	
E.M.D. Payable		66779.17	
GSLI Payable		32081.00	
Caution Money		20250.00	**127746.87**
TOTAL LIABILITIES RS..			**314570378.63**
APPLICATION OF FUNDS :			
Fixed Assets :	**41**		**108705341.84**
Deposits With :			
CCU for Constructions			**181563464.00**
Security Deposits			**45843.00**
Closing Balances	**43**		**24255729.79**
TOTAL ASSETS RS..			**314570378.63**
AUDITOR'S REPORT			
As per our separate report of even date annexed			
FOR A.K.KASHYAP & CO.,			-
			sd-
CHARTERED ACCOUNTANTS			DR. L.M.S. PALNI
			(Director)
			-
			sd-
-sd- (seal)			DR. U. DHAR
(ASHOK KASHYAP), FCA PARTNER			**(D.D.Officer)**
			-
			sd-
DATED : 21 st JULY, 2000			HARISH CHANDRA
PLACE : DEHRA DUN			**(Finance Officer)**

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)

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH 2000

PARTICULARS	ANN	AMOUNT	AMOUNT
A) INCOME :			
Grant In aid :			
Designated Project Grant For :			
MOE & F : RESEARCH & DEV./OTHER EXPENSES		33000000.00	
CONSTRUCTION WORK		17000000.00	
IERP Activity		4000000.00	
ENVIS Activity		439574.00	
PTCA NATIONAL SYMPOSIUM		353610.00	
NDBR Workshop		139119.00	
NATIONAL WORKSHOP (N.E.)		150000.00	
MOE & F (US) Project		120000.00	
MOE & F (SSS) Project		195000.00	
MOE & F (RSR) Project		107000.00	
MOE & F (RKM) Project		216000.00	
MOE & F (NDMD) Project		225000.00	
MOE & F (KSR) Project		170000.00	
MOE & F (KBR) Project		175000.00	
MEDICINAL PLANT WORKSHOP		117000.00	
INSA WORKSHOP		100000.00	
DST (HCR) Project		200000.00	
DST (GCSN) Project		250000.00	
DST (Contract Programme)		200000.00	
DOS-DBT (N E)Project		166000.00	
CSIR (SCR)		124935.00	
CSIR (RS) Project		113200.00	
CSIR (M.NADEEM)		67734.00	
BIOTECH (V II) Project		150000.00	
BIOTECH (V I) Project		1026000.00	
BIOTECH (V) Project		643250.00	
BIOTECH (IV) Project		630000.00	
BIOTECH (III) Project		715000.00	
ALAKNANDA VALLEY Project		400000.00	
ISRO(APK) Project		244000.00	
ICAR (KSR) Project		72000.00	
TSBF Project		206000.00	
MACARTHER UNESCO Project		107432.22	
ICIMOD (SALT) Project		742828.00	
ICIMOD (PKS/NAF) Project		85800.00	
ICIMOD (PARDYP) Project		2314478.00	
ICIMOD (ISSMA) Project		66353.00	
ICIMOD (DSR) Project		85938.00	
GIS Training		348097.00	
ECO TOURISM (IDRC)Project		481730.00	**65948078.22**
Less : Tfd. To Designated Funds For :			
MOE & F : RESEARCH & DEV./OTHER EXPENSES		33000000.00	
CONSTRUCTION WORK		17000000.00	
IERP Activity		4000000.00	
ENVIS Activity		439574.00	
PTCA NATIONAL SYMPOSIUM		353610.00	
NDBR Workshop		139119.00	
NATIONAL WORKSHOP (N.E.)		150000.00	
MOE & F (US) Project		120000.00	
MOE & F (SSS) Project		195000.00	
MOE & F (RSR) Project		107000.00	
MOE & F (RKM) Project		216000.00	
Balance Carried Forward		**55720303.00**	

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH 2000			
PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward		**55720303.00**	
MOE & F (NDMD) Project		225000.00	
MOE & F (KSR) Project		170000.00	
MOE & F (KBR) Project		175000.00	
MEDICINAL PLANT WORKSHOP		117000.00	
INSA WORKSHOP		100000.00	
DST (HCR) Project		200000.00	
DST (GCSN) Project		250000.00	
DST (Contract Programme)		200000.00	
DOS-DBT (N E)Project		166000.00	
CSIR (SCR)		124935.00	
CSIR (RS) Project		113200.00	
CSIR (M.NADEEM)		67734.00	
BIOTECH (V II) Project		150000.00	
BIOTECH (V I) Project		1026000.00	
BIOTECH (V) Project		643250.00	
BIOTECH (IV) Project		630000.00	
BIOTECH (III) Project		715000.00	
ALAKNANDA VALLEY Project		400000.00	
ISRO(APK) Project		244000.00	
ICAR(KSR) Project		72000.00	
TSBF Project		206000.00	
MACARTHER UNESCO Project		107432.22	
ICIMOD (SALT) Project		742828.00	
ICIMOD (PKS/NAF) Project		85800.00	
ICIMOD (PARDYP) Project		2314478.00	
ICIMOD (ISSMA) Project		66353.00	
ICIMOD (DSR) Project		85938.00	
GIS Training Programme		348097.00	
ECO TOURISM (IDRC)Project		481730.00	65948078.22
BALANCE			0.00
Interest From Banks			254439.00
Other Income :			
Interest on MCA		2990.00	
Licence Fee		80663.00	
Water Testing Fee		25350.00	
Nursery Sale		300.00	
Institutional Charges		602249.00	
Guest House/ Hostel Charges		140111.00	
Royalty		30775.00	
Miscellaneous Income		38302.00	
Sale of Scrap		723.00	921463.00
Designated Grant Utilised For :			
MOE & F : RESEARCH & DEV./OTHER EXPENSES		32917630.00	
IERP Activity		4092092.00	
ENVIS Activity		490039.00	
PTCA NATIONAL SYMPOSIUM		252065.00	
NATIONAL WORKSHOP (N.E.)		155305.00	
MOE & F (US) Project		3927.00	
MOE & F (SSS) Project		273631.00	
MOE & F (RSR) Project		7855.00	
MOE & F (RKM) Project		213438.00	
MOE & F (NDMD) Project		279941.00	
MOE & F (KSR) Project		154464.00	
MOE & F (KBR) Project		152702.00	
INSA WORKSHOP		100000.00	
FAO BIO DIVERSITY Project		92548.00	
DST(KK) Project		624630.00	
DST (HCR) Project		54684.00	
DST (GCSN) Project		173273.00	
DOS-DBT Project		80553.00	
Balance Carried Forward		**40118777.00**	1175902.00

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward		**40118777.00**	**1175902.00**
CSIR (SCR)		601344.00	
CSIR (RS) Project		169805.00	
CSIR (M.NADEEM)		76612.00	
BIOTECH (V I) Project		630823.00	
BIOTECH (V) Project		287261.00	
BIOTECH (IV) Project		742752.00	
BIOTECH (III) Project		551462.00	
BIOTECH (II) Project		97179.00	
ALAKNANDA VALLEY Project		430010.00	
AGRI BIO DIVERSITY Project		36855.00	
ISRO(APK) Project		197505.00	
ICAR(KSR) Project		28984.00	
ICAR(ES) Project		251963.00	
TSBF Project		243355.00	
MACARTHER UNESCO Project		140614.00	
ICIMOD (SALT) Project		661294.00	
ICIMOD (PARDYP) Project		2024650.00	
ICIMOD (DSR) Project		29272.00	
ICIMOD (FIBRE) Project		17722.00	
INDO CANADIAN Summer Programme		20160.00	
GIS Training Programme		348097.00	
ECO TOURISM (IDRC)Project		515304.00	**48221800.00**
TOTAL INCOME Rs.. (A)			**49397702.00**
B) EXPENDITURE :			
Revenue Expenditure :			
MOE & F : RESEARCH & DEV./OTHER EXPENSES	2	24173231.00	
IERP Activity	3	4092092.00	
ENVIS Activity	4	490039.00	
PTCA NATIONAL SYMPOSIUM	5	252065.00	
NATIONAL WORKSHOP (N.E.)	6	155305.00	
MOE & F (US) Project	7	3927.00	
MOE & F (SSS) Project	8	273631.00	
MOE & F (RSR) Project	9	7855.00	
MOE & F (RKM) Project	10	213438.00	
MOE & F (NDMD) Project	11	131041.00	
MOE & F (KSR) Project	12	154464.00	
MOE & F (KBR) Project	13	152702.00	
INSA WORKSHOP	14	100000.00	
FAO BIO DIVERSITY Project	15	12548.00	
DST(KK) Project	16	313104.00	
DST (HCR) Project	17	54684.00	
DST (GCSN) Project	18	124942.00	
DOS-DBT Project	19	80553.00	
CSIR (SCR)	20	105973.00	
CSIR (RS) Project	21	169805.00	
CSIR (M.NADEEM)	22	76612.00	
BIOTECH (V I) Project	23	429148.00	
BIOTECH (V) Project	24	287261.00	
BIOTECH (IV) Project	25	497941.00	
BIOTECH (III) Project	26	551462.00	
BIOTECH (II) Project	27	1846.00	
ALAKNANDA VALLEY Project	28	430010.00	
AGRI BIO DIVERSITY Project	29	36855.00	
ISRO(APK) Project	30	102676.00	
ICAR(KSR) Project	31	28984.00	
ICAR(ES) Project	32	86495.00	
TSBF Project	33	243355.00	
MACARTHER UNESCO Project	34	140614.00	
ICIMOD (SALT) Project	35	604921.00	
Balance Carried Forward		**34579579.00**	

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31" MARCH 2000			
PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward		34579579.00	
ICIMOD (PARDYP) Project	36	2024650.00	
ICIMOD (DSR) Project	37	29272.00	
INDO CANADIAN Summer Programme	38	20160.00	
GIS Training Programme	39	348097.00	
ECO TOURISM (IDRC)Project	40	515304.00	37517062.00
Amount transferred to Fixed Assets Fund			
(Capital Expenditure)	41		
MOE & F -RESEARCH & DEVELOPMENT			
Library		3959334.00	
Scientific Equipments		2142815.00	
Office Equipment		745899.00	
Furniture & Fixture		1436453.00	
Vehicle		459898.00	8744399.00
Scientific Equipments:			
BIOTECH (IV) Project		244811.00	
DST(GCSN) Project		48331.00	
BIOTECH (V I) Project		201675.00	
DST (KK) Project		311526.00	
CSIR(SCR) Project		495371.00	
FAO BIODIVERSITY Project		80000.00	
MOE & F (NDMD) Project		148900.00	
ICAR (ES) Project		165468.00	
ICIMOD (SALT) Project		56373.00	
ICIMOD (FIBRE) Project		17722.00	
ISRO(APK) Project		94829.00	1865006.00
Refund of unspent Grant			
BIOTECH(II)			95333.00
TOTAL EXPENDITURE RS.. (B)			48221800.00
SURPLUS (A - B)			1175902.00
EXCESS OF INCOME OVER EXPENDITURE			
(TFD.TO GENERAL FUND A/C)			
TOTAL RS...			49397702.00
AUDITOR'S REPORT			
As per our separate report of even date annexed'			
FOR A.K.KASHYAP & CO.,			sd-
CHARTERED ACCOUNTANTS			DR. L.M.S. PALNI
			(Director)
-sd- (Seal)			sd-
			DR. U. DHAR
(ASHOK KASHYAP)			**(D.D.Officer)**
FCA PARTNER			
			-sd-
DATED : 21 st JULY, 2000			HARISH CHANDRA
PLACE : DEHRA DUN			**(Finance Officer)**

M/S A.K.KASHYAP & CO, CHARTERED ACCOUNTANTS
37/1 RAJPUR ROAD, DEHRA DUN-248001
PHONE : (OFF.) 652346, 655834, (RES.) 672986, 672836

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31st MARCH 2000

PARTICULARS	ANN	AMOUNT	AMOUNT
RECEIPT :			
Opening Balance :	42		18375459.50
Grant In Aid For :			
MOE & F : RESEARCH & DEV./OTHER EXPENSES		33000000.00	
CONSTRUCTION WORK		17000000.00	
IERP Activity		4092084.80	
ENVIS Activity		439574.00	
PTCA NATIONAL SYMPOSIUM		353610.00	
NDBR Workshop		139119.00	
NATIONAL WORKSHOP (N.E.)		150000.00	
MOE & F (US) Project		120000.00	
MOE & F (SSS) Project		195000.00	
MOE & F (RSR) Project		107000.00	
MOE & F (RKM) Project		216000.00	
MOE & F (NDMD) Project		225000.00	
MOE & F (KSR) Project		170000.00	
MOE & F (KBR) Project		175000.00	
MEDICINAL PLANT WORKSHOP		117000.00	
INSA WORKSHOP		100000.00	
DST (HCR) Project		200000.00	
DST (GCSN) Project		250000.00	
DST (Contract Programme)		200000.00	
DOS-DBT (N E)Project		166000.00	
CSIR (SCR)		124935.00	
CSIR (RS) Project		113200.00	
CSIR (M.NADEEM)		67734.00	
BIOTECH (V II) Project		150000.00	
BIOTECH (V I) Project		1026000.00	
BIOTECH (V) Project		643250.00	
BIOTECH (IV) Project		630000.00	
BIOTECH (III) Project		715000.00	
ALAKNANDA VALLEY Project		400000.00	
ISRO(APK) Project		244000.00	
ICAR(KSR) Project		72000.00	51601506.80
Interest From Bank :			
Institute		254439.00	
Endowment Fund		512567.00	767006.00
G S L I Payable			32081.00
CAUTION MONEY			12650.00
Addition to Provident Fund			
Subscription		660021.00	
Voluntary Contribution		487100.00	
Institute's Contribution		677105.00	
Transfers from other deptt.		63899.00	
Interest received & accrued		772601.00	2660726.00
E.M.D.RECEIVED			16060.00
Adv. Dr. H C Rekhari			500.00
Other Income :			
Interest on MCA		2990.00	
Licence Fee		80663.00	
Water Testing Fee		25350.00	
Nursery Sale		300.00	
Institutional Charges		602249.00	
Guest House/ Hostel Charges		140111.00	
Royalty		30775.00	
Miscellaneous Income		38522.00	
Sale of Scrap		723.00	921683.00
TOTAL RECEIPTS RS..			84387672.30

RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31st MARCH 2000			
PARTICULARS	ANN	AMOUNT	AMOUNT
PAYMENT :			
Project Payment For :			
Project Expenditure (Revenue)			
MOE & F : RESEARCH & DEV./OTHER EXPENSES		24175734.39	
IERP Activity		4092092.00	
ENVIS Activity		490039.00	
PTCA NATIONAL SYMPOSIUM		252055.00	
NATIONAL WORKSHOP (N.E.)		155305.00	
MOE & F (US) Project		3927.00	
MOE & F (SSS) Project		273631.00	
MOE & F (RSR) Project		7855.00	
MOE & F (RKM) Project		213438.00	
MOE & F (NDMD) Project		131041.00	
MOE & F (KSR) Project		154464.00	
MOE & F (KBR) Project		152702.00	
INSA WORKSHOP		100000.00	
FAO BIO DIVERSITY Project		12548.00	
DST(KK) Project		313104.00	
DST (HCR) Project		54684.00	
DST (GCSN) Project		124942.00	
DOS-DBT Project		80553.00	
CSIR (SCR)		106973.00	
CSIR (RS) Project		169805.00	
CSIR (M.NADEEM)		76612.00	
BIOTECH (V I) Project		429148.00	
BIOTECH (V) Project		287261.00	
BIOTECH (IV) Project		497941.00	
BIOTECH (III) Project		551462.00	
BIOTECH (II) Project		1846.00	
ALAKNANDA VALLEY Project		430010.00	
AGRI BIO DIVERSITY Project		36855.00	
ISRO(APK) Project		102676.00	
ICAR(KSR) Project		28984.00	
ICAR(ES) Project		86495.00	33593192.39
Capital Expenditure :	41		
MOE & F : RESEARCH & DEVELOPMENT			
Library		3959334.00	
Scientific Equipment		2142815.00	
Office Equipment		745899.00	
Furniture & Fixture		1436453.00	
Vehicle		459898.00	8744399.00
Scientific Equipments:			
BIOTECH (IV) Project		244811.00	
DST(GCSN) Project		48331.00	
BIOTECH (V I) Project		201675.00	
DST (KK) Project		311526.00	
CSIR(SCR) Project		495371.00	
FAO BIODIVERSITY Project		80000.00	
MOE & F (NDMD) Project		148900.00	
ICAR (ES) Project		165468.00	
ISRO(APK) Project		94828.00	1790911.00
Provident Fund : Final Settlement/Transfers			131482.00
E.M.D./SECURITY REFUNDED			48265.24
SECURITY DEPOSIT			16060.00
REFUND OF BIOTECH (II) PROJECT GRANT			95333.00
TFD.TO CCU FOR CAPITAL EXPENDITURE			17000000.00
Closing Balances:	43		22958029.67
TOTAL PAYMENTS RS...			84387672.30
AUDITOR'S REPORT			
As per our separate report of even date annexed'			-sd-
FOR A.K.KASHYAP & CO., CHARTERED ACCOUNTANTS			DR. L.M.S. PALNI, Director
-sd- (Seal)			-sd-
(ASHOK KASHYAP) , FCA PARTNER		-sd-	DR. U. DHAR, D.D.Officer
DATED : 21 st JULY, 2000 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.) 672966, 672836
FAX : (0135) 655634

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KATARMAL, KOSI (ALMORA)
SCHEDULE OF FIXED ASSETS AS ON 31st MARCH 2000 ANNEXURE '41'

PARTICULARS	COST AS ON 1/4/99	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:	**8611669.40**	**1436453.00**	**0.00**	**10048122.40**
Institute	8594062.40	1436453.00	0.00	10030515.40
ICIMOD SALT	11000.00	0.00	0.00	11000.00
ICIMOD ISSMA	6607.00	0.00	0.00	6607.00
Scientific Equipments :	**52940978.11**	**4007821.00**	**0.00**	**56948799.11**
Institute	40056803.19	2142815.00	0.00	42199618.19
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	46592.00	80000.00	0.00	126592.00
ICAR (ES)	1687.00	165468.00	0.00	167155.00
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)	160074.92	56373.00	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	0.00	0.00	88530.00
ICIMOD (CBD)	52801.00	0.00	0.00	52801.00
ICIMOD (FIBRE)	199160.00	17722.00	0.00	216882.00
MRE	2450.00	0.00	0.00	2450.00
ICIMOD-GIS EQUIPMENT	148800.00	0.00	0.00	148800.00
BIOTECH (IV)	0.00	244811.00	0.00	244811.00

SCHEDULE OF FIXED ASSETS AS ON 31st MARCH 2000				
				ANNEXURE '41' Contd...
PARTICULARS	COST AS ON 1/4/99	ADDITIONS DURING THE YEAR	COST OF SALES/TFD. DURING THE YEAR	TOTAL
C S I R (SCR)	0.00	495371.00	0.00	495371.00
D S T (KK)	0.00	311526.00	0.00	311526.00
I S R O (APK)	0.00	94829.00	0.00	94829.00
M O E & F (NDMD)	0.00	148900.00	0.00	148900.00
BIOTECH (VI)	0.00	201675.00	0.00	201675.00
D S T (GCSN)	0.00	48331.00	0.00	48331.00
Office Equipment:	**3809334.35**	**745899.00**	**0.00**	**4555233.35**
Fire Fighting Equipment:	**60962.00**	**0.00**	**0.00**	**60962.00**
Library:	**22723723.50**	**3959334.00**	**0.00**	**26683057.50**
Vehicle :	**3555201.25**	**459898.00**	**0.00**	**4015099.25**
Institute	2471537.30	459898.00	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..	**98095936.84**	**10609405.00**	**0.00**	**108705341.84**

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 BALANCES

PARTICULARS	ANN	AMOUNT	ANNEXURE '42' AMOUNT
Opening Balances : (IC A/C)			
Cash & Bank Balances :			
Cash in Hand :			
Almora:		10490.55	
Srinagar		185.64	
Sikkim		3515.02	
Kullu		1300.17	**15491.38**
Cash at Bank :			
CBI Kosi A/c No.CD-14		882343.46	
SBI Almora A/c No.22752		2779453.33	
SBI Almora A/c No.23884		28778.15	
SBI Tadong A/c No.CA/4/65		648310.00	
SBI Kullu A/c No.50201/7		187219.81	
SBI Srinagar A/c No.3/615		43462.57	
SBI Almora P.F.A/c No.22021		18425.40	**4587992.72**
Advances			
House Building Advance		1326194.00	
Motorcycle/Car Advance		437360.00	
Festival Advance		13200.00	
Provident Fund Advance		206549.00	
GSLI		224.90	
CPF		36.00	
Units of Institute :			
HP UNIT		5000.00	
GARHWAL UNIT		54277.00	**2042840.90**
Fixed Deposits :			
With SBI Endowment Fund :		4127883.00	
Intt. Accrued on above		57724.00	
SBI Provident Fund		4808923.00	
CBI Provident Fund		1761416.00	
Intt.Acc.on FDR (P.F.A/C)		479471.00	
FDR(Margin Money L/C A/c)		66000.00	
FDR(Margin Money L/C A/c)SK UNIT		157000.00	**11458417.00**
Balance Carried Forward			**18104742.00**

DETAIL OF OPENING BALANCES			ANNEXURE '42' Contd
PARTICULARS	**ANN**	**AMOUNT**	**AMOUNT**
Balance Brought Forward			**18104742.00**
Due Staff/Others :			
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		5050.00	
Sigma Aidrich Chemicals		10590.00	
Siltap Chemicals Ltd. (BIOTECH III)		408.00	
N.R.S.A.Hyderabad		74800.00	
Klenzaids Con.Controls (P) Ltd.		57175.00	
M.P.C.B.		16382.00	
Hindustan Times		10000.00	**268217.50**
F.C.Inter A/c			**2500.00**
Opening Balance(I/C)			**18375459.50**
Opening Balance (F/C A/C)			
Cash & Bank Balances :			
Cash In Hand		386.00	
With SBI A/c No.20910		754928.90	**755314.90**
Advances :			
N.E.UNIT (SALT)		19445.00	
E.T.& T.N.DELHI		23040.00	
SIKKIM UNIT (ECO TOURISM)		23346.00	
N.R.S.A.HYDERABAD (PARDYP)		14500.00	
N.R.S.A.HYDERABAD (CBD)		11000.00	**91331.00**
Opening Balance(F/C)			**846645.90**
TOTAL RS...			**19222105.40**
CLOSING BALANCE AS ON 31st MARCH 2000			**ANNEXURE '43'**
Closing 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	
Balance Carried Forward		**2066845.31**	**13613.38**

Balance Brought Forward		**2066845.31**	**13613.38**
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**
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**
Closing Balance(I/C)			**22968029.67**
Closing Balance (F/C A/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		2680.00	
SIKKIM UNIT (ECO TOURISM)		23772.00	
N.R.S.A.HYDERABAD (PARDYP)		14500.00	
N.R.S.A.HYDERABAD (CBD)		11000.00	**64476.00**
Closing Balance(F/C)			**1287700.12**
TOTAL RS...			**24255729.79**

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

HEAD QUARTERS
KATARMAL, ALMORA
PH : 05962-41014
FAX : 05962-31507 Attn.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

Printed at Shiva Offset Press, Dehradun Phone : 91 135 655748