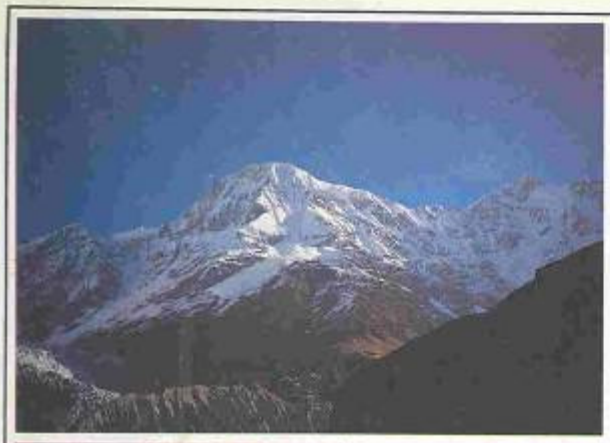

ANNUAL REPORT

1995-96

G.B. Pant Institute of Himalayan Environment and Development

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

Kosi, Almora-263643

INDIA

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ANNUAL REPORT

1995-96

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

CONTENTS

THE YEAR 1995-96 : AN OVERVIEW

This was a particularly important year for a variety of reasons for the Institute. Since its inception in 1988, during Pandit Govind Ballabh Pant birth centenary year, the Institute has continued to foster, carefully nurture, improve and develop various research and developmental programmes based on its mandate, under the capable guidance of the Science Advisory Committee, members of the Board of Governors and the Society. During the year, while a number of studies were brought to a logical conclusion, a number of new initiatives were also undertaken in addition to providing necessary support to ongoing activities. The Institute added two major publications to its credit, which were released during the Annual Day celebrations held in Shimla; a list of Institute publications is given on the inside back cover.

The milestone events, mentioned in subsequent pages in this report, indicate that a number of important achievements were made. The Institute strengthened its ties with a number of National and International partners, and also established links with some more organizations committed to the welfare of the mountains in general and, Himalayan region and its inhabitants in particular. Funding received from many National and International sources is an indication of increasing scientific capabilities of the Institute.

With construction activities nearing completion, it is hoped that the residential and administrative cum laboratory complex would be ready sometime early next year. With improved infrastructural support and facilities the Institute is looking forward to strengthening its commitments to ongoing programmes, expanding its activities in the 9th plan period and forging stronger links with various partners in development and research.

The year also witnessed the successful completion of five year tenure by Professor A.N. Purohit, FNA, as Director of the Institute. During his tenure (1990-95) substantial and all round development of the Institute took place, and the Institute would like to record its appreciation for his untiring service and for providing dynamic leadership.

L.M.S. PALNI
Director Incharge

MAJOR ACHIEVEMENTS

Suitable models for efficient upland farming systems were developed applying soil, water and nutrient conservation techniques in watersheds of Sikkim and Garhwal Himalaya.

Integrated approaches on the management of irrigation systems, keeping in view rural water supply and sanitation, were developed in selected areas of Kumaun.

Sustainable Natural Resource Management models through peoples' participation are being developed in selected villages of Nanda Devi Biosphere Reserve.

Preliminary studies on Biodiversity assessment were completed in selected Protected Areas of Kumaun and Himachal Himalaya.

Environmental awareness programme and Biodiversity Conservation through school children was continued in the district of Pithoragarh of Kumaun Himalaya.

Resource use in Kullu valley has been studied with a view to evolve sustainable practices.

Conventional and in-vitro propagation protocols for selected multipurpose tree species were developed.

Badrivan Restoration Programme at Badrinath was further strengthened through the participation of traditional institutions and army personnel.

Microbial interventions for improved plant performance of selected plant species were developed.

A number of projects have been sanctioned to Institute staff from National and International agencies.

Several on site training programmes on nursery technology, conservation practices and protected cultivation were organized in remote villages with participation of farmers, NGOs and army personnel. Training workshops and policy level meetings were arranged for professionals/planners from hill regions on advance technologies like GIS.

A model for use of Biotechnology and Biodiversity for rural development has been demonstrated in Haigad watershed.

Documentation of inhouse R & D studies was further strengthened through the publication of two new titles in addition to regular publications.

1. INTRODUCTION

The reporting year 1995-96 is the seventh financial year of research and development initiatives being carried out by the Institute, including its units, at various locations in the Indian Himalaya. These activities include programmes supported through core funds of the Institute and projects financed by external agencies, both national and international. All programmes are formulated with a strong focus on regional issues, and endeavour to seek practical and workable solutions to specific, problems *pro bono publico* with peoples' participation at all levels. The Science Advisory Committee of the Institute provides approval, general guidance and help for all programmes *ab initio*. At the present time, R & D activities of the Institute can be broadly classified into six core programmes. Some projects were successfully concluded during the year, summaries of these are placed at appropriate places in the text; in due course detailed documents will be published and made available to the public. The progress made during the year 1995-96 on various ongoing and newly initiated projects, and a brief account of academic and other activities, along with the statement of accounts, is presented in this report. We would be most grateful for critical comments, suggestions for improvement and for indication of our shortcomings by anyone interested in the well-being of Himalaya and its people.

2. MILESTONE EVENTS

* The Institute celebrated its Fifth Annual Day Function at Regency Hall, Shimla on September 14, 1995. The function was attended by many dignitaries which included Hon'ble Chief Minister of Himachal Pradesh, Shri Virbhadra Singh and Member Planning Commission, Dr. S. Z. Qasim. In his inaugural address, Shri Virbhadra Singh focussed on Himalayan environment related problems in general and those of Himachal in particular. He appealed to the scientists to come out with feasible developmental strategies wherein environment protection is not relegated to a second place. Dr. S. Z. Qasim delivered Fifth G. B. Pant Memorial Lecture. He dwelt on diverse potentials of Himalayan resources. In the concluding remarks he quoted a Sanskrit proverb which says that a hundred divine epochs would not suffice to describe all the marvels of the Himalayas. He further said, "It is only in modern age that man has begun to look at the abode of gods for the exploitation of its material resources. There is no denying that in the Himalayan region, the socio-economic development has not been harmonious with the region and has not adequately met the felt need of the local population. It has been accepted by one and all that the unique ecology of the Himalayas, which has such an extensive and pervasive influence on the life of our people, needs to be preserved, conserved and qualitatively upgraded.... Even a qualitative appreciation of the problems involved would suffice to arrive at a happy compromise between development and environment". Later, two publications of the Institute, namely, Fodder Trees and Shrubs of Central Himalaya and Cultivation of Medicinal Plants and Orchids of Sikkim Himalaya were released by Shri Virbhadra Singh and Dr. S. Z. Qasim, respectively.

* A workshop on "Biodiversity Conservation, Community Resource Management and Ecotourism Development in Sikkim" was organized by the Institute and the Mountain Institute, USA.

* Three days on-site training programme to villagers/women, ex-service army personnel and NGOs on "Nursery Development, Trees Plantation techniques and Natural Resource Conservation and Management" was organized by the Institute at village Arah in Almora district from April 15 to 17, 1995. The on-site training programme was attended by 44 trainees (11 ex-service army personnel from 7 villages, 15 representatives from 6 NGOs, 9 farmers and 9 women from village Arah and adjacent areas). The scientists of the Institute (INHI Core) imparted on-site training to the identified trainees.

* Three days on-site training programme on nursery development, tree plantation techniques and natural resource conservation and management was organized by the Garhwal Unit of the Institute at village Bhiri (Banswara) on June 12-14, 1995. The target groups for the training included villagers, women, ex-service army personnel and NGO's. The training programme was inaugurated by Padmshri Chandi Prasad Bhatt on June 12, 1995. Over 45 trainees attended the programme.

* A workshop on Soil Testing for Iodine (sponsored by UNICEF) was organized in the Institute on July 18 & 19, 1995. Director Incharge delivered the inaugural lecture followed by a speech by Mr. Ahmad Salman (Project Officer, UNICEF, Lucknow Office) who mentioned the role of their organization in sponsoring various projects, and the relevance of the Workshop in funding a project on "Soil Testing for Iodine in districts of U.P." Three outside experts (Prof. B. Mishra, Drs. P.C. Srivastava and L.S. Bisht) spoke on various aspects of the problem. Field training was conducted by the Institute scientists on soil sampling methods. Among others, 18 outside participants which included mainly NGOs from Uttar Pradesh, attended the workshop.

* As a follow-up of the restoration activity in and around Badrinath area initiated in September 1993, a massive plantation programme was organised on World Environment Day (June 5, 1995) by the Institute through active participation of the people of all walks of life. Pilgrims, local inhabitants, villagers, saints, army personnel, temple committee staff members, officials of district administration, forest department officials, journalists, women organisations, students, etc. who gathered at the temple premises were provided with the seedlings of bhojpatra as "Brikshya Prasad" by the Chief Priest of Badrinath Temple- HH Shri Vishnu P. Namboodari). Later, they went in a procession to the plantation site at Narayan mountain behind the temple. Shri Shiv Charan Mathur (Chairman, Bisesadhikar Samiti, Lok Sabha and ex-Chief Minister, Rajasthan), who was the chief guest on the occasion, was the first to receive the sapling of bhojpatra from the chief priest of the temple and later planted it at the plantation site. Among others, Sbri Radha Krishna Vaishnav (senior journalist), Shri Hemant Kumar IFS (DFO, Gopeshwar) and Shri Radhesyam Mishra (SDM, Joshimath) participated in the programme.

* Three days on-site training programme on nursery development, tree plantation techniques and natural resource conservation and management to Army Personnel was organized at Hanumanchatti on October 30-November 1, 1995 with inputs from Col. Ajay Prakash, Commanding Officer, Garhwal Scouts and Brigadier Dalvir Singh,

Commander, 9 (Ind.) Mountain Brigade, Joshimath. Thirty six Army personnel nominated by Mountain Brigade from seven sectors (i.e. Garhwal Scouts, 3 Jakli, 5009 ASC (Camp), 2009 FD ASC, 15 Jat, 5 Mahar and 8 (1) F. C. - Engineers) attended the on-site training programme. The programme was inaugurated by Brigadier Dalvir Singh (Vr C, VSM) and closed officially by Mr. Radheshyam Misra, Sub District Magistrate, Joshimath. Establishment of `SAINYA PAUDHSHALA' by the trainees was the important outcome of this exercise.

* A training programme in Geographical Information System (GIS) and Geographic Positioning System (GPS) Applications in Natural Resource Management and Environmental Monitoring was held in the Institute from November 5-26, 1995 as a collaborative activity of G. B. Pant Institute of Himalayan Environment & Development and International Centre for Integrated Mountain Development (ICIMOD). This training was held for the first time in India. Eleven participants who took the Certificate course came from various Institutes in the Himalaya ranging from Sikkim to Himachal Pradesh. The course covered basic concepts in GIS and computers, data integration, application of remote sensing and GPS data and spatial analyses. There was ample hands-on experience on digitizers and computers. Project work was also carried out by participants on various aspects of Natural Resource Management within the selected field area of Haigad Watershed. Feedback given by participants will be used for improving future training programmes.

* The second two days workshop on "People's participation in biodiversity conservation" was organized by the Institute on November 9 & 10, 1995 at Government Inter College, Narayan Nagar. Over 150 participants from different schools/colleges attended the workshop. On-site training on information collection, nursery preparation and plantation of important local species was the focus of training.

* To appraise the capabilities of GIS/GPS systems for decision support, a one day policy level workshop was organized at Almora on 6th Jan. 1996. The programme was chaired by Mr. E. Pelinck, Director General, ICIMOD. The participants included Vice-Chancellors of Universities in Himalaya, Heads of the organizations dealing with development and environment. The meeting discussed the modalities of creation and maintenance of GIS/ GPS facilities and manpower requirements in the region.

* Sikkim Biodiversity and Ecotourism Workshop cum Training for TAAS operators and their staff included discussions between public and private sectors, field training in responsible trekking and the production of Code of Conduct for members of the Travel Agents Association of Sikkim was organized on February 12-16, 1996. More than 75 participants from TAAS, the Green Circle, Govt. of Sikkim officials and local community member from North and West Sikkim were represented.

* Two separate models (restoration of degraded land and agroforestry) have been developed at Banswara, (1200 m amsl) Garhwal Himalaya, with an emphasis on the plantation of socially valuable and ecologically important multi-purpose tree species using sub-surface/ seepage water through cost-effective water harvesting technology. To ensure peoples'

participation and replication of these models, long term as well as short-term economic benefits were also incorporated through raising perennial and annual cash crops. Local people have started replicating the technique and methods of land rehabilitation. Second phase (March, 1996 onwards) includes scientific studies. It is hoped that the project will enable us to formulate appropriate management techniques for rehabilitation of degraded lands in the region.

* Environmental Impact of Multipurpose River Valley Project-Tehri Dam, a joint venture of G.B. Pant Institute of Himalayan Environment and Development and Space Application Centre, ISRO, Ahmedabad has been successfully completed in March, 1995 and Final Technical Report of this Project is in press.

3. RESEARCH AND DEVELOPMENT PROGRAMMES

As a general rule 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 to achieve sustainable development of the Indian Himalaya. In this process special attention is placed on the preservation of fragile mountain ecosystems, indigenous knowledge and customs. A consicuous effort is made to ensure participation of the local population for long term acceptance and success of various programmes. The R & D activities of the Institute are centered around six core programmes, viz., Land and Water Resource Management, Sustainable Development of Rural Ecosystems, Ecological Economics and Environmental Impact Analysis, Environmental Physiology and Biotechnology, and Institutional Networking and Human Investment. The progress made in various projects during the year has been placed under appropriate core programmes in the text. The project implementation sites are carefully selected, keeping in view the heterogeneous heritage of the Himalaya along with the 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. Whenever required, for which 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 t! eir second or third year of operation. Highlights of the progress made during the year 1995-96, alongwith a brief, conceptual background, specific objectives and major achievements are summarized for individual projects. Brief summaries of projects completed during the year are placed in the text and detailed findings will be made available shortly.

3.1. LAND AND WATER RESOURCE MANAGEMENT

3.1.1. Integrated Watershed Management : A Case Study in Sikkim Himalaya (Phase II)

This is an ongoing project. Please see previous Annual Reports for background and objectives.

Results and Achievements

1. The soil map of the Mamlay watershed was generated using FCC paper print of IRSIA/IB

data in band 2 3 4 by the visual interpretation of imagery and the detailed field survey in the watershed area. The soils found in the area are grouped under different families. The soils of the area comprised of clay in low lying cropped area (paddy field) followed by sandy loam in structural ridges (temperate natural forests), and silty/clay-loam mainly confined to the spurs and erosional areas.

2. In order to see the effect of change in land-use on soil properties and fertility, soil samples were collected and analyzed for three depths (0-30 cm, 30-60 cm and 60-90 cm) from different land-uses representing almost all elevations as distributed in the watershed. Bulk density of the soils increased with depth in all the stands. Bulk density of soil of temperate natural forests is relatively lower than that of other land-usage. This is attributed to intensive agriculture causing soil erosion and exposure of inner rocks. Overall per cent stone in different depths and land-uses varied from 25% to 77%.

3. The soil pH increased with depths in all the stands. Carbon (%), total nitrogen (%) and total phosphorus (%) of soils decreased with depth in all the land-uses. These values were higher for temperate natural forest than for other land-uses. Organic carbon, total nitrogen and total phosphorus per hectare in the soils were high in the temperate natural forests as compared to sub-tropical natural forests. The higher organic carbon in 0-90 cm depth was recorded in temperate natural forests on north-west facing slope (239 mg/ha) than on south-west facing slope (55 mg/ha). The total nitrogen ranged from 5 mg/ha in sub-tropical cropped area to 19 mg/ha in temperate natural forests. The total P was also high in temperate natural forests (5 mg/ha). The results of pH, organic carbon, total nitrogen and total-P of soils from different land-uses at different elevations indicate that the biological activities were lower in natural forests and cardamom agroforestry systems as compared to soils from all other land-uses from the sub-tropical regions.

4. *Furcroea gigantea* Vent. is grown by the villagers and forest department for the purpose of biofencing and soil binding. The species is also a raw material for making ropes and bags from leaves. A detailed study on distribution, phenology, growth, germination and nutrient levels of this plant were made. The study was taken up on the observation of abrupt flowering in a number of *Furcroea* plants which is quite rare. Normally this plant is said to flower only after 10 to 15 years and this being a good opportunity, complete study was made in terms of plant dimensions and biochemical parameters such as reducing sugar (3.39-3.99%), total sugar (6.21%), total chlorophyll (0.056-0.069 mg/g), nutrients (total nitrogen 0.17-1.09% and phosphorus 0.039-0.167%) and protein (1.062-6.810%) in different plant components. The study also provides information on growth and germination with respect to incubation before sowing and storing conditions.

3.1.2. Soil, Water and Nutrient Conservation in Upland Farming Systems of a Watershed in Sikkim.

Background

Based on the land-use mapping of the watershed in Sikkim, the project aims to identify available resources and physical constraints. The

main problem of upland farming systems is erosion; this is being evaluated under NWDPRA (National Watershed Development Project for Rainfed Areas). Broadly the farming systems in hill areas are classified into (a) rainfed, and (b) irrigated. The rainfed upland farming systems suffer from soil erosion and nutrient leaching specially in monsoon. Different crop combinations and cropping patterns conserve soil, water and nutrients, and are being evaluated. The upland farming system in Sikkim is an integrated system with linkages between forests, agroforestry, agriculture, live-stock and other components of the environmental setting. Ecologically and economically important agroforestry species are selected and worked in detail for future promotion.

Objectives

1. Estimation of run-off and erosion in different improved cropping practices under NWDPRA as against traditional practices.
2. Estimation of soil, water and nutrient conservation under different cropping systems.
3. Use of N_2-fixing species and nitrogen accretion.
4. Role of bund species on conservation and their competition with crops.
5. Identification of ecologically and economically useful agroforestry trees.

Results and Achievements

1. The Khanikhola (Melli Dara-Paiyong) watershed was delineated and a map prepared for the area coverage under different land-uses in the watershed. Identification of cropping pattern and crop combinations under different cropping patterns have been completed. Three major types of agroforestry systems based on cardamom, horticulture and fodder were identified. Sites have been characterized on the basis of soil physical and chemical analysis, and soil erosion and overland flow are being estimated.
2. Detailed survey on the use of N_2-fixers in cultivation and natural occurrence has been made. *Albizia stipulata* has been used extensively for agroforestry strengthening in this project. Details on the N_2-fixation by *Albizia* in cardamom agroforestry are being worked out.
3. All the bund species planted in the watershed have been identified. Extensive survey was made to select most widely raised bund species in the watershed. The use of bund species by farmers was recorded. The direct use and indirect benefits were also evaluated.
4. Identified all agroforestry trees in both traditional and introduced systems, and theperformance of these species have been evaluated. Broadly the lands under various coverage such as, sal forest, scrub land, cardamom agroforestry, mandarin agroforestry and cropped area (maize and paddy-wheat fields) were studied for soil performance-chemical properties. The highest value was recorded in sal forest followed by scrub, mandarin agroforestry, cardamom agroforestry, maize field and wheat field. Total nitrogen (scrub < cardamom < sal < mandarin < wheat < maize), available phosphorus (sal < maize < mandarin < scrub < wheat < cardamom) and exchangeable potassium (sal < cardamom < mandarin < maize < scrub < wheat) distinctly varied with depth and different land cover type.

3.1.3. Appropriate Technologies for Soil Conserving Farming Systems

This is an ongoing project, please see previous Annual Reports for background and objectives.

Results and Achievements

1. Land treatment using interventions like introductions of hedge rows using suitable multipurpose tree/shrub/grass species was completed.
2. Monitoring of growth and survival of introduced plants were continued.
3. While interventions and introductions showed positive results at Changki, the growth of hedge rows at Maine was disappointing. The forest dieback of all species introduced during winter months is major deterrent for establishment of the model. However the traditional/MPTs introduced on terraces have good survival with some protection.
4. Screening of suitable species for hedgerows is continuing.
5. Germination of seeds procured from secondary sources was found to be far below the expected levels and almost nil in some cases.

3.1.4. Integrated Watershed Management: Case Studies in Garhwal Himalaya

This is an ongoing project. Please see previous Annual Reports for background and objectives.

Results and Achievements

1. Hydrological studies under different land use in Dugar Gad indicated low overland flow in pine forest (32.8 m^3/ha) as compared to wasteland (188.9 m^3/ha). Wasteland also lost greater sediment (92.4 kg/ha) as compared to chir pine forest (32.8 kg/ha). Agricultural landuse exhibited a high overland flow and high top soil loss.
2. In Sirkot Gad, hydrological studies involving 60 rain events registered a rainfall intensity ranging between 0.30 and 13.55 mm/hr and 92% rain events were of small size (10 mm/hr). Overland flow was found maximum for waste-land and minimum for bushland (Table 1). Rain intensity, rainfall and overland flow were positively correlated for all the three landuse practices. Rainfall intensity and overland flow tend to decline from morning to evening. In this watershed, the soil loss from pine forest (1133.7 kg/ha) was greater than from bushland (758.1 kg/ha). The sediment load was found to be highly variable (i.e., 70 mg/1 for bushland to 14722 mg/1 for pine forest).
3. Peoples' perception on land and water resource management represented a variety of thoughts. People felt the need for wasteland afforestation with MPTs (82%), improvement in farming conditions (35%) and making provision for irrigation and drinking water (56%). However, only a few (3%) volunteered for physical participation and planted 1119 seedlings of MPTs in their 1 ha wasteland, protected from thoroughfare.
4. Soil pH under the six land uses in Dugar Gad was within a narrow range of 6.46 to 6.67, soil organic carbon between 0.91% (current fallow) and 1.98% (irrigated cropland) and total nitrogen between 0.42% (pine forest) and 0.77% (irrigated cropland), indicating that the soil nutrient status is greatly affected by land use.

Table 1. Hydrological studies under different land use practices in selected catchments

Land use	Runoff (m^3/ha)	Sediment (kg/ha)	C (%) in Sediment	N (%) in Sediment	N (%) in Overland flow
Agriculture	656.3	2749.9	0.88	0.70	0.70
Chir Pine Forest	174.0	578.6	3.26 ± 0.40	1.08 ± 0.15	0.14
Bush Land	289.9	758.1	1.82 ± 0.31	0.89 ± 0.09	0.21
Grazing Land	277.5	572.2	3.15 ± 0.71	1.45+0.25	0.40
Agroforestry	96.4	5699.9	1.29 ± 0.08	0.90 ± 0.05	--

(Values for all the parameters have been averaged across all sites/catchments)

5. Amongst the engineering and vegetative methods to revive the discharge of a near extinct spring, 283 trenches measuring 1429 m length were dug out and plantation of evergreen and deciduous species was done along the slopes of upper catchment of a near extinct spring.

3.1.5. Irrigation Systems Management, Hydrology and Rural Water Supply and Sanitation

This is an ongoing project. Please see previous Annual Reports for background and objectives.

Results and Achievements

1. In Kumaun region of the Central Himalaya, an increase of 1066 ha was reported in gross irrigated area from 1981 to 1991, whereas net irrigated area decreased by 182 ha during that period (Table 2). Poor management of irrigation systems may be one possible reason for this trend which shall be confirmed by the primary data.

2. The "gool" system is the dominant means of irrigation in the region. In 1981, about 73.94 percent of the net irrigated area was covered

Table 2. Irrigated area and means of irrigation in Kumaun hills (Area in ha)

District	Cultivated Land		Gross irrigated area		Net irrigated area		Canal		Tanks		Gool/Others	
	80-81	90-91	80-81	90-91	80-81	90-91	80-81	90-91	80-81	90-91	80-81	90-91
1. Almora	113630	123606	21247	25176	10890	12839	2897	6217	-	-	7993	6621
2. Pithoragarh	70634	68394	10446	9697	6191	5524	512	1064	-	-	5679	4460
3. Nainital hills	22143	27165	6284	4150	3609	2146	1984	1974	-	28	1625	144
4. Kumaun hills (total)	206407	219165	37957	39023	20690	20508	5393	9255	-	28	15297	11225

Source: Statistical hand books, 1982,1992 ; Almora, Pithoragarh and Nainital

by gool irrigation which was reduced to 54.72 percent in 1991-92. Khanda canal selected for detailed study in Pauri district has 8.7 ha CCA, out of which only 1.7 ha is actually irrigated due to several constraints. Out of 45 families falling under CCA of this canal only 25 families utilize it leaving a large portion of CCA either uncultivated or cropped with rainfed varieties.

3. The study of rural water supply was also started in two small watersheds of Dugar Gad and Sirkot Gad. Dugar Gad peak discharge recorded for four springs was found in August (Fig. 1) and during September in Srikot Gad.

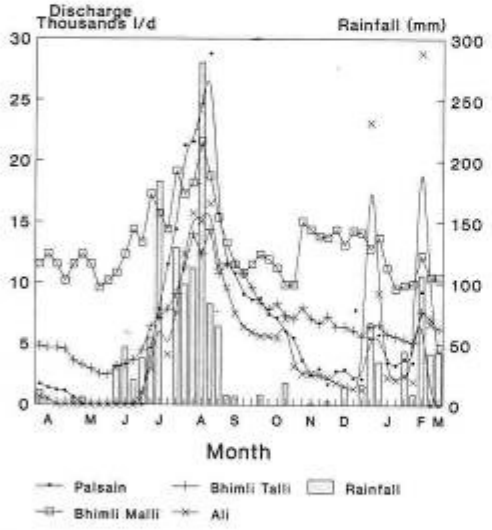

Fig. 1. Discharge rate of four springs and rainfall in Dugar Gad

The discharge revived marginally following winter rains. In Dugar Gad, the only spring of Palsain (a harijan village) becomes dry between mid-May to mid-July. A tank was constructed involving community participation to tap its low discharge and to provide safe drinking water as a demonstration (Plate 1).

Plate 1. A tank constructed to conserve spring water

3.1.6. Development of Agroforestry model in Garhwal Himalaya

Summary of completed project; please see previous Annual Reports for details.

Forestry and agroforestry could be feasible management options to bring back the degraded and abandoned land into productive form and to ensure improvement in the quality of physical, biological and human environment. Applying aforesaid approach at Banswara (1200 m amsl) in Garhwal Himalaya two separate models viz., restoration of degraded forest land (3.5 ha) and agroforestry on abandoned agricultural land (2 ha), both belonging to the local community have been developed. In this programme emphasis was laid on the plantation of socially valuable multipurpose trees and use of sub-surface/ seepage water through cost- effective water harvesting technology. While developing the models, long-term and short-term economic benefits to the local inhabitants were also incorporated through raising perennial and annual cash crops so that peoples' participation and replication of these models in the region could be ensured.

A total of 19 multipurpose tree species were examined under different conditions for

their suitability in land rehabilitation programmes. On the basis of this study it has been concluded that species, e.g., *Alnus nepalensis, Albizia lebbek, Boehmeria rugulosa, Celtis australis, Ficus glomerata, F. roxburghii* and *Grewia optiva* can contribute significantly in the rehabilitation of abandoned agricultural land and agroforestry of the region.

For the restoration of degraded forest land, species like *A. nepalensis, A. lebbek, A. stipulata, Cedrela toona, D. sissoo, Prunus cerasoides* and *Sapindus mukorossi* are most suitable, and hence recommended.

3.1.7. Badrivan Restoration Programme at Badrinath Dham

This is an ongoing project of the Institute. Please see previous Annual Reports for details.

Results and Achievements

1. To start with, the Badrivan restoration activity in and around Badrinath area was initiated in September 1993. A massive plantation programme at Badrinath Dham was organized on World Environment Day (June 5, 1995) by the Institute through active participation of the people from all walks of life. Pilgrims, local inhabitants, villagers, saints, army personnel, Badrinath-Kedarnath Temple Committee staff members, officials of Chamoli Garhwal district administration and forest department, journalists, women organizations, students and others, gathered at Badrinath temple premises, were provided with the seedlings of bhojpattra (*Betula utilis*) and Utis (*Alnus* sp.) as "Brikshya Prasad" by the Chief Priest - HH Sri Vishnu P. Namboodari and Naib-Rawal (HH Sri Badri P. Namboodari) of Badrinath temple. Sri Shiv Charan Mathur (Chairman, Bisesadhikar Samiti, Lok Sabha and former Chief Minister, Rajasthan), was the Chief Guest of the program who was the first, among other dignitaries, to receive the sapling of bhojpattra from the Chief Priest of the temple and planted it at the plantation site.

2. In pursuance of Badrivan restoration programme initiated earlier by the Institute, Garhwal Scouts, Joshimath has taken up initiatives to develop "Garhwal Scouts Manavan / Badrivan Programme" at Mana in Badrinath Dham under the guidance of the Institute. A memorandum of understanding (MOU) was signed with Garhwal Scouts, Joshimath on 19th August 1995. To start with, in the last week of August 1995 extensive plantation was done at Mana in Badrinath Dham by the officials of Garhwal Scouts, Joshimath/Mana under the supervision of scientists of the Institute. Seedlings were supplied from Institute's Hanumanchatti Nursery. As and when required, army personnel provided assistance to the Institute in its ongoing activities relating to Badrivan restoration programme.

3. One acre private land was given to the Institute, free of cost, for 10 years by a local resident at Hanumanchatti (near Badrinath Dham). A central nursery of broad-leaved/ narrow-leaved trees in 1 acre area with two polyhouses and a water harvesting tank, was established and developed at Hanumanchatti at an elevation of 2500 m amsl. Till third week of Nov. 95 plants raised in the nursery numbered 11,066 tree seedlings (*Betula utilis* - 3432; *Prunus cornuta* - 2883; *Pinus excelsa* - 1891; *Alnus* sp. - 1310; *Populus ciliata* - 500; *Juglans regia* - 349; Others - 701). Due

to snow fall and severe cold Hanumanchatti area remains closed from the last week of November to the middle of April / May.

4. After acclimatizing and hardening the seedlings of *Alnus* sp. at 2576 m amsl in Garhwal Himalaya, 2 years old 72 seedlings of *Alnus* sp. after completing soil stabilization work were planted at Badrinath Dham from June to August 1995 at three different sites - agriculture fields, in avalanche zone and in non-avalanche zone, which were protected from cattle by erecting iron guards around them. All the saplings of *Alnus* sp. showed satisfactory survival till the middle of Nov. 95. Before the closure of Badrinath valley, i.e., in the middle of November 1995, tin-made round devices were fabricated and put on each tree guard for the protection of saplings from snow during winter season. One hundred and thirty seven tin made triangular devices were also erected around the tree seedlings, especially of *Betula utilis* and *Populus ciliata*, which were planted by Garhwal Scouts, Joshimath, at Mana camp, for protecting them from snow fall during Nov-April.

5. The survival of tree saplings/seedlings planted during the year at Badrinath Dham will be monitored next year in the middle of April/May and the nursery at Hanumanchatti will be further enriched by growing seedlings of identified trees, and the saplings after acclimatizing and hardening, will be planted at Badrinath Dham. Some biological and engineering means will also be followed to ensure better survival.

3.2. SUSTAINABLE DEVELOPMENT OF RURAL ECOSYSTEM

3.2.1. Jhum and Sustainable Development of Village Cluster in Nagaland

(Summary of completed project, please see previous Annual Reports for details)

The intricate relationship of Jhum and development of villages has been worked out by various workers. Most models proposed previously by various workers failed to generate any significant impact as either they were capital intensive requiring drastic change of lifestyles or lacked involvement of stake-holders/beneficiaries. This attempt has used the lessons learnt in the previous experiences and developed a practicable model that fulfilled most of the requirements. It has not addressed at large / regional levels which require infrastructure and government machinery support. The objectives envisaged for the programme were achieved and the results are being compiled.

3.2.2. Resource Management Strategies in Himachal Pradesh and Uttar Pradesh Hills

(Summary of completed project, please see previous Annual Reports for details)

An in-depth survey of resource availability, quality and quantity analysis for two selected watersheds was completed. The diversity of cropping systems, crop requirements, forest types, minor forest produce used/dependency was studied in-depth. A model of alternate resources development started for Pranmati Watershed was completed upto designing and model demonstration stages. Value addition to the local produce was lab tested and need to be installed at the fieldlevel. This includes oil expeller and drier.

To reduce the burden on natural regeneration of forests for domestic energy requirements, a micro-hydel was demonstrated. However, this need to be installed to full capacity before it can meet the requirements of villagers. A rope-way planned for reducing the time and transport cost needs additional support for successful completion of phase II part of the programme. Detailed technical report has been completed.

3.2.3. Institutional Strengthening for Sustainable Mountain Farming Systems

This is an ongoing project, please see previous Annual Reports for background and objectives.

Results and Achievements

1. A review of the progress of work was done and priorities were set afresh.
2. For strengthening the institutional capacities, partial financial support to two workshops/ seminars was provided.
3. The work of NGO, Dhauladhar Public Education Society, of Kangra in the area of agricultural support and land redevelopment was strengthened.
4. Mountain Ecozoning programmes for sustainable agriculture were pursued.

3.2.4. Sustainable Resource Management Strategies for Rural Development in Himalaya

Background

Keeping in view the Scientific Advisory Committee recommendations, resource constrains, manpower optimization requirements, the following projects initiated in the previous years have been integrated into one main project. This was possible mainly because all these projects addressed location specific resource management problems for achieving sustainable rural development.

1. Integrated development of a village cluster in Nagaland, through participatory approach involving traditional village level institutions.
2. Study of resource use in Kullu Valley to evolve sustainable practices.
3. A study of the 'land-holding' and 'land-tenure' systems in Ao village having Jhum and settled agriculture.

Fresh location specific studies were started to cover more agroclimatic/ administrative subunits of Himalaya. These include Arunachal Pradesh (High Altitude Trans Himalaya); Assam/Meghalaya (shifting cultivation areas + lower valley); and U.P. Hills (settled agriculture and agroforestry). Location specific studies addressed the pertinent issues falling under the broad objectives of the project.

Objectives

1. To identify the critical resources and to study their qualitative/quantitative attributes.
2. To explore whether the local/indigenous knowledge or peoples' participation can be used for effective resource management.
3. To study the linkages, impacts of government programmes on resource management strategies and on rural development.

Results and Achievements

a) Agroforestry and Restoration Model for U.P. Hills

1. The survival percentage for all the species in the 5th year remained same in the agroforestry site after six months of plantation. However, on the restoration site the average survival percentage declined from initial 74% to only 46%. Majority of the species at this site have more than 50% survival whereas very low survival was recorded for *Boehmeria rugulosa, Sapium sebiferum* and *Ficus glomerata.*

2. Species like *Alnus nepalensis, Dalbergia sissoo* and *Ficus glomerata, Albizia lebbek* and *Albizia stipulata* exhibited higher frequency, density and total basal cover at agroforestry and restoration sites whereas these values were recorded lowest for *Ficus rumphii, Pyrus pashia, Bauhinia variegata, Celtis australis* and *Boehmeria rugulosa.*

3. The growth of the main axis in the 5th year of plantation was recorded highest for *Alnus nepalensis* followed by *Dalbergia sissoo* and *Celtis australis* at agroforestry site whereas species such as *Alnus nepalensis, Albiziastipulata* and *Albizia lebbek* showed maximum growth of the main axis at restoration site.

4. On agroforestry site the growth diameter at breast height was recorded highest for *Ficus glomerata* followed by *Alnus nepalensis* and *Dalbergia sissoo.* However, the minimal DBH was exhibited by species like *Bauhinia variegata, Grewia optiva, Pyrus pashia,* and *Celtis australis.* On the other hand, on restoration site, maximum DBH was observed for *Alnus nepalensis, Albizia stipulata* and *Albizia lebbek.*

5. However, minimum crown length was observed for *Ficus rumphi* and *Melia azedarach,* respectively, on agroforestry and restoration sites. *Alnus nepalensis,* exhibited maximum crown diameter on both the sites while minimum was recorded for *Ficus rumphii* on agroforestry site and for *Pyrus pashia* on restoration site.

b) Studies on Shifting Agriculture and Valley Systems

1. The soil fertility changes are being monitored. Preliminary observations indicate enormous nutrient loads being washed down to valley systems from slash and burn systems.

2. Rice yields of various land races were compared. It was found that the most preferred land races had low productivity and the least preferred ones the highest.

3. Off farm employment is preferred over agricultural activities in the study villages.

4. The land-tenure/land holding systems of Ao village are being worked out in relation to changes occurring both in time and space.

5. Relationships of institutions with resource management strategies are also being probed. The new generation is more interested in consumer/market oriented approach than the self-help oriented traditional institutional setups.

c) Studies on High Altitude Trans Himalayan Areas

1. The pressure on wood is enormous and the removal of boles/standing dead trees upto the ground level indicates this.

2. Even regeneration is hampered due to heavy open grazing and persistent pruning of sprouts.

3. Resource utilization to the optimal level is not present as alternate opportunities are not available.

d) Studies on Buffer Zone Villages of a Sanctuary in High Himalaya

1. The laxity of government agencies in imposing regulations is helping both industries and illegal encroacher to over exploit the resource base.

2. Regeneration of the most valuable resources is fast depleting. This can be inferred from the time taken to collect the same resource in comparison to previous years.

3. The proportionate time allocations worked out indicated that less available high cost produce, gets maximum time.

4. Predominant part of cash requirements of the studied villages are dependent on minor forest produce trade.

(The project is being further supported by compatible studies on the similar objectives/ programmes. They are, Appropriate Technologies for Soil Conserving Farming Systems; An Empirical Study of Development of Tribal Communities from Eco-cultural perspectives : A Case Study in the Central Himalayan Region of India; Institutional Strategies for Sustainable Mountain Farming Systems; Tropical Soil Biology and Fertility Programme - South Asian Region Network and Designing; Developing and Testing Sustainable Natural Resources Management Models through People's Participation in Critical Villages in Nanda Devi Biosphere Reserve for achieving the objectives of conservation of biological resources in the Himalaya).

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

Background

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

The use of natural resources in and around protected areas is a reality, particularly in less developed countries. The conventional managerial attitude of the prohibition of such resource use by policing has, in the past two decades, given way to negotiation and cooperation with local people to find alternatives to their dependence on natural resources within protected areas. Therefore, the present project envisages to

design, develop and test sustainable natural resources seeking people's participation in the buffer zone villages of NDBR and to come up with appropriate strategies to achieve the goal of conservation of biological resources in the Himalaya.

Objectives

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

Results and Achievements

1. Based on the preliminary survey, general information regarding forest type, geology, location, boundaries, natural features and the inhabitants of the NDBR buffer zone areas have been collected from the different sources.
2. A detailed survey of the NDBR buffer zone villages located in the Chamoli district was conducted to enumerate the name of the total Bhotiya villages (Tolchha community) at their both (winter and summer) dwellings and also to understand and locate their exact migration patterns and routes.
3. Based on the mode and type of migration, resource use pattern and their access to the forest/natural resources, four villages namely Lata, Reni, Malari and Suraithota/Sigri in buffer zone and one village namely Jugzu, located outside of the buffer zone have been selected for in-depth study.
4. Two appropriate sites (village degraded community land) have been identified at Lata and Peng villages, respectively for land rehabilitation demonstration programme and the site preparation work. Wall fencing, land levelling and shaping operations at both the sites have been completed.
5. Plant species of multiple utility preferred by the buffer zone villagers of NDBR for land rehabilitation programme have been identified. Germplasm of some of the species have been collected for nursery raising.
6. Detailed demographic studies for NDBR buffer zone villages were undertaken based on the data collected from census hand-books of 1971, 81, 91, and collected during recent survey. Besides the above, data related to land use (forest, agriculture, wasteland, and degraded land, etc.) for the above periods were also collected from census hand-books as well as from the revenue department.

3.2.6. Rehabilitation of Degraded Land in Mountain Ecosystems: Indian Central Himalaya

This is an ongoing project. Please see previous Annual Reports for background and objectives.

Results and Achievements

1. Apart from raising mechanical fencing for enclosing the entire 9 ha land at Balgari, renovation of old terraces, plugging of gullies, and raising check dams were some of the major initial activities.
2. All efforts to raise the productivity of any land-form are futile if renovative processes are implemented without sufficient water.

Prior to initiating any soil amendment technologies, two polyethylene lined underground storage tanks were constructed for storing natural spring as well as surface (rain) water.

3. Difficulties arise and damages occur when saplings are transported to long distances. A nursery of over 15,000 saplings of tree species was raised at Balgari. More than 10,000 saplings have been planted, including a few perennial grasses. The planted species have recorded a high survival rate of 95% and significant increment in their annual girth and length have been recorded (Tables 3, 4 & 5). Species selected are socially and ecologically acceptable and meet the high demands for fodder, nitrogen fixing and high value timber, etc.

4. Soil amendments have been made with easiest and least expensive mechanical and biological means. To increase soil fertility status, nitrogen fixing crops viz. *Cicer arietinum, Glycine max, Pisum sativum* were raised using hybrid varieties recommended for mid hills.

5. To supplement the usage of compost manure, bio/weed compost is being prepared by simple but efficient weed composting technology.

6. Cash crops like large cardamon and maggar bamboo have been planted and significant growth performance was recorded for the latter.

7. In-depth studies of regional and area-specific landuse patterns, population growth, literacy, livestock population, spatial pattern of economy, fuel demand, etc. have been documented. In addition, a comparative study of energy inputs per year (%) by women of different age groups in various activities has been completed.

8. Soil physical and chemical parameters have been analysed for experimental and forest soils. Values obtained for different parameters during 1993-95, have not shown very significant changes.

9. Phytosociological studies of project site Balgari were done in Sept. 1993, 94 and 95. The relative dominance of C_4 species e.g., *Imperata cylindrica, Chrysopogon serrulatus* and *Fimbristylis miliacea* has been recorded for degraded lands.

10. Microbiological studies; Irrigation of project site during the period has brought about gradual increase in micro-organisms per gram of soil in both rhizosphere and non rhizosphere regions (Table 6). An increase in the population of fungi, bacteria and actinomycetes is an indication of enhanced microbiological activities in the soil - necessary for nutrient cycling.

11. Apart from the practical demonstration of viable technologies, formal and informal discussions relating to nursery development, general environmental issues, conservation and multiplication of existing natural resources, education etc. have been organised from time to time. Training camps for Ex-Army personnel, NGOs, women, school children were organised at Arah under the INHI Core Group of the Institute. A formal formulation of a villagers' co-operative is under process, for transferring the project land for future management to the villagers under the guidance of Institute staff.

Table 3. Survival of tree species planted at Arah (project site)

Species planted	Local name	No. of trees planted		% Survival
		1994	1995	
Grewia optiva	Bhimtal	3662	98	96
Dalbergia sissoo	Shisham	630	97	97
Quercus incana	Banj	460	95	92
Quercus glauca	Faliyat	800	97	94
Ficus macrophylla	Timil	27	93	92
Ougeinia dalbergioides	Sanan	48	96	96
Debregeasia longifolia	Tushiar	43	93	92
Alnus nepalensis	Utish	60	100	100
Bauhinia retusa	Kanual	654	98	98
*Dendrocalamus**	Bans	79	--	97
*Diploknema butyracea**	Chura	25	--	98
*Thysanolaena maxima**	Ons	130	--	100
Albizia lebbeck	Safed Shisham	68	98	98

* The species were planted in the year 1994.

Table 4. Changes in mean height (cm) of different tree species planted at Arah (project site)

Species planted	1993	1994	Change	1995	Change
Quercus glauca	19.50	38.10	18.60	80.33	42.23
Quercus incana	12.30	29.90	17.60	62.36	32.46
Grewia optiva	28.40	80.00	52.60	159.93	79.93
Ficus macrophylla	21.00	40.00	19.00	69.14	29.14
Ficus nemoralis	24.90	58.10	33.20	92.00	33.90
Debregeasia longifolia	25.10	60.00	34.90	100.42	40.42
Ougeinia dalbergioides	25.30	52.00	26.70	91.89	39.89
Bauhinia retusa	40.00	79.50	39.50	149.50	70.00
Albizia lebbeck	36.00	69.50	33.50	143.50	74.00
Dalbergia sissoo	30.50	102.10	71.60	207.36	105.26
Alnus nepalensis	33.72	114.00	80.28	292.40	178.40

Table 5. Changes in average girth (mm) of different tree species planted at Arah (project site)

Species planted	1993	1994	Change	1995	Change
Quercus glauca	7.31	9.49	2.18	13.04	3.55
Quercus incana	7.35	10.14	2.79	13.17	3.03
Grewia optiva	5.16	11.36	6.20	19.52	8.16
Ficus macrophylla	8.91	13.01	4.10	18.98	5.97
Ficus nemoralis	10.13	15.46	5.33	21.73	6.27
Delbregeisia longifolia	9.21	13.41	4.20	20.26	6.85
Ougeinia dalbergioides	7.19	14.23	7.04	18.72	4.49
Bauhinia retusa	8.10	17.25	9.15	24.67	7.42
Albizia lebbeck	6.62	12.19	5.57	19.01	6.82
Dalbergia sissoo	8.42	13.67	5.25	22.63	8.96
Alnus nepalensis	14.21	26.22	12.01	58.29	32.07

Table 6. Changes in average number of micro-organisms/gm dry soil (% D)* during 1993-95

Micro-organism	1995		1993	
	N	R	N	R
Fungi	220	122	97	74
Bacteria	172	115	125	95
Actinomycetes	68	44	38	20

R = Rhizosphere, N= Non-rhizosphere

* dilution factor: fungi 10^3; for bacteria and actinomycetes 10^5

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

This is an ongoing project, please see previous Annual Report for details.

Results and Achievements

1. Twenty sampled villages, ten each for the Jaunsaries and the Bhotias have been studied to satisfy its objectives. Primary survey has been completed in all the villages and data analysis are being carried out on important data files like demography, economy, socio-cultural milieu and development interventions etc. using Statistical Package

for Social Science (SPSS) package. Completion of natural resource maps for all the twenty villages with spatio-temporal connotations has been a very satisfying achievement, which will be of immense use in the resource based planning for both the tribal communities. A national Seminar christened "Tribal Development: Options" has been scheduled to be held under the project during May 22-24, 1996 to disseminate the major findings of the project.

2. Considering the vastness of data, the study will be confined to important findings on demography for this issue. A comparative analysis between both the tribes reveals that 78.2 and 21.8% of the families among the Jaunsaries are joint and nuclear families respectively in contrast to 47.0 and 53.0% among the Bhotias. Further, average family size among the Jaunsaries is 10.39 in comparison to 6.12 that for the Bhotias. While females constitute 2.60% head of the households among the Jaunsaries, it is 13.5 for the Bhotias.

3. The male and female literacy rates among the Jaunsaries are 60.0 and 25.6% respectively against 84.4 and 50.9% among the Bhotias. Probably the Bhotias as a tribe has the highest literacy percentage among the Indian tribes.

4. The sex ratio is low in both the tribes being 835 among the Jaunsaries and 909 among the Bhotias. It becomes acute among the Jaunsaries (520) above the age-group 60+ in comparison to the Bhotias (667).

5. More percentage of marriage by elopement is found among the Bhotias (7.2%) than the Jaunsaries (3.7%). However, arranged marriage appeared to be rule of thumb in both the societies i.e. 90.9% among the Bhotias and 96.3 % among the Jaunsaries. Interestingly, 22.6% of the females at first marriage were below the age 9 only among the Jaunsaries in comparison to 1.0% that for the Bhotias (Table 7).

Table 7. Age at first marriage (of females)

Age Group	Percentage of marriage	
	Jaunsaries (N=1328)	Bhotia (N=1278)
Below 9	22.6	1.0
10 - 13	22.3	6.3
14 - 17	22.4	28.9
18 - 21	20.1	30.0
22 - 25	7.5	22.7
26 - 29	2.6	6.7
30 - 33	1.6	2.4
33 +	0.9	1.8

6. A woman was found maximum 14 times pregnant among the Jaunsaries in contrast to 13 times among the Bhotias. Further, among the Jaunsaries 73% of the women were found pregnant for 5 times while it was 82.3% for the Bhotias. A maximum miscarriage upto 8 was found among the Bhotias against 5 found among the Jaunsaries. Maximum percentage of females had only 1 miscarriage, i.e. 55.1% and 60.7% among the Jaunsaries and the Bhotias respectively. Preference for more number of children was high among the Jaunsaries (Table 8).

Table 8. Child preference among ever married females (%)

Preferred Number of Children	Total Children		Sons	
	Jaunsaries	Bhotias	Jaunsaries	Bhotias
1	2.8	29.1	15.7	81.3
2	16.8	60.7	53.6	17.3
3	40.8	7.1	14.1	1.4
4	21.2	2.8	11.8	--
5	6.9	0.3	3.9	--

The findings convincingly establish the higher social advancement of the Bhotias than the Jaunsaries.

3.3. CONSERVATION OF BIOLOGICAL DIVERSITY

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

Background

In view of the increasing population in the Himalaya many habitats are being constantly converted into simpler systems for providing more harvestable goods to the people. As a result the scenario of habitat heterogeneity and species diversity is changing. The identification and characterization of habitats of the Himalaya, especially those supporting sensitive biota is of paramount importance for identifying the disruptions and magnitude of pressures leading to habitat degradation and extirpation of important species. The consequences of habitat fragmentation are multiple. Therefore, the whole process has a negative effect on the population size, extinction rates and dispersal capacity. Index of change in a system can effectively be monitored and conservation measures adopted when habitats, instead of single species are taken as study units. The project envisages initially to study the habitat diversity in protected area of Kumaun (Askot Wildlife Sanctuary, AWLS) and Himachal Pradesh (Kanawar Wildlife Sanctuary, KWLS).

Objectives

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

Results and Achievements

Askot Wildlife Sanctuary in Kumaun (U.P.)

1. Inventory of 1262 species of vascular plants belonging to 173 families and 707 genera has been prepared. Representation of species in different taxonomic groups and life form classes is presented in Table 9.
2. Diversity of floristic elements in various identified habitats was analysed. Forest habitat represented maximum diversity (623; 49.37%), followed by exposed open/grassy slopes (366; 29%), shady moist places (234; 18.54%), alpine meadows/slopes (219; 17.35%), riverine/water courses (176; 13.87%),

Table 9. Diversity of taxonomic groups and life forms in AWLS

Taxonomic groups	Families	Genera	Species			Life forms	
			Herbs	Shrubs	Trees	Ferns	Fern allies
Angiosperms	136	641	1112	771	191	150	--
Gymnosperms	4	7	7	--	2	5	--
Pteridophytes	33	59	143	--	--	--	143
Total	173	707	1262	771	193	155	143

agricultural field borders (175; 13.87%), rocks/ boulders / rock crevices / walls (175; 13.87%), and shrubberies (169; 13.39%).

3. Similarity in species composition was maximum (71.7%) in shrubberies and alpine meadows / slopes. This is followed by exposed open / grassy slopes and shady moist places (47.32%), exposed open / grassy slopes and waysides / roadsides (40.73%), exposed open/grassy slopes and agricultural field borders (35.5%), way sides / road sides and agricultural field borders (27.54%), shady moist places and riverine / water courses (26.83%) and rocks / boulders / rock crevices / walls and epiphytic habitat (25.87%) respectively.

4. Along vertical gradient maximum species richness (860, 68.2%) was in the zone, between 1001-2000 m. Species richness decreases both above and below this zone.

5. Of the native taxa (432 spp.), 24 were endemics and 250 near endemics. The range restriction and small population size of these endemics and near endemics merit attention for conservation.

6. Among other sensitive taxa 10 species have been recorded in Red Data Book of Indian Plants.

7. Inhabitants preference for use of the species was analysed. Of the total (348) woody species, 71 (21.40%), are used as fodder. Analysis revealed that 13 species are highly preferred fodder and therefore facing high anthropogenic pressures (Resource Use Index, RUI > 20). Among others, 6 species (RUI 10-20) showed average demand. Species subjected to high pressure are presented (Table 10).

8. 31 species (8.91%) were used as fuel. Of these, 8 species showed RUI > 50% indicating high pressure (Table 10). Seven species (RUI 20-50) are among other preferred taxa. Other species (16, RUI < 20) are less preferred.

9. Floristic representativity (richness and abundance of native taxa) in identified forest communities (see Annual Report 1994-95) was analysed. Along vertical gradient floristic representativity in all growth forms (tree, shrub, herb) increased significantly (trees, $p < 0.05$; shrubs and herbs, $p < 0.01$). High degree of alien presence and abundance in herbaceous flora of most forests is of serious conservation for concern.

Table 10. Preference analysis of fodder and fuel resource in AWLS

Taxa	Average collection (Kg/house hold/day)	Probability of use	Recource Use Index (RUI)
Fodder:			
Phoebe lanceolata	4.85	0.36	174.60
Ougeinia oojeinensis	3.77	0.34	128.18
Castanopsis tribuloides	5.26	0.24	126.24
Bauhinia variegata	2.82	0.28	78.96
Boehmeria rugulosa	1.85	0.24	44.40
Mallotus philippensis	2.07	0.21	43.47
Boehmeria platyphylla	1.59	0.22	34.98
Ficus semicordata	3.03	0.09	27.27
Bridelia retusa	1.45	0.17	24.65
Quercus leucotrichophora	1.82	0.13	23.66
Millettia auriculata	1.53	0.15	22.95
Quercus lanuginosa	3.11	0.07	20.54
Fuel:			
Woodfordia fruticosa	18.56	0.78	1447.68
Pinus roxburghii	8.82	0.71	626.22
Macaranga pustulata	4.70	0.56	263.20
Quercus leucotrichophora	5.86	0.34	199.24
Engelhardia spicata	3.16	0.36	113.76
Mallotus philippensis	3.10	0.34	105.40
Casearia glomerata	2.42	0.39	94.38
Phoebe lanceolata	2.06	0.30	61.80
Eurya acuminata	1.64	0.27	44.28
Lyonia ovalifolia	2.42	0.18	43.56

Kanawar Wildlife Sanctuary (H.P.; Fig. 2)

1. Preliminary survey of Mathinala valley, the zone of potential habitats for wildlife, revealed a total of 36 woody taxa (20 trees and 16 shrubs). Of the total, 69.4%, 39.9%, 25% and 30.5% taxa respectively have habitat preference towards forest, ravines (humid), riverine and shrubberies.
2. Observations and data were obtained for seasonal habitat preference, possible predation and perceived use, crop damage and peoples' perception of local conservation

status of wildlife etc. A total of 95.5% cultivated land of two lower zone village was under crop during 1994-95. Analysis on crop damage by wildlife revealed that, there was an estimated maximum loss of 2,235.75 kg/h for apple and 822.49 kg/h for maize. Notable amongst crop raiders were Monkey (93.5%), Porcupine (42.1%) and Black Beer (31.71%), causing maximum crop field damage (Fig. 3).

3. Perception survey revealed that black Beer, Serrow, Himalayan Thar (mammals), and Cheer, Monal and Tragopan (pheasants) are top ranking threatened taxa. However, Civet, Monkey, Porcupine, Flying Squirrel (mammals), Khalij and Koklas (pheasants) are the most represented fauna in KWLS.

4. Fuel wood use pattern in KWLS were studied. Observations on fuel wood consumption and consequent pressure on adjacent habitats/ taxa at different camping sites along 1555-3900 m during 1994 and 1995 trekking seasons suggest that habitats at high altitude camping sites (Khaccha Thach, 3100-3400 m; Mang Thach, 3280 m and above) are highly unsustainable. *Rhododendron campanulatum* is the most threatened taxa above tree line.

5. Man made bark-stripping incidence on *Quercus semecarpifolia* trees at treeline habitat (1.5 ha scanned area) was assessed. Out of 650 trees/ha of *Q. semecarpifolia*, 12.67 trees/ha were victimized for a total bark removal of 2,872.75 m^2/ha.

6. Bioresource inventory, use pattern and traditional knowledge on their management is being prepared. Data have been obtained for heavy used taxa. Leaves of *Iris milesii* and *Aesculus indica* used heavily as fodder during winter months at high altitude village. For example, to meet a requirement of about 56,700 kg fodder per season, 34 families in one study village need harvesting of 79,96968 individuals of *I. milesii*. Likewise, for a demand of 17,850 kg fodder from *A. esculenta*, 89.14 trees are to be lopped. *Ficus palmata* covers 42.9% (maximum) of total agroforestry trees at lower zone and observed as the most productive taxa for fodder and fuel supply.

7. A survey on traditional bee keeping including socio-economics revealed that *Rhus wallichii, Morus serrata, Ulmus wallichiana* and *Populus ciliata* are preferred taxa for making log hives. In general, practice of bee keeping declined at lower zone village.

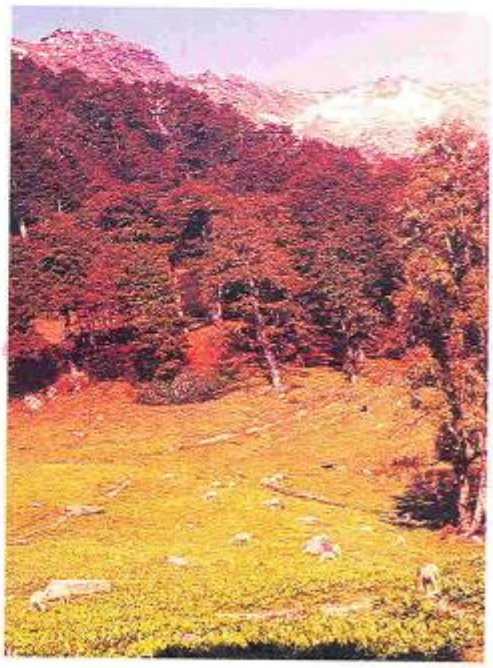

Fig. 2. Kanawar Wildlife Sanctuary

8. Of the total 23 medicinal plant species in local trade market 13 taxa are extracted from KWLS. Of these, *Morchella esculenta*, *Aconitum heterophyllum* and *Saussurea costus* alone were responsible for a local purchase of Rs. 86.28, 28.61 and 6.61 lac respectively in 1995; and 29.73, 11.5 and 2.09 lac respectively for 1990. However, highest increase in money transaction was obtained for *Pistacea chinensis*, i.e. 1,22.13%. *A. heterophyllum* emerged as top ranking trade taxa in terms of percent increase in total supplied amount from 1990 to 1995.

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, land scape elements and ecosystems. As such, it is imperative to develop a computerized data base of existing bioresources of the Himalaya. So far, comprehensive base line data for the Himalayan bioresources is not available. Therefore, preparation of inventory of bioresources (family wise, rare-endangered, ethnobiological, endemics, key stone species) has been initiated. The analysis of the data generated so far has proved useful.

Objectives

1. Develop a computerized data base of all species and their habitats.
2. Identify gaps therein.
3. Draw information about various attributes of specific habitats/species.
4. Make it available to any user for effective dissemination.
5. Prioritization of activities related to conservation.

Results and Achievements

1. The diversity of family Brassicaceae in Indian Himalaya was analysed. Family comprises 202 species in 56 genera.
2. Trans/Northwest Himalaya (161 spp. 78.9%) showed maximum diversity, followed by Central (82, 40.2%), West (80, 39.2%) and East Himalaya (57, 27.9%).
3. Species representation in Central and East Himalaya is much similar (69.5%). This trend is followed by West-Trans/North West Himalaya (55.2%) and Trans/North West-East Himalaya (35.2%). The similarity with other Himalayan countries, i.e. Nepal and Bhutan is high (> 50%). When compared with Brassicaceae of Pakistan (48%), Soviet Asia (23%) and Europe (16%) species similarity is low.
4. Himalayan Brassicaceae shares 107 species (52.9%) with West-Central Asia and 70 (34.6%) with Europe. Most of the species rich genera show similar pattern.
5. Endemism is poorly represented (7 spp., 3.5%) in comparison to neighbouring areas (i.e. Europe 44.5%, USSR 34.2%, Iran 33.2%, Afghanistan 23% and Pakistan 12.6%). However, if near endemic taxa are also included the endemic figure for Himalaya (sensu lato) increases to sixty six (32.7%) and is comparable with endemism of other areas.
6. Of the 59 near endemic taxa, percentage of restricted and broad near endemics is 50.8

and 49.2% respectively. Restricted near endemics further manifest localized distribution based on political boundaries of neighbouring nations.

7. While considering both the endemic (*sensu stricto*) and near endemics for analysis, the percentage endemism for major genera reads as under Arabidopsis (66.7%), Arabis (54.4%), Draba (42.8%), Erysimum (50.0%) and Sisymbrium (22.2%). The endemism in species rich Himalayan genera is compared with neighbouring areas (Fig. 4).

of endemic and near endemic taxa makes conservation in Trans/North West Himalayan province imperative.

3.3.3. Establishment and Maintenance of a 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)

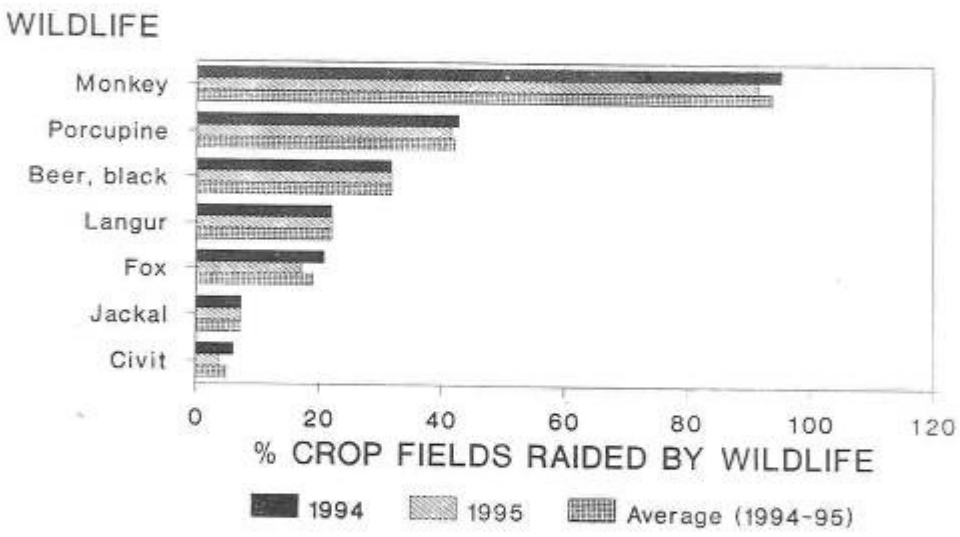

Fig. 3. Major crop raiders (wildlife) in lower zone villages of Kanawar Wildlife Sanctuary.

8. Proportional representation of Brassicaceae is high in temperate (1501-3000 m) zone (116 taxa, 57.4%), followed by alpine (3001-4500 m) zone (70.34%). Two extremes of altitude range, i.e. <1500 m (Sub-tropical) and >4500 m (high alpine) are relatively species poor (17.8% and 14.9% respectively).

9. The existence of characteristic complements

and maintenance of Rhododendron arboretum at Sikkim are continuing. The project is envisaged to be extended to Himachal Pradesh and North-East region of Indian Himalaya. The activity will not only serve as a gene bank of different Himalayan life forms but also provide opportunities for facilitating research, training and development activities.

Objectives

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

Results and Achievements

1. Infrastructure facilities such as site development and extension of arboretum area for the plantation of seedlings of Himalayan species continued.
2. Propagules of 55 species collected from different parts of Kumaun Himalaya and sown in the arboretum nursery and monitored forgermination and growth performance. *Aleurites moluccana, Albizia procera, A. chinensis, Aegle marmelos, Robinia pseudo-acacia, Leucaena leucocephala* and *Phoenix humilis*, showed 100% germination. On the contrary, *Pittosporum nepalense* (4.3%), *Olea glandulifera* (2.1%), *Quercus semecarpifolia* (6.7%), *Syzygium cumini* (3.5%) and *Terminalia chebula* (5.2%) showed poor germination.
3. Growth performance of 5 species in three conditions (Glass house, Net house and Nursery) was observed (Table 11).
4. Effect of frost on different species planted in the arboretum and seedlings growing in nursery was recorded. *Dalbergia sericea, Butea pellita, Saurauia nepaulensis, Albizia chinensis* and *A. julibrissin* were highly frost sensitive taxa (> 60% damage of aerial part). Amongst others, *Bischoffia javanica, Emblica*

Table 11. Germination and growth performance of five tree species in different conditions (seed sowing March 1995)

Taxa	Germination (%)	Growth performance (height cm) n = 10								
		Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Heynea trijuga										
A	42.5	--	3.3	10.0	10.5	12.3	14.0	15.8	16.0	16.3
B	37.5	--	2.5	6.5	7.8	9.8	10.7	11.0	11.0	11.0
C	85.9	2.1	3.8	5.4	6.7	6.8	8.2	8.5	8.5	8.8
Semecarpus anacardium										
A	46.7	--	4.7	7.7	10.0	10.6	11.5	12.3	13.8	14.0
B	46.7	--	3.4	5.2	6.2	6.4	6.4	6.4	6.7	7.0
C	35.7	3.3	4.9	6.1	6.3	6.7	7.0	7.5	8.0	8.0
Fraxinus micrantha										
A	92.5	1.9	5.9	10.3	13.9	14.8	15.5	15.7	15.8	16.2
B	87.5	1.8	3.8	6.9	12.2	12.6	14.5	14.8	15.0	15.0
C	84.3	1.1	2.7	7.6	14.0	16.8	18.3	18.5	18.5	18.5
Garuga pennata										
A	10.0	--	--	7.5	11.2	14.7	16.1	19.5	21.0	21.0
B	10.0	--	7.8	13.5	13.7	14.8	17.3	17.7	18.0	18.0
C	44.3	--	2.5	7.8	10.1	14.7	15.8	16.5	16.5	16.5
Olea glandulifera										
A	5.0	--	--	2.0	3.5	4.8	8.7	9.5	11.5	11.7
B	--	--	--	--	--	--	--	--	--	--
C	2.1	2.1	4.0	5.2	5.7	7.1	8.1	8.5	9.0	14.0

A= Glass house; B= Net house; C= Nursery

officinalis, Cassia fistula, and *Ehretia laevis* were also frost sensitive. Among frost resistant species, *Prunus cerasoides, Olea glandulifera, Spondias pinnata, Fraxinus micrantha, Quercus leucotrichophora, Q. semecarpifolia, Q. serrata, Castanopsis tribuloides, Ligustrum nepalense, Aleuritis moluccana, Dalbergia sissoo*, and *Betula alnoides* were notable.

5. Biotic pressures on the various planted species was recorded. *Ficus* (*F. nemoralis, F. roxburghii, F. semicordata, F. palmata*) and *Bauhinia* (*B. retusa, B. vahlii, B. variegata*) species, being preferred by rhesus monkey and porcupine, face problem in proper establishment.

6. Three thousand seedlings raised in arboretum nursery were used for the development of arboretum sites and Institute Campus. Also 300 seedlings of ten multipurpose tree species were used for developing a conservation model in College Campus at Narayan Nagar (Pithoragarh).

7. Analysis of soil characteristics in arboretum sites is continuing. Table 12 includes the data on yearly variation of organic Carbon and Nitrogen ratio (C/N ratio). High C/N ratio in 1992 can be attributed to the supply of compost manure during plantation.

Table 12. Variation of C / N ratio in arboretum soil

Plot	C / N Ratio			
	1992	1993	1994	1995
A	5.70	3.32	2.67	3.06
B	6.60	2.96	2.75	2.98
C	7.27	3.30	3.00	1.72
D	4.18	3.12	1.40	1.44

3.3.4. Timberline and Snowline Vegetation of Kumaun in Central Himalaya: Aspects of Composition, Diversity and Conservation (Background, Objectives as in previous report) (sponsored by DST, New Delhi)

The project has been completed and highlights of the projects are as follows:

Table 13: Distribution of endemic taxa in different rarity classes and frequency in different habitats

Rarity Taxa Class	No. of species	Habitat Types, no. of species					
		Forest	Forest edges/ open slopes	Boulders/ Rock crevices	Moraines	Marshes/ moist situations	Disturbed sites
1.	43 (26.2)	15 (31.3)	36 (33.3)	9 (28.1)	20 (40.8)	17 (32.7)	9 (45.0)
2.	29 (17.7)	12 (25.0)	21 (19.4)	4 (12.5)	9 (18.4)	6 (11.5)	3 (15.0)
3.	27 (16.5)	4 (8.3)	15 (13.3)	6 (18.8)	10 (20.4)	12 (23.0)	2 (10.0)
4.	31 (18.9)	5 (10.4)	11 (10.2)	9 (28.1)	9 (18.4)	7 (13.5)	3 (15.0)
5.	11 (6.7)	7 (14.6)	9 (8.3)	2 (6.3)	0 (0.0)	3 (5.8)	1 (5.0)
6.	10 (6.7)	3 (6.3)	8 (7.4)	1 (3.1)	1 (2.0)	3 (5.8)	2 (10.0)
7.	10 (6.1)	1 (2.1)	7 (6.5)	1 (3.1)	0 (0.0)	3 (5.8)	0 (0.0)
8.	3 (1.8)	1 (2.1)	1 (1.0)	0 (0.0)	0 (0.0)	1 (1.9)	0 (0.0)
	164	48	108	32	49	52	20

Values in parenthesis are % of endemic species

1. A complete inventory of timberline flora was prepared and nativity of the flora assessed. The flora consists of 465 species of which 64% (298 spp) are native. *Scrophulariaceae* (78%), *Ranunculaceae* (70%), *Asteraceae* (69%), *Rosaceae* (68%) and *Saxifragaceae* showed relatively high percentage of natives. In general, timberline flora suggested proportional representation of alpine and temperate (38 and 42%) taxa and diversity of growth forms (Annual Report 1994-95).

2. Forest vegetation was quantitatively analysed and three dominant physiognomic types identified : evergreen broad-leaves (*Quercus semecarpifolia, Rhododendron* spp); deciduous broad-leaves (*Betula utilis, Acer spp., Pyrus* spp.) and evergreen needle leaved (*Abies* spp., *Taxus baccata* subsp. *wallichiana*).

3. Flora was assessed for its sensitivity considering three broad ecological attributes ofa taxon (i.e. Geographic range, Ecological amplitude and local abundance). Total 8 categories of rarity were identified and frequencies of taxa in these categories and in different habitats was assessed (Table 13).

4. Considering nativity and sensitivity of flora together following conservation priorities were identified: (i) Over 35% of total flora are endemic and more importantly 20% are narrow range endemic, hence deserve priority, (ii) 34 taxa being locally scarce and narrow ecological amplitude deserve greater attention at local level; 10 taxa deserve attention at Himalaya scale. However, three taxa *Aconitum balfourii, Caragana gerardiana* and *Cypripedium himalaicum* being most sensitive at both scales are top ranking priority taxa (iii) Among habitats forest edges/ open slopes, marshes/moist situations and boulders/rock crevices deserve priority.

3.3.5. Initiating Biodiversity Conservation Through Peoples' Participation in Himalaya

Background

Biodiversity conservation programmes are being pursued across the Himalaya by both the Government and Non-Government agencies. Presently, such initiatives are restricted to identification of surveys, inventorisation of biological resources, strengthening the net work of Protected Areas, conservation of threatened species and ex-situ germplasm maintenance. It has been argued that conservation action needs to be promoted and implemented by bringing local people into the conservation movement and considering them as potential allies. Since these aspects are not adequately focused in the Himalaya an initiative in this direction was taken to promote interaction, facilitate flow of information, impart education, organize workshops / on-site training camps, prepare conservation related print material, develop preservation models in community land/College Campus and analyse responses of different target groups for ensuring follow up action, has been undertaken.

Objectives

1. Promote and strengthen interactions with the target groups.

2. Promote conservation science especially among School/College students.

3. Impart on site training on collection,storage and propagation methods of target species focusing on teachers and students.

4. Obtain and analyse response of different target groups with respect to location

specific conservation options/priorities.

5. Establish preservation models in college/ community lands depicting locally important bioresources.

6. Prepare easy to grasp print material for target groups focusing on locally available biodiversity, their importance and methods for value addition.

Results and Achievements

1. The activity has been initiated in district Pithoragarh of Kumaun (West Himalaya). Two training workshops on "Conservation through people's participation" at remote localities (i.e. Gangolihat and Narayan Nagar) were organised. During these workshops, the subject "Biodiversity Conservation" was introduced to the participants. Focus was on-site training on different aspects of biodiversity conservation (i.e. gathering information on local bioresources, collection of propagules of important taxa, identification, nursery practices, restoration of degraded lands around school/college campus and community lands, preparing awareness material, etc.).

2. On the basis of the specific work area, preferences and working capacities of the participants of the workshop three groups i.e. i) the Resource Group (People's representatives, NGO'S and Government officials); ii) the Management Group (Teachers and academics); iii) the Workforce Group (students) were identified.

3. Of the 125 questionnaires distributed to the participants, 122 responded. The structure of the questionnaire dealt with the suggestions/ reactions/remarks and also about their perception of the utility of organising such workshops.

4. The reaction/suggestion from all the identified groups indicated that (i) protection and monitoring be ensured with respect to the plantation/nurseries being developed through the help of students and local communities; (ii) such activities must be organised more frequently in remote areas; (iii) most of the participants suggested to encourage women participation, involve related organisations, disseminate information packages to all adjoining Schools and Colleges, include this subject in the syllabi of Schools and Colleges. Attempts being made to incorporate these suggestions for future action.

5. The analysis of the questionnaires revealed that programme objectives were formulated in tune with their perception, however, the Institute could improve upon the nature of technical inputs (Table 14).

Table 14. Analysis of the responses of workshop participants

Features	Total (n=122)	Group 1 (n=45)	Group 2 (n=47)	Group 3 (n=30)
Objectives				
Agreed (%)	90.2	88.9	91.5	90.0
Achievements				
Objectives (%)	55.7	64.4	51.1	50.0
Interaction (%)	71.3	64.4	66.0	90.0
Attitude				
Willingness (%)	88.5	73.3	100.0	93.3
Volunteer (%)	75.4	64.4	74.5	93.3

Performance categories: < 50% - pour; 50-70% - satisfactory; 70-90% - good; >90% - very good

6. Plantation of 15 multipurpose species was done in a piece of community land (Gangolihat 3.5 ha) and College Campus (Narayan Nagar 1.5 ha). Survival and growth of these species are being observed with the help of college students.

3.3.6. Exploration of Lesser Known Crops of Garhwal Himalaya as a Food Source

(Summary of the completed project, please see previous Annual Reports for detail)

Results and Achievements

1. Over 40 species of food grains (i.e cereals, millets, pulses, oil seeds etc.) are grown in traditional agroecosystems and managed by the local farming communities. Several of these crops possess great potential for future exploitation.

2. These species/ varieties evolved over a span of centuries and are adapted to particular area and varied edaphic, topographic and climatic factors. Also different selection pressures over centuries of cultivation, resulted in immense variations, withstood the rigors of time, escaped attacks from insects, pests and diseases, tolerated harsh climatic conditions and possess the desired agronomic and genetic traits from which high yielding and resistant sources could be developed.

3. During the recent past traditional crop diversity of this region has been reduced due to various reasons and the knowledge of cultivation and uses of these crops is also disappearing from the region very fast.

4. To meet the increasing demand of food of local communities, it is imperative to conserve these traditional food crops for posterity.

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

Background

Indian Himalayan zone consists of 13% of total geographical area and supports 6% of the total population of the country. The region has vast diversity at genetic, social, cultural, economic and ecological levels. All over Himalaya consumption of wild edible plants is common and perhaps it is more prevalent in the Sikkim Himalaya. The wild edible species are frequently collected and consumed by the inhabitants in Sikkim from natural habitats. Due to increase of the human population the consumption of these species is crossing conceivable limit of their productivity levels. As exploitation of these wild edible species is increasing, a study seems to be of prime importance to see their nutritional status and natural regeneration. Some of these species can be saved through mass multiplication and popularizing them in traditional agroforestry systems. This will reduce pressure on the natural habitat and also lead to conservation and sustainable production of wild edible plants.

Objectives

1. To make inventory of wild edible species, their distribution and in-situ regeneration in the Sikkim Himalaya.

2. To know phenology and reproductive biology of important wild edible plants.

3. To estimate nutritive value of selected wild edible species, and

4. Mass multiplication of few important wild edible species and their domestication through agroforestry practices.

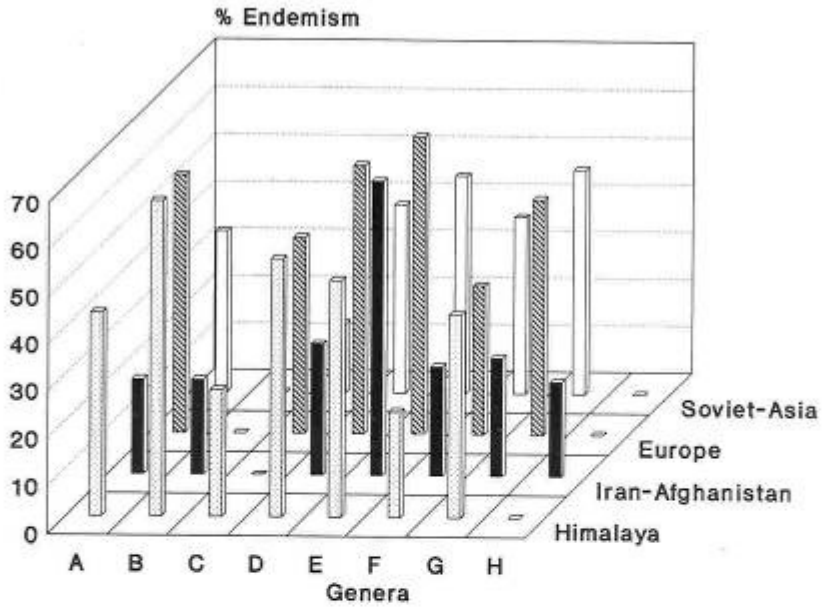

Fig. 4. Extent of endemism in selected genera in family Brassicaceae in Himalaya and neighbouring regions (A-Draba; B- Arabidopsis; C- Cardamine; D- Arabis; E- Erysimum; F- Sisymbrium; G - Thlaspi; H-Lepidium)

Results and Achievements

1. Out of 175 wild edible species belonging to 138 genera and 77 families have been screened. Most of the species (77%) are perennial in nature. Low-hills (< 900 m elevation) harbours maximum number of wild edible plants followed by mid-hills (900-2000m) and least at high-hills (> 2000 m). Most of the species are eaten as fruits/seeds (119), leafy vegetables (35), flower bud (18) and root/rhizome (8).

2. Each family generally takes 5-10 meals for a particular species, though most of the species are eaten just 2-3 times a year. On an average each family uses/consumes 7-8 types of wild edible species every year. A number of species are consumed as food during lean period and scarcity.

3. Six species, viz. *Diploknema butyracea, Spondias pinnata, Elaeagnus latifolia, Baccaura sapida, Machilus edulis* and *Eriolobus indica* are selected for detailed study for their nutrient analysis, fruit productivity and large scale multiplication (seed germination) in nursery, considering

Fig. 5. Nursery of medicinal herbs.

their use and preference in local folks (Fig. 5). The market prices for each species is from Rs. 5-8, 4-5, 8-10, 6-10, 15-25, and 8-10 per kg, respectively.

3.4. ECOLOGICAL ECONOMICS AND ENVIRONMENTAL IMPACT ANALYSIS

3.4.1. Ecology and Socio-economy of Transhumance Communities of Garhwal Himalaya

(Summary of completed project, please see previous Annual Reports for details)

The Bhotiyas, comprising three sub-communities viz., Marchha, Tolchha and Jadh are the transhumance communities of the Garhwal Himalaya inhabiting in northern most mountainous border areas of Chamoli and Uttarkashi districts of Central Himalaya and represent a total population of about 12573. All the three sub-communities of the Bhotiyas have two dwellings, and practice transhumance every year from higher Himalayan zone (2000-3600 amsl) to lower Himalaya (400-1400 m amsl) during winters and vice-versa during summers. Each Bhotiya sub-community has its own culture, tradition and religious beliefs. The main driving force behind transhumance activity is the constant need of the grazing land for sustenance of their livestock, which is the mainstay of their economy. Besides, their traditional summer abodes which is situated in tough and rugged mountains, where the climatic conditions are severe and it does not allow them to live in these areas permanently. Before the out break of Indo-China war in 1962, the trade relationship between Bhotiyas and Tibetans was very strong and therefore, during that period they were least depended on the natural resources to fulfil their basic needs. But as a consequence of Sino-Indian war the trade links were stopped their reliance on forests and agricultural products increased tremendously, resulting in heavy pressure on existing forests and other natural resource base. The major occupation of the Bhotiya sub-communities particularly of the Marchhas and Tolchhas have been sheep rearing and agriculture, with agriculture taking primacy over pastoralism in contemporary time. However, in the Jadhs, sheep rearing is still the main source of their livelihood because majority of the families do not own agricultural land.

The traditional culture and indigenous knowledge base of the Bhotiya sub-communities have faced a series of challenges during recent past. In these tribal communities, the rules and regulation by which the Tribal people have been traditionally governed have broken down. The traditional beliefs of the people are now being questioned by the young generation who are supposed to keep the culture alive. The causes of these problems are many and are related to economic, social and political factors. As a result, the social norms and value which were respected by these tribal communities in the past are now being ignored.

Traditionally the tribal villages were self-sufficient and therefore, the emphasis should be to improve upon this self-sufficiency to the extent required and subsequently emphasis could be to provide cash income. With fast depletion of the forest cover and resource base, the village ecosystem redevelopment of Bhotiyas should emphasize the pressure on the forest and effective conservation strategy of this resource. An integrated strategy for redevelopment linking rural ecosystem with forest ecosystem would alone ensure conservation of higher Himalayan mountain forest in a holistic way.

3.4.2. Development of Roads and its Socio-economic Impact: An analysis of Kapkot Block, Kumaun Himalaya

This is an ongoing project, please see previous Annual Report for details.

Results and Achievements

1. In order to achieve the objectives of the study, the villages in the block were categorized into 3 different zones on the basis of their locations from road side. The three zones are i) villages located on the road or within 2 kms. from the road, ii) villages located between 2 to 5 kms and iii) villages located at more than 5 kms from road side. In the present study, an attempt has been made to assess the impact of road network on human settlements. Impact of road on the type and pattern of settlement, shape and size of dwelling, building material, functional morphology of the dwelling have been compared.

2. Although in the mountainous area the pattern of settlement are primarily governed by the physical aspect, but transport routes play an important role in the expansion of the settlements as villages connected with roads have more new constructions along the roads which gives birth to linear pattern of settlements.

3. In the first zone after the construction of road, about 10 rural service centres have come into existence, which have paved the path for urbanization. All these centres are generally occupied by permanent and double storied buildings. The ground floor are mostly used for shops and the first floor for residence purpose, where as almost all the houses in the second and third zone are for residential purposes.

4. It was found that all the houses have courtyard 'Angan' which is always found in the front side of the house. The shape of 'Angan' is totally dependant on the shape of the house, and the size of house and 'Angan' depend upon the economic conditions of the dwellers. This feature (Angan) is almost absent in the first zone along the road side new houses.

5. Generally, construction of rural dwelling depends upon the availability of local materials (stone, slate, wood and mud which is found very common in the mountain areas). It was recorded that in the first zone the construction materials have changed to bricks, cement and lantered roof houses, and is a fashion along the road side villages. On the basis of material used and roof type, three types of houses have been recorded in the study area given as below:

   (i) Stone-mud and inverted "V" shaped roof mostly found in second and third zone.

   (ii) Stone-cement wall and inverted "V" shaped roof, mainly found in the second and some part of the first zone.

   (iii) Stone-brick-cement walls and lantered roof, found only in the first zone.

The size of room, window (with glass), door etc. have been found larger in the first zone as compared to the second and third zone. The introduction of septic toilets and bathrooms have also been recorded in the first zone.

3.4.3. Carrying Capacity Assessment of Kullu-Manali Complex

Background

This study was initiated in 1993-94, keeping in view the inputs to tourism planning in

the area. In the first phase, an assessment with respect to tourist accommodation was carried out at Kullu and Manali. Also the tourist flows and use of various modes of transport was documented. It was noted that Kullu Valley is facing various infrastructural constraints. Major ones being solid waste management and architectural and landuse control over hotel construction.

As tourism in this area can adversely affect the general surroundings through degradation, it was proposed to focus attention on this problem. In the second phase, two sites-one within municipality limit (Kullu) and other outside municipality (Mohal) were selected for study. The Kullu town study was carried out during famous tourist and cultural event of Dussehra focusing on solid waste generation and peoples' perception about infra-structural sufficiency and related aspects.

During 1995-96, recommendations for Kullu Dussehra were finalized and submitted to District Administration. In Mohal, solid waste sampling and perception study survey was carried out largely to access women's perception about their wastes and their willingness to participate in the process of management.

Objectives

1. To carry out survey, with greater emphasis on the views of women to ascertain their perceptions on wastes and level of participation in its management at Mohal (Kullu).
2. To estimate quantity of solid wastes and its characteristics.
3. To initiate waste management activities in Manali.

Results and Achievements

1. In Mohal, the perception and participatory survey was carried out in 78 households and 24 commercial outlets. It covered about 25% of all households and 50% of commercial establishments.
2. The survey indicated that 92% of the households and 96% of commercial establishments perceived solid waste in the area as a problem. 90% of households and 100% of commercial outlets admitted that they had a problem in terms of where to throw their garbage.
3. When asked about their current place of throwing the garbage 40% of the households and 46% of commercial establishments were found to be throwing it immediately outside their premises. 9% of households and 38% of commercial establishments stated throwing in a common area, whereas, 49% of residences and 17% commercial establishments reported to be using/disposing garbage within the premises.
4. On a very important aspect of willingness to segregate their own garbage in bio-degradable and non-biodegradable fractions, the willingness in both segments was found to be > 95%.
5. On a question of willingness to compost their own garbage, the willingness was found to be 96% amongst households and 92% in the commercial establishments.
6. In order to assess locational feasibility of common collection points, survey documented the distances people are willing to walk. The households indicated willingness to walk larger distances than the commercial

establishments in general. Most households were willing to go up to 100 m for a common collection point.

7. If provided with a common collection point, 96% of respondents in both categories were willing to ensure that their garbage is thrown in that.

8. 87% of households and 67% of commercial establishments confirmed visits by the waste handlers (Kabaries). Largely the frequency of visit was monthly. The most sought after items by the waste handlers were noted to be metal, plastic, glass and paper.

9. Solid waste characterization was carried out at 33 households and tentatively ready biodegradable were found to be 11%, biodegradable 25% and non-biodegradable 64%.

10. The preliminary estimates of garbage generation are 427 gm / day / household and 5 TPD.

11. The landuse mapping and survey was initiated in Manali during the year. The biggest problem noted was the fact that the part of Manali along the left bank of Beas is not part of the notified area.

3.4.4. Ambient Air Quality Monitoring in the Himalayan Eco-systems

Background

Initially, a project on bio-geochemical cycles was conceptualized in collaboration with Indian Institute of Tropical Meteorology, Pune to study interaction in biogeochemical cycles in Himalayan ecosystem. As it comprises of ambient air quality monitoring, revised title is more representative of the work.

Due to remoteness, the data on background concentrations of air pollutants for Himalayan region is virtually non-existent. This project attempts to systematically document these data on a long term basis and build institute's capacity to undertake air quality monitoring work and predict air quality impacts.

The present area of study namely Kullu Valley is an important tourist destination in Western Himalayas. It has experienced tremendous growth in tourism over past five years. The Valley is a 100 km. long starting from Aut (south) near Pandoh dam upto Rohtang Pass (north).

Objectives

i) Assessment of background concentrations of air pollutants

ii) Atmospheric chemical transformations in the Himalayan Eco-systems

Results and Achievements

1. In 1995, three locations along the longitudinal traverse of the Kullu Valley were identified at Mohal (Kullu)- 1100 m, Manali- 2000 m and Kothi in the upper Kullu Valley at 2500 m for air monitoring.

2. Suspended particulate matter measurements were initiated in Kullu Valley. Eight hour day time sampling was carried out using Envirotech High Volume Sampler (APM-415) at the selected sites.

3. The concentration of SPM ranged from 15-150 microgram per cubic meter of air.

4. While SPM at Kothi were found to be very close to pristine levels, at Mohal (Kullu) also SPM values were within specified limits.

The SPM concentrations were however found to be in excess of specified 24 hr. standard for sensitive areas during summer time at Manali. This is thought to be closely related to increased tourist activity at Manali during summer.

3.4.5. Environmental Assessment in and around Valley of Flowers

Background

The problem of solid waste has not remained confined to the metropolitan and urban areas alone. Due to increased influx of tourists, this has begun to affect places of scenic beauty and tourist interest in the high Himalayas too.

Trash along beautiful Himalaya treks is beginning to be noticed by all concerned. The Valley of Flower area in the UP Hills is one such Himalayan treks having large visitation population of the order of about one lakh persons per year.

The project was initiated in light of large scale problem of litter in the Valley of Flower area. While the project attempts to deal with a real life problem situation and throw light on possible solution, it also offers hope of providing insights which will be useful in tackling similar problems along numerous such treks already under threat or likely to come under such threat due to increased tourist influx.

Objectives

1. Assessment of solid waste problem in the study area.
2. Perception/Participatory surveys.
3. Identification of remedial strategies.

Results and Achievements

1. As the enroute shops were noted to be focal points of waste generation and disposal, a survey of shopkeepers were conducted to ascertain their potential participation in the solutions.
2. The survey covered over 60 or 40% of all shops in the area. Typical profile of the shopkeeper was noted to be a male below 35 years with education level less than matriculation.
3. Two thirds of all shopkeepers acknowledged solid waste to be a problem and rated the problem from moderate to serious.
4. Nearly 78% respondents stated that their current method of disposal is throwing around the shop. 12% respondents were found to bedisposing the waste in the nearby water body. Burning and burying were reported by about 10% respondents.
5. While 73% of shopkeepers were willing to install their own trash bins, 55% of respondents were also willing to segregate their garbage in biodegradable and non-biodegradable fractions.
6. Visitors were also felt to be an important group for the perception and solution of the problem. Keeping this in view, a survey of 350 visitors was carried out to ascertain their profile, perceptions and potential for participation in possible solutions.
7. About 60% visitors were found to be below 35 years of age. The professional profile ranged from business, government service, agriculturist and students and housewives. Educationally, while 38% were graduate, upto 66% visitors were found to be at least

matriculate, overall literacy percentage was about 96%.

8. Socially, while 58% visitors rated themselves as middle or lower middle class, upper middle class accounted for 37% and upper/high class accounted for 3%. About 75% visitors were noted to be from urban areas.

9. About 70% visitors surveyed perceived the problem of solid waste in the area. Most visitors rated garbage problem en-route to be most serious. However, in rating the groups/ agency responsible for the problem, they ranked themselves as group with highest amount of responsibility in the matter. The other groups responsible for problem and solution according to them were shopkeepers and local people.

10. The toilet problem was perceived mostly en-route followed by at Ghangharia and Hemkund. Cleanliness in toilets etc. was also noted to be a problem by the visitors due to lack of attendant staff and/or water.

11. When asked specifically, about their willingness to carry back their own garbage, 38% visitors were willing to do it. 51% were found willing if a carry bag is provided to them; however, upto 73% visitors were willing to bring back their garbage if a religious decree were to be passed by the Granthiji. Nearly 77% visitors showed willingness to take part in a mass initiative/drive for clean up.

12. The interactions with villagers in the Bhyundar village of survey area revealed that villagers themselves wished that the number of shops be limited and shop clusters should be located at few designated places. They also felt that soft drink bottles should be transported by ponies to Govindghat for selling. Proper toilets en-route and in the village was another point raised by villagers. They also indicated that proper drinking water arrangements are required at various places.

3.5. ENVIRONMENTAL PHYSIOLOGY AND BIOTECHNOLOGY

3.5.1. Microbial Inoculants for Improved Plant Performance in the Himalaya

Background

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

isolates can be developed as inoculants for better plant performance at higher elevations.

Objectives

1. Isolation and selection of plant growth promoting rhizobacteria.
2. Studies on rhizoflora associated with conifers.
3. Selection of phosphate solubilizing microorganisms and mycorrhizae in conifers.
4. Microbial interactions in tea rhizosphere.
5. Maintenance of useful microbial cultures of the Himalayan region.

Results and Achievements

1. A large number of rhizosphere and rhizoplane associated plant growth promoting rhizobacteria have been isolated, and screened for their i) nitrogen fixing ability, ii) phosphate solubilising activity, iii) production of antifungal metabolites, and iv) their survival at low temperatures (please see 1994-95 Annual Report for details). The selected bacteria were used as seed inoculants with various plant species grown in hills. The plant species selected were *Eleucine coracana, Zea mays, Fagopyrum esculentum, Amaranthus paniculatus* and *Vigna mungo* for pot experiment, and *E. coracana, Panicum milliaceum, Sorghum vulgare, V. mungo* and *Glycine* spp. for field experiment. The bacterial inoculation resulted in stimulation of various root associated micro-organisms, improvement in various plant growth parameters and significant increase in yield.
2. The rhizosphere communities of a particular plant species may be beneficial or detrimental for seed germination and subsequent growth. Significant increase in seed germination, from 18 to 42% in *Pinus wallichiana* and from 18 to 38% in *Cedrus deodara*, and improvement in plant growth parameters like mycorrhizal roots, needle numbers, shoot height, etc. were recorded due to rhizosphere soil inoculation. On the other hand, rhizoflora of *Taxus baccata* were found to have some antigermination factors, probably of microbial origin. Seed germination improved from 22 to 70% following modifications in the rhizosphere.
3. Studies have been initiated on the free living as well as symbiotic phosphate solubilising microorganisms of *Cedrus* and *Pinus* rhizosphere. Fungal species from rhizoplane and rhizosphere were isolated and screened for their phosphate solubilising activity, using a medium containing tricalcium phosphate @ 5g/l (Pikovskaya). Various species of *Penicillium* and *Aspergillus* showed strong phosphate solubilising activity in a range of 99 to 347 ug/ml. Mycorrhizal associations of *Pinus* and *Cedrus* have also been developed using various soil combinations. Experiments on isolation, infection, and nutrient uptake due to mycorrhizae are being carried out.
4. Tea is one of the most important cash crops of our country and is grown in most Himalayan states. Three aspects related to tea rhizosphere have been studied, viz., a) the rhizosphere effect, b) the role of antagonistic activities in the rhizosphere, and c) influence of environmental factors on microbial communities in tea rhizosphere. The tea growing Himalayan locations for these experiments are (1) Banuri and Mansambal tea gardens, Palampur, H.P. (2) Temi Tea Estate, Sikkim (3) Singell Tea Estate, Kurseong, West Bengal, and (4) Pant Tea

Estate, Bhowali, U.P. It has been found that the rhizosphere of young tea plants is stimulatory to microbial communities, whereas the rhizosphere of established tea bushes is strongly inhibitory as seen by (rhizosphere: soil) ratios of well below one. An established tea rhizosphere provided a natural site for the isolation of antagonistic microorganisms. Various bacterial species, belonging to genus *Bacillus*, have been studied in detail for their ability to secrete antifungal metabolites. The selected bacterial species are being tested for their potential towards better establishment of fresh tea plantations.

5. Isolates of bacteria, fungi and actinomycetes are being maintained for further study.

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

This is an ongoing project, please see previous Annual Report (1994-95) for details.

Results and Achievements

1. Vegetative propagation of *Taxus baccata* using young shoots of 1st year's growth has been standardized. The rooting response of small cuttings (approx. 6-7 cm) without any older base wood has been found to be better than that of larger cuttings (10-15 cm, of 2nd year's growth).

2. A marked seasonal effect (i.e. monsoon, autumn, winter and spring) on adventitious root formation was observed. While all the cuttings collected, planted and raised during spring (April) did not survive, the stimulatory effect during winter was, in general, similar to that of monsoon (July) but with somewhat lesser success. The most suitable season for rooting young, 1st year's stem cuttings with the aid of some of the chemicals (please see 1994-95 Annual Report) is in declining order: monsoon, winter and autumn.

3. In order to conserve this species in its natural habitat, the growth and survival of cutting raised plants were monitored. Growth (69.5% increase over initial height) and survival (63%) following 14 months (upto November 1995) after transfer indicated a satisfactory performance.

4. Attempts are being made to develop *in vitro* protocols for multiplication of *T. baccata* and callus cultures have been initiated. Leaching of seeds in water markedly influenced *in vitro* germination of excised embryos.

3.5.3. Impact of Possible Climate Change on Growth Performance of Plants

This is an ongoing project, please see Annual Report (1993-94) for details.

Results and Achievements

1. Effect of different concentrations of CO_2 on photosynthetic characteristics of some alpine plants, viz., *Podophyllum hexandrum, Aconitum balfourii, Rheum emodi, Nardostachys jatamansi, Picrorhiza kurrooa, Berginia ligulata* at temperatures and light intensities was studied.

2. The net photosynthetic rate, in general, decreased with increase in temperature. However, plants differed with regard to their temperature optima for photosynthesis at ambient CO_2 concentration.

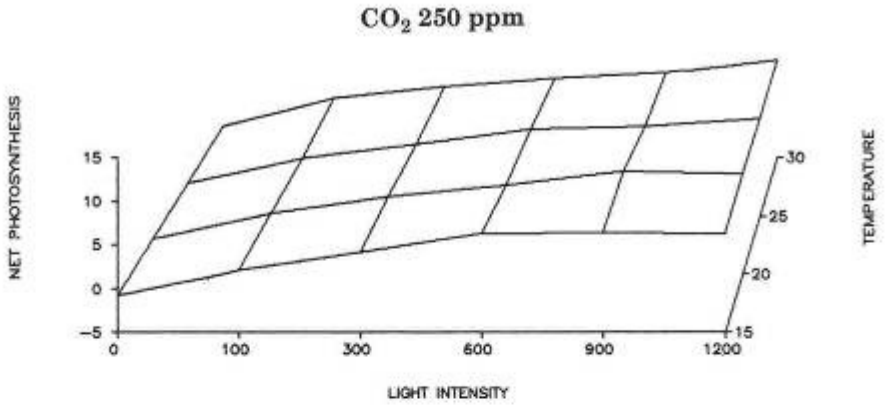

Fig. 6. An interactive effect of temperature (^{0}C) and light intensity (umol $m^{-2}s^{-1}$) on net photosynthesis (umol $m^{-2}s^{-1}$) of an alpine plant (*Podophyllum hexandrum*) at 250 ppm CO_2

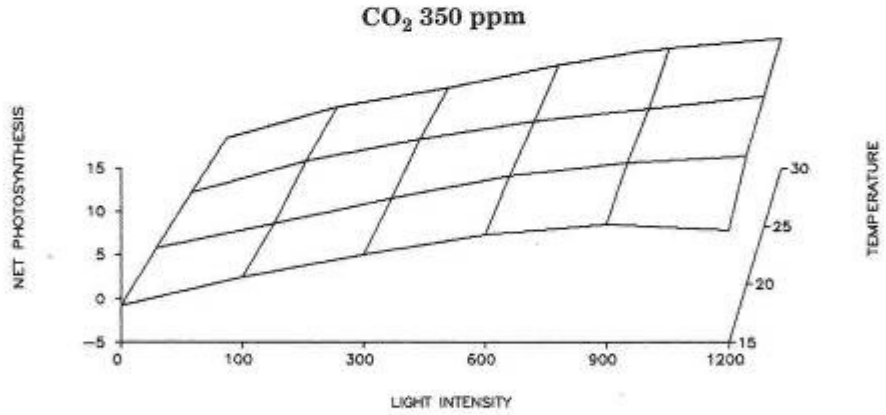

Fig. 7. An interactive effect of temperature (^{0}C) and light intensity (umol $m^{-2}s^{-1}$) on net photosynthesis (umol $m^{-2}s^{-1}$) of an alpine plant (*Podophyllum hexandrum*) at 350 ppm CO_2.

3. Enhancement in net photosynthesis was observed in alpine plants at elevated CO_2 concentrations (Figs 6-8). However, the magnitude of enhancement was related to plant thermal tolerances.

4. Stomata of alpine plants seem to be highly sensitive to temperature as stomatal conductance, in general, showed a decreasing trend with rise in temperatures.

5. Significant decrease in stomatal conductances for CO_2 and water was observed with rising CO_2 concentration.

6. Water use efficiency of alpine plants decreased considerably with increase in

temperature at ambient CO_2. However, the decrease was less pronounced at elevated CO_2.

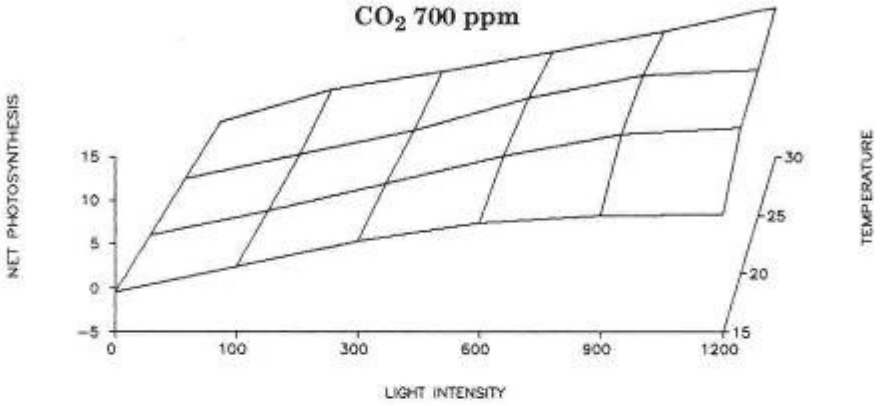

Fig. 8. An interactive effect of temperature (^0C) and light intensity (umol $m^{-2}s^{-1}$) on net photosynthesis (umol $m^{-2}s^{-1}$) of an alpine plant *(Podophyllum hexandrum)* at 700 ppm CO_2.

3.5.4. Evaluation, Propagation and Utilization of Selected Multipurpose Trees for the Waste and Marginal Lands of Central Sub-Himalayan Hills

Background

In view of the increasing pressure on natural plant resources and depletion of green cover, the multipurpose trees have emerged as one of the promising options for meeting the necessities for sustenance. The project envisages the importance of initiating plantations of economically viable selected tree species of the region by developing simple conventional and *in vitro* propagation packages, which will be eventually made available to the local inhabitants.

In this context, *Bauhinia vahlii, Diploknema butyracea* and *Sapium sebiferum* have been identified as potential income generating and under exploited tree species of this region.

Results and Achievements

1. Preliminary work to evaluate genetic variability studies in all three species at interpopulation level has been standardized for both protein and some isozyme systems, viz., POD, GOT, SOD, etc.
2. Air layers of *D. butyraceae* are successfully rooted in summer season through auxin application whereas propagation by root suckers was achieved in *S. sebiferum*.
3. Success has been achieved to establish mature explants of Bauhinia and Diploknema, however, currently attempts are in progress to further improve the percentage establishment.
4. Callus regeneration protocol has been improved further by developing a single step rooting procedure in *Sapium sebiferum*.

5. In Sapium, hardening procedures for both micropropagated and callus regenerated plantlets have been standardized and fine tuning of the procedure are being undertaken.

6. *In vitro*-raised-micropropagated plants of Sapium have been transplanted to field as an experimental trial at Narayan Nagar (Distt. Pithoragarh).

3.5.5. Conservation and Multiplication of Himalayan Threatened Plant Species

This is an ongoing project, please see Annual Report (1994-95) for background and objectives.

Results and Achievements

1. Germplasm of natural populations of *Aconitum atrox, A. heterophyllum, A. violaceum, Picrorhiza kurrooa, Nardostachys jatamansi* and *Podophyllum hexandrum* have been collected. Natural populations of *P. hexandrum* have been marked and characterized.

2. Methods for seed germination and vegetative propagation have been standardized.

3. For *A. atrox*, multiplication by tissue culture technique has been achieved.

4. Viable callus cultures have been developed for all the species.

5. Podophylloresin content of several populations of *P. hexandrum* have been analysed. Some of the elite clones with higher Podophylloresin content have been identified. Attempts are being made to multiply these clones in large scale.

6. Laboratory raised plants/seedlings of *P. hexandrum* have been reintroduced in natural habitat conditions.

3.5.6. Biomass of Woody Debris and Other Detrital Pools in Different Forest Types of Binsar Wild Life Sanctuary

Background

Woody debris in the form of snags, logs, large branches and small twigs, and other detrital pools form a major structural feature with many crucial ecological functions as habitat for other organism, in energy flow, and nutrient cycling, thus influencing soil and sediment transport and storage in a forest ecosystem. Input of woody debris within the forest ecosystem is a common phenomenon,however, due to catastrophic events like fire, wind, epidemics, etc. substantial amounts are further added thus, creating gaps within the forest ecosystem. Studies on forest gaps help to understand the mechanism of ecosystem function. A study was, therefore, undertaken in a mixed (*Quercus leucotrichophora, Lyonia ovalifolia* and *Rhododendron arboreum*) forest as a result of fire event of 1992.

Objectives

1. To analyse changes in species composition
2. Estimation of biomass and productivity
3. Computation of turnover rate

Results and Achievements

1. The crown cover was reduced to about 4% from above 80% as a result of fire in May 1992.

2. Due to changed environment, dominant species were replaced by *Carex cruciata* and

Anaphalis triplinervis under the open canopy forest, whereas under the closed canopy forest dominant species were *Mondo intermedium* and *Smilax aspera*.

3. Floristic similarity between open and closed canopy forest sites was only about 18%.

4. Diversity and species richness were recorded to be higher under the open canopy forest in comparison to the closed canopy forest.

5. Dominance-diversity curve showed almost random distribution of resources among different species after fire.

6. Biomass during different sampling dates for the live shoots (sedges, grasses and forbs), dead attached shoots and belowground parts were found to be significantly higher following fire.

7. Peak net accumulation rate for both the sites was recorded between 1 July to 15 August and was about 19 times higher under the open canopy (2.27 g/m^2/day) compared to the closed canopy forest (0.12 g/m^2/day).

8. Above and below ground productivity values were significantly higher under the open canopy forest in comparison to the closed canopy forest.

9. The fire also affected forest functioning as apparent by changes in turnover rate of belowground parts.

3.5.7. Network Programme for Mass Propagation and Improvement of tree Species of the Himalayan Region

This is an ongoing project, please see previous Annual Report (1994-95) for details.

Results and Achievements

1. Tissue culture and conventional, clonal propagation techniques have been developed for tea using explants from local chinery bushes.

2. In vitro shoot multiplication and somatic embryogenesis have been obtained.

3. Clonally propagated plants of *Dendrocalamus hamiltonii* (maggar bamboo) and tissue culture raised plants of *D. strictus* have been planted in the field at various locations.

4. Tissue culture protocols using inverted embryo technique are being developed for *Pinus wallichiana, P. gerardiana* and *Cedrus deodara*.

5. Multiple shoot formation has been obtained in vitro germinated seedlings of *Quercus glauca* and *Q. lanuginosa*.

6. Microbial isolations have been carried out and a variety of inoculants have been tested for improvement of seed germination and seedling growth.

7. Considerable growth improvements have been recorded for all plant species grown using the polypit technique.

8. By using plant efficiency analyser and recording of Fv/Fm ratio, a simple method has been developed for screening tea clones for frost-prone areas.

3.5.8. Asian Biotechnology and Biodiversity Subprogramme of UNDP-FARM Project: A Case Study of Haigad Watershed

This is an ongoing project, please see previous Annual Report (1994-95) for details.

Results and Achievements

1. The documentation of the existing plant biodiversity prevailing in the watershed has been completed. This includes biodiversity in food grains, vegetables, spices, oil seeds, fruit trees, multipurpose trees within the cultivated land, forest trees and medicinal plants.

2. A number of high yielding varieties of fruit trees (e.g., mango, amla, guava, papaya), and vegetables (e.g., tomato, brinjal, capsicum, lady's finger, French been) have been introduced. High yielding varieties of wheat, mustard, pea, lentil, etc. have also been introduced in different altitudinal zones. Large cardamom (*Amomum subulatum*) has been introduced as a cash crop in appropriate agroforestry systems at four different locations with nitrogen fixing plant species, e.g., *Alnus nepalensis, Crotolaria* spp., and *Bauhinia variegata*.

3. Rooted plants of Bulgarian rose (*Rosa damascena*) raised from cuttings in a nursery at Haigad, have been transplanted at four locations, namely (i) Ladura (900-1000 m), (ii) Haigad village (1300-1400 m), (iii) Hawil village (1500-1600 m) and (iv) Kulwan village (2150-2250 m).

4. Keeping in view the hilly terrain, susceptibility to erosion and general local conditions, trials of a silvipastoral system with fodder, fuel trees of multiple uses in combination with pasture species have been initiated at two locations in the watershed. Other introductions include (i) perennial grasses (e.g. *Thysanolaena maxima, Pannisetum* spp., etc.) along the terrace edges for fodder and checking soil erosion, (ii) biofencing demonstrations using economically important *Agave* spp. and (iii) plantation of multipurpose nitrogen fixing plant species on degraded slopes for site improvement.

5. Concept of protected cultivation has been introduced by setting up low cost demonstrations of polyhouses and polytrenches.

6. Biocomposting has been carried out using local weeds and chir-pine (*Pinus roxburghii*) needles.

7. Using free living - nitrogen fixing bacteria (e.g., isolates of *Rhizobacterium* spp., *Azotobacter chroococcum* and *Azospirillum brasilense*), biofertilizer experiments were carried out (both field trials and pot trials) using locally grown kharif crops like *Eleusine coracana, Zea mays, Vigna mungo, Panicum milliacum, Sorghum vulgare, Glycine* spp. and a major rabi crop, namely *Triticum aestivum*, etc.

3.6. QUICK APPRAISAL STUDIES

3.6.1. Urban Sprawl Assessment of Gangtok City and its Environs: An Environmental Appraisal

Background

Pattern of urbanization in the mountains is altogether different from that of the plains. Himalayan environmental set-up ismuch more complex due to its comparatively younger age geologically as well as complex geotectonic set-up. Growth of population and pressure on its cities necessitate an appraisal of the carrying capacity with primary considerations of their capabilities to sustain the increasing number of city

dwellings. In Gangtok, the capital city of Sikkim state, trend of construction of multistorey buildings even on steep to very steep slopes are common. The hazards of such trends got exemplified in a calamitous landslide (Plate 2) in Gangtok at its Deorali area on the night of 5-6 September 1995 in which so many dwelling units were swept away downslide claiming nearly 30 precious lives. This emphasizes the need for more planned and systematic city development approach in such regions.

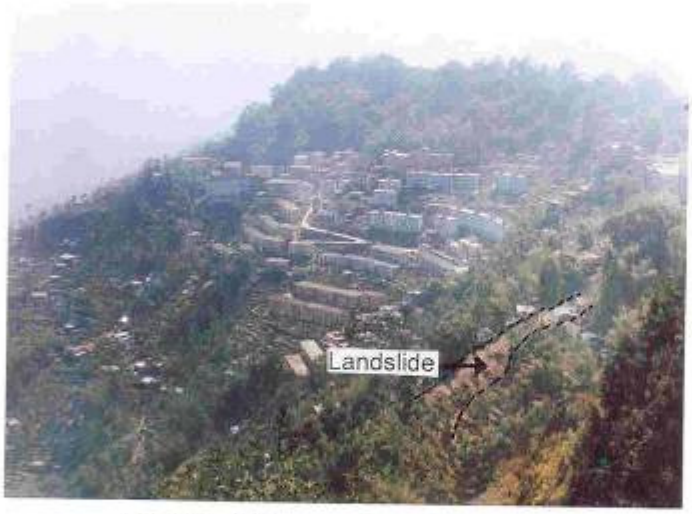

Plate 2. Landslide at Deorali area of Gangtok.

It is in this context that an urban sprawl assessment of Gangtok has been donewhich is aimed at providing an insight into understanding the pressure on urban built-up land by drawing comparisons from other land uses within the city limits. For a faster status appraisal, remote sensing techniques have been used utilizing Indian Remote Sensing Satellite (IRS 1B) scene. False Colour Composite (FCC) with band combination of 2, 3 and 4 of its LISII sensor (spatial resolution - 36.25m) has been used for preparing the urban sprawl map with mappable land-use units (Fig. 9). Rora Chu and Kali Khola streams flank its eastern and western boundaries respectively. Survey of India topographic sheet has been used as collateral information coupled with ground verification. The image has been interpreted using visual interpretation facilities followed by spatial quantification using electronic planimeter.

Table 15 shows the urban land-use (level I) categories of Gangtok including its contiguous localities such as Tadong, Chanmari, Lakamthang and Ranipool as interpreted from IRS 1B LISII FCC. This shows a fair composition of the urban land-use which is a prerequisite to rational planning and zoning.

Table 15. Level I land-use categories of Gangtok city

S.No.	Urban land-use	Area (km^2)	Area (%)
1.	Urban Built-up Land	6.38	39.23
2.	Open Mixed Forest	2.05	12.61
3.	Scrub/Rocky/Vacant Land	4.44	27.31
4.	Agriculture/Mixed Use	3.39	20.85

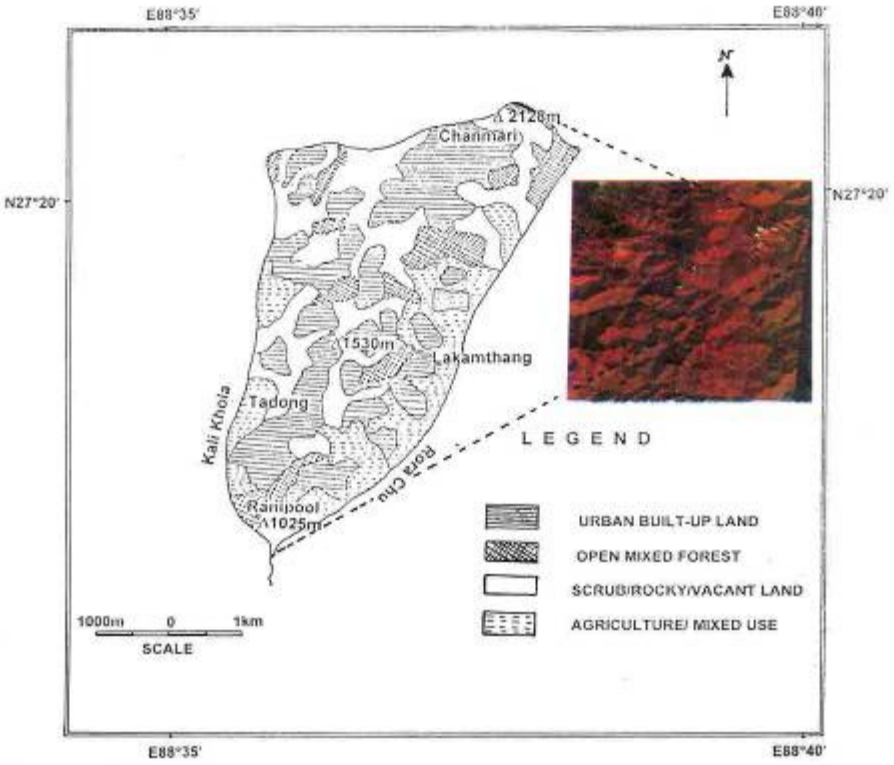

Fig. 9. Urban sprawl map of Gangtok city derived from IRS 1B LISSII FCC.

Observations:

1. In an area of 16.26 km^2 of Gangtok city and its vicinity studied, the areas under different land-use classes identified are -
   * Urban built-up land - 39.23%.
   * Scrub/Rocky/Vacant land - 27.31%.
   * Agriculture/Mixed use - 20.85%.
   * Open mixed forest - 12.61%.
2. Field observations, topographic map information and remote sensing interpretation indicate that the urban built-up land has following spatial distribution with respect to:

Slope:

- 25% area on slopes less than 25^0
- 60% area on slope range 25^0 to 35^0
- 15% area on slopes greater than 35^0.

Altitude:

- 15% area at altitude less than 1000 m.
- 55% area at altitude range of 1000 to 1500m.
- 30% area at altitude greater than 1500 m.

Another remarkable observation is that nearly 40 percent dwelling units are multistorey with majority of 2 to 4 storey and above structures (Plate 3). Remaining 60 percent are single and double storey structure.

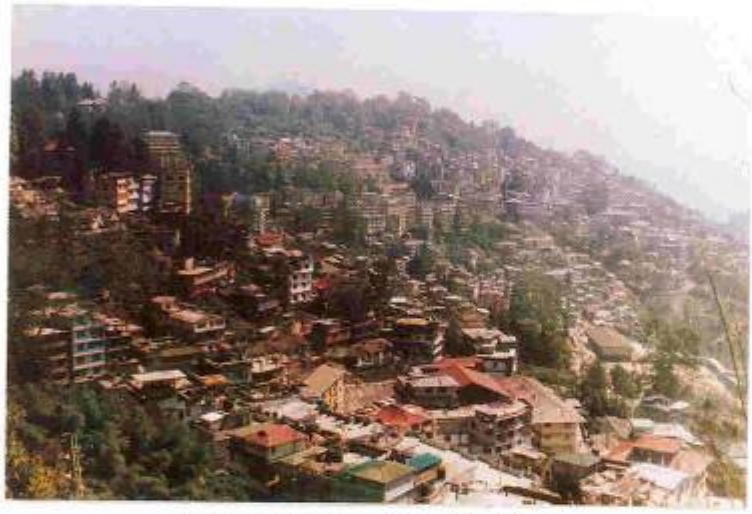

Plate 3. Multistorey dwelling of Gangtok city.

3. Topographic map of the survey year 1972-74 shows a good quantum of area under open mixed forest (10 to 40 percent canopy cover) and some dense mixed forest (>40 percent canopy cover) also. But these areas show no dense mixed forest category on satellite imagery of 1992 and drastically reduced open mixed forest area within the city limits. These have apparently got converted into scrub land (<10 percent canopy cover) category mostly. This category also includes some scattered settlements not identifiable on the satellite scene.

4. Agriculture/mixed use category contains irrigated and rainfed lands. Some area is under agroforestry. There are scattered farm settlements also in this land-use.

5. A thorough carrying capacity study of urban land-use classes for their capabilities to sustain such a city structure in terms of long term planning strategies can be accomplished effectively. Remote sensing techniques such as digital image processing utilizing multidate satellite data shall be much more beneficial for temporal variation studies of the city and its environs. This shall provide faster and precise inputs to urban planning in hills for site suitability with due land capability assessment for minimizing adverse environmental impacts of development.

3.6.2. Khangchendzonga National Park, Sikkim : A Pilot Report

The Khangchendzonga National park (KNP) 22° 33' 51"E, 88° 06' 36"N) has an area of ca 896 km^2. It covers a greater part of northern Sikkim taking in its fold the Mts. Pandim, Simvo, Kabru, Siniolchu, Narsing and the Nepal Peak and Twin Peak. The Lhonak and Zemu valleys contain the major glaciers of Sikkim and numerous tributaries of Tista and Rangit rivers originate from the KNP (Fig. 10). The entire area falls within 1829-8585 m amsl. Out of the 69 National Parks identified in the Indian subcontinent the KNP is the only one which covers a vertical distance of ca 6655 m within an area of 849 km^2. The rainfall and relative

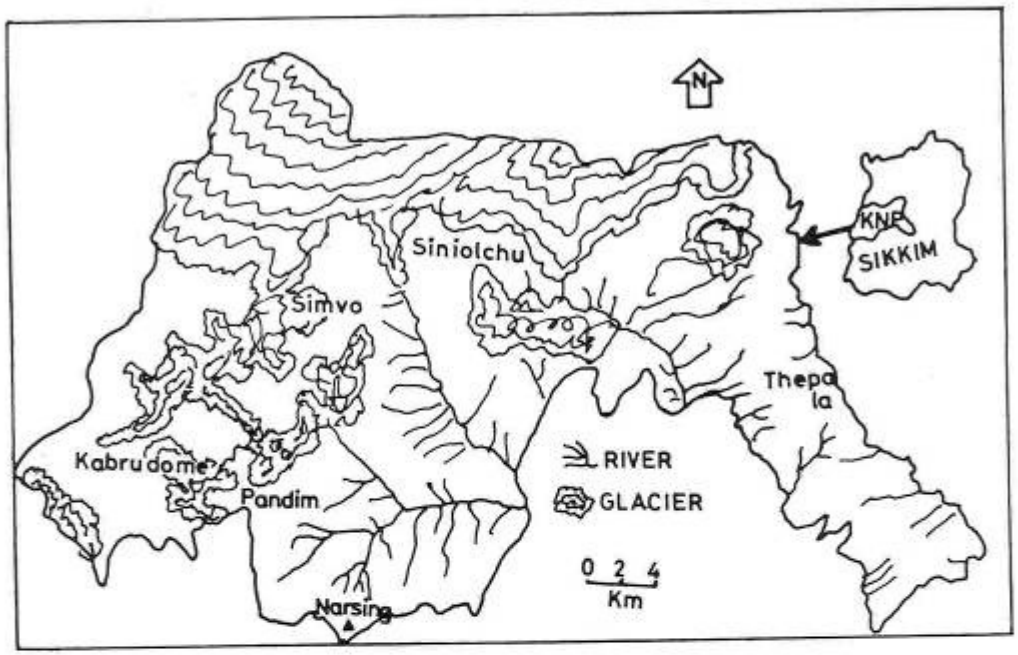

Fig. 10. Kangchendzonga National Park, Sikkim.

moisture percent is high and varies from place to place. The park was commissioned in 26 August 1977.

Biota

The vegetation may be broadly subdivided into the following types:

Temperate Broad-leaved forests (1830-2730 m)

Falling in higher elevations it is of a mixed character with a majority of *Abies densa* interspersed with species of *Acer, Salix, Betula, Larix, Picea, Juniperus, Arundinaria* and *Rhododendron*.

Alpine Scrub and Grassland (above 3650 m)

Ground level vegetation characterize this group where the densities are higher for members of Primulaceae, Papaveraceae and species of *Iris, Gentiana, Juniperus* and *Rhododendron*. This is the herbal belt of the Sikkim Himalaya as well as the KNP. Seasonal collection of medicinal plants is made from this region. Common plant species are from the following genera: *Aconitum, Anemone, Arenaria, Astragalus, Bistorta, Carduus, Cassiope, Chesneya, Codonopsis, Corydalis, Delphinium, Draocephalum, Hippophae, Leontopodium, Meconopsis, Pedicularis, Primula, Potentilla, Rheum,*

Rhododendron, Rumex, Saussurea, Saxifraga, Sedum, Silene, Thalictrum.

Land Status

A considerably large area of KNP has a Reserve Forest status and hence there are practically no local rights. Human habitation can be found at the southeastern fringes only mainly along Tholoung, Sakyong and a few odd places which are thinly populated. A large part of these habitations are migratory in nature covering upper temperate to the alpine scrublands. The Sakyong populace practice agriculture and the farm animals are bound to enter soon the fringes of KNP. Grazing is done by yak and sheep and cover the Lhonak valley in general and the lower Zemu in part which falls in the northern part of KNP. Some area are restricted to yak grazing. The number of yaks grazing in the Lhonak valley is estimated near to 500 and sheep are even more. No serious depletion in grass resource is recorded. However, thorough study will reveal more. April-May is the time when the herds reach upper fringes of KNP for grazing.

In view of diversity in landform the different natural habitats, niches that arise here carries an enormous biota. The KNP perhaps is the richest in biological spectrum among the present national parks in India. A project has been designed to find out the biotic aggregation of the park which will serve as the baseline material for further research. It is also envisaged to understand the relationships of surrounding population on the natural resources of KNP.

3.6.3. Efficiency of Traditional and Cash Crops in Different Highland Agro-ecosystems of Lahaul Valley in North West Himalaya

Background

Lahaul Valley in between Greater Himalaya and Pir Panjal ranges of Himalaya is a landlocked geographical region. The valley remains accessible only for about four months (July to October) in a year owing to heavy snowfall and snow deposit in Rohtang pass (4111m) which is entry point to the valley. Because of limited growth period of crops, most marginal farmers have primarily to depend on almost only one crop. Buckwheat and barley were the only traditional staple crops in the valley but at present these highlanders have also been under influence of modern cash cropculture. In keeping with the market values of crops even in remote villages, farmers have turned towards pea (*Pisum sativum*), potato (*Solanum tuberosum*) and hop (*Humulus lupulus*) as cash crops rather than adhering to traditional ones only. In absence of suitable cultivable land and increasing competition among the farmers to earn more and more cash from the crop, farmers are cultivating above 45^0 slope terrace fields (as in Khoksar) where irrigation is also created on these steep slopes. Keeping in view the same, three distinct villages (Hinsha, Jahalma and Khoksar) were geographically selected to achieve the following objectives.

Objectives

1. To understand traditional and modern cropping patterns in the Lahaul valley.

2. To assess energy and monetary efficiency (output: input ratio) of traditional vs. modern cropping systems of the valley.

Results and Achievements

1. Out of 24 crops identified, 9 crops belonged to traditional food crops of local breed, 9 vegetables, 3 modern cash crops, wild cultivated crops of medicinal use and 1 pulse crop. Crop diversity decreased along with increasing altitudes. In lower elevation (Hinsha 2700 m), two successive crops were sown in one growing season, while single crop was hardly harvested in high elevation (Khoksar 3185 m).

2. Cropping strength of major traditional vs. cash crops in low lying Hinsha village showed that wheat occupied 15.31% buckwheat 10.59%, barley 8.83% and `kuth' (*Sausurea lappa*) 4.17%, whereas cash crops such as pea occupied 23.11 %, potato 18.13% and hops 9.15% of total cropped land. In Jahalma buckwheat occupied 5.58%, barley 4.93%, `rajmath' 1.95% and wheat 1.49% among the traditional crops. Among the cash crops, hops contributed to 32.90%, pea 31.60% and potato 20.63% of the total cropped land of the village. Khoksar, one of the highest altitudinal village of the valley, is completely different regarding traditional crops of buckwheat (1.7%) and `kuth' (0.94%) where two cash crops like potato (51.80%) and pea (45.53%) were prominent.

3. Every agroecosystem was found to be manure intensive. Table 16 shows that amongst the total inputs (in energy) applied in the farming, manure input was on the top. While inputs in monetary term, both manure and human labour had raised the cost of hill farming. To get sustainable yield in highly fragile and stressed environment of glaciers and avalanches, farmers have to maintain soil fertility by applying relatively high amount of manure every year amongst other inputs.

4. Output/input ratio showed that amaranths had obtained as the highest energy produce amongst traditional ad modern cash crops in Hnisha village. This crop was followed by French bean, wheat, barley and maize. Khoksar had obtained as a maximum output / input ratio of buckwheat which was followed by barley. Traditional crops emerged out rich and viable while assessed their energy values in output / input terms. Cash crops under current practice while taken into account, those were found to be under imbalance output / input ratio of gross energy investment and return as compared to traditional crops.

5. The energy efficiency (output/input ratio) for traditional crops ranged in between 1.04 (barley) to 1.94 (buckwheat) in Khoksar, 0.87 (buckwheat) to 6.11 (amaranths) in Hinsha. Energy investment in manuring and human labour dominated other farm inputs of seeds, inorganic fertilizer and insecticides in the valley. Similar trend was also found in inputs of cash crop cultivation of potato and pea. Moreover, energy efficiency ratio of traditional crops were higher than the cash crops. Energy efficiency of HYVs of cash crops were found in a range of 0.89 (potato) to 2.69 (pea) in Hinsha, 1.22 (potato) to 2.84 (pea) in Jahalma ad 1.09 (potato) to 1.62 (pea) in Khoksar villages.

Table 16. Energy (MJ ha^{-1} yr^{-1}) and economic (Rupees ha^{-1} yr^{-1}) efficiencies of traditional food and modern cash crops in different agro-ecosystems of Lahaul valley in Greater Himalaya.

Production measures	Hinsha (2700 m)	Jahalma (3026 m)	Khoksar (3185 m)
Input total	643918 (280799)	1894467 (143932)	340484 (126417)
Human labour	9602 (75387)	3894 (36239)	942 (25515)
Animal labour	4566 (8903)	1084 (4120)	1886 (6246)
Seeds	30426 (26950)	14293 (27627)	16923 (8452)
Fertilizer	26505 (166191)	11445 (6379)	32529 (7136)
Manure	566914 (148509)	157422 (67839)	288204 (79068)
Insecticides	5905 (4359)	1329 (1728)	– (–)
Output total	1063193 (1100936)	357204 (543006)	519646 (234135)
Foodgrains	784906 (276118)	– (–)	245126 (56663)
Cash crops	278288 (433759)	357204 (543006)	274520 (177472)
Kuth*	– (400059)	– (–)	– (–)
Net profit/loss	683034 (810138)	167737 (140237)	179244 (107719)
Output-input ratio	1.65 (3.92)	1.89 (3.77)	1.53 (1.85)

Values in parentheses are monetary units; * *Sausurea lappa*

6. Monetary efficiency of traditional vs. modern cash crop showed a different pattern regarding economic profits. Traditional crops were less monetary income intensive except a few ones, viz; amaranths, kuth, etc. Output/ input ration of traditional crops were in between 0.84 (maize) to 4.36 (amaranths) in Hinsha and 1.04 (barley) to 1.26 (buckwheat) in Khoksar. But when cash crops were taken into account they differed from 1.79 (potato) to 6.85 (hops) in Hinsha, 2.32 (pea) to 6.16 (hops) in Jahalma and 2.06 (potato) to 2.68 (pea) in Khoksar villages.

3.6.4. Growth Problems of Tree Crops in Lahaul Valley in Highlands of North West Himalaya

Background

The Lahaul valley (consists of Chandra and Bhaga river basins) of Himachal Himalaya, experiences extremes of climatic conditions. Minimum temperature ranges between -20^{0}C in Bhaga Valley at Udaipur to -38^{0}C in Chandra Valley at Khoksar during winter and very little rainfall during showerless rainy seasons. The hill slopes at present are more or less without forest vegetation due to extreme geo-climatic condition

and excessive exploitation of *shur* (*Juniperus recurva*) forests in past. In the past the local population removed a significant amount of timber and fuelwood from thealready disturbed forest patches of *Juniperus recurva*. Once 'kail' (*Pinus wallichiana*) was also found in these forests relatively in lower density but at preset hardly a tree can be seen. In Lahaul valley there is an acute shortage of fuelwood and timber. In order to reduce pressure from the forest resources. The Department of Forest is trying to raise plantations of timber (*Populus nigra*) and fuelwood/fodder (*Salix* sp.) crops in different locations of the Lahaul valley.

Observations

1. Plantations above 3000 m altitude near Khoksar in Chandra valley at all did not survive due to high amount of snowfall and snow deposits (approximately 3 m), but at lower elevations, i.e. at 3000 m (Bhaga valley) and below, plants did survive but had very slow growth rates (Table 17).

2. Performance of poplar (*Populus nigra*) was significantly better than the two varieties of willow (*Salix* sp.) in terms of diameter increment and shoot elongation; the Kashmiri variety of willow performed better in shoot elongation compared to the local variety. There was no significant difference between diameter increment of these two varieties.

3. Avalanches, glaciers, heavy snow deposits and dry soil during growing seasons are the major obstacles for the establishment of tree saplings. Limited numbers of growing days (May to September) also play a significant role in poor growth of the tree species.

Table 17. Growth (diameter increment and shoot elongation) of Populus nigra and Salix sp. under extreme climatic conditions of Lahaul valley in North West Himalaya highland.

Species	Plantation years		Growth rates (cm year^{-1})
	1989	1991	
Populus nigra Linn.			
Basal diameter	4.78±0.38	2.43±0.17	1.05
Height	465.54±47.83	222.14±14.01	108.18
Salix sp. (local variety)			
Basal diameter	2.83±0.33	1.88±0.24	0.425
Height	343.75±13.34	192.25±0.24	76.22
Salix sp. (Kashmiri variety)			
Basal diameter	4109±0.35	3.13±0.38	0.429
Height	413.75±41.87	192.50±0.50	98.33

Measurements were done at Gurma village near Jahalma in August 1995.

4. INSTITUTIONAL NET-WORKING AND HUMAN INVESTMENT

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

The programme strengthened institutional networking for development of a comprehensive action oriented research during the year. On the recommendations of the Project Evaluation Committee, the following 10 projects (3 to universities, 5 to NGOs and 2 to autonomous organizations/ Govt. institutions) were processed, sanctioned and funded during the year.

1. Bagwani vikash avam prasar. (Mr. Prakash Pandey, Parwatiya Falotpadam avam Bahudhandhi Sansthan, Kanalgaon, Champawat, Pithoragarh, U.P.).

2. Studies on certain ethnozoological aspects in East Siang and West Siang districts of Arunachal Pradesh. (Mr. Asham Borang, Forest and Plant Protection Division, State Forest Research Institute, Itanagar, Arunachal Pradesh).

3. Soil and water conservation integrating the rural women developed in Motna village of Tehri Garhwal district, U.P. (Mr. R.K. Uniyal, A Society for the Hill Reconstruction of Youth Activities (ASHRAYA), Dehradun, U.P.).

4. Nursery development and plantation of Chyura in Pithoragarh. (Dr. Virendra Kumar, Himalayan Study Circle, Pithoragarh, U.P.).

5. Nanisar mini micro watershed management project. (Mr. Narendra Rautela, Voluntary Association for the Development of the Hills of Uttarakhand (VADHU), Ranikhet, Almora, U.P.).

6. Ecological reconnaissance of Chail Wildlife Sanctuary in Himachal Pradesh. (Dr. M.L. Narang, Department of Silviculture and Agroforestry, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, H.P.).

7. Biological nitrogen fixation for productivity of soil and crop-characterization of efficient Rhizobium species isolated from wild leguminous weeds of north eastern hills. (Dr. G. Bhowmik, Department of Biotechnology, Gauhati University, Guwahati, Assam).

8. Eco-biology and regeneration potential of woody perennials of riverline vegetation from Deoprayag to Rishikesh. (Dr. Arvind Kumar, Department of Botany, Pt. L.M.S. Government Post Graduate College, Rishikesh, Dehradun, U.P.).

9. Ankur jari-booti pradarshan prakshetra avam paudhashala Ramni. (Mr. Sudarshan Kathait, Garhwal Himalaya mein Gramya avam Parishtitikiya Vikas ka Sansthan (ANKUR), Ghat, Chamoli Garhwal, U.P.).

10. Studies of induced spawning and milt morphology of snow trout (*Schizothorax* sp.) in the Garhwal Himalaya. (Dr. S.N. Bahuguna, Department of Zoology, HNB Garhwal University, Srinagar, Pauri Garhwal, U.P.).

Besides, financial commitments of 45 ongoing projects were also fulfilled during the year. Among the twenty two projects (sanctioned earlier by Ministry of Environment and Forests, Govt. of India) nineteen were completed earlier and three were completed during the year. Recommendations of these projects have been sent to the concerned user departments of State/ Central Govt. for follow-up action / replication as they may find necessary. Follow-up action on 82 completed projects (transferred by the Ministry of Environment and Forests, Govt. of India to the Institute in 1992-93) was also pursued during the year. At present, R & D activities under IERP have been spread out in 10 states of Indian Himalaya.

4.2. Environmental Awareness Programmes

For wide dissemination of environmental protection and conservation message, students participation was actively mobilized and under this concept a two-day programme was organized by the Institute at G.I.C. Narayan Nagar, Pithoragarh from Nov. 9 to 10, 1995. About 130 students representing various schools / colleges of Pithoragarh district actively participated and planted tree saplings / seedlings of various

promising trees at plantation site by signifying their commitment to the environmental cause. The positive response indicated an urgent need to develop and strengthen environmental awareness and education campaign to prevent impoverishment of the natural resources in the remote areas of Indian Himalaya.

World Environment Day was organized by the Institute all across the Himalaya. Plantation programme at Kosi campus and a group discussion among the staff were organized at Head Quarters- Kosi, Almora. Himachal Unit at Kullu organized it by involving local school children. N.E. Unit of the Institute celebrated it at Dimapur, Nagaland which was attended by the members of the Timber Loggers Association. The members were impressed about the dilatory effects of timber logging on deforestation and were sufficiently convinced to initiate afforestation in the land cleared by such activities and also to adapt villages for compensatory afforestation. Sikkim Unit, Gangtok organized it with the participation of local NGOs, school children, villagers and rural women.

4.3. On-site training programmes

Short term on-site training programmes for villagers/women, ex-army personnel, NGOs and army personnel on nursery development, tree plantation techniques and natural resource conservation and management were organized during the year at following locations in Central Himalaya.

(a) Village Arah, District Almora

Three days on-site training programme from April 15 to 17, 1995 was organized at village Arah, which was attended by 44 trainees (11 ex-army personnel from 7 villages, 15 representatives from 6 NGOs and 18 villagers (9 farmers and 9 women) from Arah and adjoining villages. The scientists of the Institute imparted the training. This programme was inaugurated by Mrs. Nandi Devi, the oldest educated lady of the village Arah and was presided over by Mr. Harak Singh Dosad, the oldest farmer of Arah village on 15th April 1995. Closing ceremony was presided over by Sri Dan Singh Parihar, the Sarpanch of the village on 17th April 1995. The response was very encouraging to strengthen such programme.

(b) Village Bhiri-Banswara, District Chamoli Garhwal

The above programme in Bhiri-Banswara was also organized from June 12 to 14, 1995. Fortytwo trainees attended the training programme. The target groups for the training included villagers (16), women (7), ex-army personnel (9) and NGOs (10). It was inaugurated by Padmshri Chandi Prasad Bhatt on June 12, 1995 and closed officially on 14th June 1995 by the Scientist Incharge of GBPIHED-Garhwal Unit. Participants welcomed this activity and the response was quite encouraging for active furtherance of the programme.

(c) Village Hanumanchatti, District Chamoli Garhwal

This training programme at Hanumanchatti was organized from 30.10.95 to 1.11.95 specifically for the army personnel by the Institute on the inputs and aspirations obtained from Col. Ajai Prakash, Commanding Officer, Garhwal Scouts and Brigadier Dalvir Singh, Commander, 9 (Independent) Mountain Brigade, Joshimath. Thirty six army personnel nominated

by 9 (Independent) Mountain Brigade, Joshimath, U.P. from seven sectors (i.e. Garhwal Scouts, 3 Jakli, 5009 ASC (Camp), 2009 FD ASC, 15 Jat, 5 Mahar and 8(1) F.C.-Engineers) attended the training. The programme was inaugurated by Brigadier Dalvir Singh (VrC, VSM)), Commander, 9 (Independent) Mountain Brigade, Joshimath on 30th October, 1995 and closed officially by Mr. Radhesyam Misra, SDM, Joshimath on 1st November, 1995. The training was successfully imparted by the scientists / staff of the Institute. The important feature of this programme was the establishment of '**SAINYA PAUDHSALA**' by the trainees. The positive response from the trainees indicated an urgent need to create environmental awareness through on-site training programmes among army personnel working in the border zones of Indian Himalaya.

Thus, on-site training was imparted to 122 persons (36 army personnel, 20 ex-army personnel, 25 representatives of NGOs, 16 rural women and 25 villagers) during the year.

4.4. Dissemination of information through Networking

The Core is actively involved in the dissemination of knowledge through in-house publications, such as Hima-Paryavaran was disseminated to various institutions (traditional, academic and research) working in the Indian Himalaya. In this context technical inputs were also provided to a number of NGOs, academic institutions, forest department and army officials, women organizations and village level organizations during the year. Valuable technical inputs especially in the field of endangered medicinal plants were also provided to the medical students / teachers of Tibetan Medical and Astrological Institute, Dharamsala, H.P. This activity was strengthened significantly during the year by organizing on-site training programmes for villagers / women, ex-service army personnel, NGOs and army personnel on nursery development, tree plantation techniques and natural resource conservation and management. A number of NGOs, academic, scientific, defence, medical and village level institutions are seeking technical inputs from the Institute. These activities will be continued and strengthened further.

4.5. Tropical Soil Biology and Fertility Programme - South Asian Regional Network

This is an ongoing programme, please see previous Annual Reports for details.

Result and Achievements

1. Contacts were made to extend the network activities in the other countries in South Asia. A data base on workers is being processed.

2. A data base on published information is being processed. The first Volume of data is expected for dissemination in the Second Quarter of 1996.

3. Governing Council meeting of the Board of Directors was held in the country to appraise the individual members and evaluate the necessity of developing more funds for this programme.

4. Projects funding was pursued with various donors.

5. Both Coordinator and one Research Associate continued the work on resource quality studies.

4.6. Environmental Information System on Himalayan Ecology

Background

To monitor and constantly update the changes (economic & ecologic) at global level, UNDP of UNO started INFOTERA programme a decade back. In India, the Ministry of Environment and Forests, Government of India is the focal body for collection, assessment and dissemination of the data of this programme. Keeping in view the diversity and vastness of the task the ministry has identified regional/area-specific projects for pursuing the goals set. This Institute has been given the task of doing justice by achieving goals in the area of Himalayan Ecology in 1989-90.

Objectives

1. To collect, compile, analyze the information/ data pertaining to Himalayan ecology from diverse sources.
2. To disseminate available information to users/ possible users.
3. To provide required information to MOEF to fulfill the programme objectives.

Results and Achievements

1. ENVIS Bulletin - Himalayan Ecology and Development Vol. 3 (Nos. 1 & 2) was compiled using the collected, compiled and analyzed data and information.
2. Contacts were made with District Information Officers of all 72 Himalayan districts to collect information vide district statistical reports and to disseminate information.
3. 112 requests for information/queries receivedat the center were processed/ addressed to the satisfaction of requesters.

4.7. Mountain Environment and Natural Resources Information System Programme

Background

To support the growing digital information acquisition and dissemination specifically, in the regions of limited information/ data availability, UNDP of UNO supported a proposal of ICIMOD to develop and maintain regional (Hindukush) "Mountain Environment and Natural Resources Information Systems Programme" for participating countries. This Institute being the focal organization for india has started supporting this programme by providing facilities.

Objectives

1. To develop and maintain infrastructure facility, data bases on mountain natural resources.
2. To train human power in capacity building.
3. To support other organizations in pursuing goals similar to the programme.

Results and Achievements

1. Digital databases on Pranmati and Haigad watersheds, and Kapkot block were developed and maintained.
2. GIS cycle II training to eleven personnel was imparted for manpower development.
3. GIS policy level workshop was held to provide information to other organizations.

YSPUHF Solan, was given support to develop the infrastructural facilities.

5. MISCELLANEOUS ITEMS

5.1. SOCIETY AND GOVERNING BODY MEETINGS

During this year the Governing Body of the Institute met on 1st August 1995 at New Delhi. The 4th G.B. Pant Society of Himalayan Environment and Development met on 15th December 1995 at New Delhi. The Science Advisory Committee meeting was held on 20 & 21 May 1995 under the chairmanship of Prof. S.K. Sinha.

5.2. ADDITIONS TO LABORATORY AND LIBRARY AND PROGRESS OF CONSTRUCTION WORKS

Two new instruments, namely Plant Water Status Console (Soil Moisture Equipment Corp., USA) and Portable Infrared Gas Analyser with CO_2 injector system (LI-6400; Licor, USA) have been procured. The former can provide an accurate and flexible measurement of plant water status for understanding various aspects of plant growth and crop yield. The LI-6400 is a powerful photosynthesis measurement system which is quite easy to operate and in addition to the features of the previous model i.e. LI-6200, this new model features new open path analysers in the sensor head, chamber for varying light source, automatic analyser matching, easy response curves, superior file handling capabilities, etc.

Addition of some new books during this year raised the number of titles to a total of 5922. A total of 93 international and national periodicals are being received in the library including 14 periodicals subscribed by the ENVIS Centre on Himalayan Ecology at the Institute. Databases of library have been updated. Subject Bibliography of Books on Himalaya has been prepared with the coverage of books available in the Institute library. Yearwise volumes of "Published Research Papers, Popular Articles, and Books (1989-95) (Work done at Head Quarters, G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora - 263 643, U.P.)" have been compiled. Articles Alert Services are being provided by the library.

The construction of Institute buildings was started at Katarmal in 1991-92. Building complex at the headquarters (Katarmal) includes 46 quarters, faculty building, hostel, library, shopping complex, guest house and an electric sub-station with infrastructural facilities. The work of guest house and residential quarters is almost complete. The construction of faculty building, library and hostel are in advance stage.

In Kullu construction of faculty building and residential complex has been initiated. Construction of Sikkim Unit and site development is likely to start shortly; work of approach road is in progress.

5.3. MEMBERSHIP OF SPECIALIZED COMMITTEES / SOCIETIES

* Member of Mountain Protected Area Network, USA (P.P. Dhyani)
* Member of the New York Academy of Sciences, USA (Anita Pandey)
* Member of University Court and Executive Council of HNB Garhwal University, Srinagar, Garhwal, U.P. (P.P. Dhyani)
* Ecological Society of America, USA (Subrat Sharma)

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

5.4. PUBLICATIONS OF THE FACULTY

5.4.1. Scientific Papers & Reviews

Bhadula, S.K., S.C. Joshi & A.N. Purohit (1995). Seasonal variation in photosynthetic characteristics of some mountain tree species from Garhwal Himalaya. Physiology and Molecular Biology of Plants, 1: 151-160.

Dhaila, S., S.P.Singh, **G.C.S. Negi** & Y.S.Rawat (1995). Shoot growth phenology of co-existing evergreen and deciduous species in an oak forest. Ecological Research, 10: 151-159.

Dhar, U. (1995). Overview of Himalayan Biodiversity. In: G.S.Gujral & Virinder Sharma (eds.), Changing Perspectives of Biodiversity Status in the Himalaya, British Council Division, New Delhi. pp. 3-20.

Farooquee, N. A., A. Nautiyal & **K.G. Saxena** (1996). Diversity: An Important Component for India's Foreign Policy. In : Nautiyal, A. (ed.), India and the New World Order. South Asian Publishers, New Delhi. pp. 128-141.

Garg, J.K., A. Narayana, A.S. Arya, T.V.R. Murthy, A. Narain, **V. Joshi, & K.G. Saxena** (1995). Landslide hazard zonation around Tehri dam using remote sensing and GIS techniques. In: Proceedings of International Conference on Disasters and Mitigation, Anna University, Madras. pp. 41-46.

Ghosh, S., U. Rana & K.K. Sen (1995). Environmental Monitoring for Sustainable Development in Pranmati Watershed, Uttar Pradesh. In: Singh, R. B. & M. J. Haigh (eds.), Sustainable Reconstruction of Highland and Headwater Regions: Proceedings of Third International Symposium on Headwater Control, New Delhi.

Jain, A.P. & J.C. Kuniyal (1995). Environmental Impact Assessment (EIA): A tool for Effective Management & Decision making for Tourism Development in the Himalayan region of India. In: Himachal, India (souvenir of 7th *HIMTAB*, Manali (HP). pp. 28-30.

Joshi, S.C. (1995). Species specific diurnal changes in chlorophyll fluorescence in tropical deciduous and evergreen plants growing in the field during summer. Photosynthetica, 31 (4): 549-557.

Joshi, V. & G.C.S. Negi (1995). *Garhwal Himalaya mai vibbhin bhumi upyog wale do jalagamo mai jal utpadan adhyyan* (in Hindi). In: K.K.S. Bhatia, R. Singh, R. Mehrotra & Divya (eds.), *Jal Vigyan Evam Jal Sansadhan par Rastriya Sangosthi*. National Institute of Hydrology, Roorkee. pp. 303-307.

Joshi, V. & G.C.S. Negi (1996). Surface runoff, soil loss and land use studies in two micro-catchments of the western Himalaya, India. In: S.R. Chalise & N.R. Khanal (eds.), International Conference on Ecohydrology of High Mountain Areas, ICIMOD, Nepal.

Joshi, V. & Y.P. Sundriyal (1995). Natural lakes in the Garhwal Himalaya : economic utility and conservation. Journal of Hill Research, 8(2): 209-219.

Kothyari, B.P., D.S. Rawat & S.K. Bhuchar (1995). SWEET: An environment friendly landuse package for the reforestation of degraded land in

the Himalaya. In: Proceedings of SHERPA Seminar on Landuse Planning in the Hill Regions and People's Participation. Lucknow. pp. 154-163.

Krishna, A.P. & E. Sharma (1995). Environmental impact assessment of dynamic anthropogenic activities in Mamlay watershed of Sikkim Himalaya : A remote sensing approach. Asian-Pacific Remote Sensing Journal, 8(1) : 23-30.

Kuniyal, J.C. & A.P. Jain (1995). Environmental Impact Assessment (EIA) Tourism Development in Kullu-Manali Complex of Himachal Himalaya. In: Himachal, India (souvenir of 7th *HIMTAB)*, Manali (HP). pp. 25-27.

Kuniyal, J.C., S.C. Ram, G.S. Singh, & A.P. Jain (1995). Environmental assessment of Kullu Dussehra in Himachal Himalaya, India, In: R.B. Singh and M. J. Haigh (eds.) Sustainable Reconstruction of Highland and Headwater Regions. Proceedings of IIIrd International Symposium on Headwater Control, New Delhi, India. 6-8 October 1995. pp. 73-85.

Maikhuri, R.K. (1995). Prinsepia utilis (Bhenkel) : A promising wild edible oil shrub of Higher Himalaya. A case study in Urgam valley of Garhwal Himalaya. Ecology Environment and Conservation, 1: 115-123.

Maikhuri, R.K., K.G. Saxena & K.S. Rao (1995). Experience in developing a village agroforestry project in Garhwal Himalaya, India. International Tree Crops Journal, 8: 213-221.

Nandi, S.K., L.M.S. Palni & Rashmi (1995). Chemical manipulation of dormancy in tea shoots and associated biochemical changes. Journal of Plantation Crops, 25: 52-58.

Nandi, S.K., L.M.S. Palni & H.C. Rikhari (1996). Chemical induction of adventitious root formation in *Taxus baccata* cuttings. Plant Growth Regulation, 19: 117-122.

Nautiyal, M.C. **& P.P. Dhyani** (1995). Effect of auxins on rooting of stem cuttings of two *Aconitum* species. Indian Journal of Forestry 17(1): 58-60.

Negi, G.C.S. (1995). Phenology, leaf and twig growth pattern and leaf nitrogen dynamics of some multipurpose tree species of Himalaya: Implication towards agroforestry practice. Journal of Sustainable Agriculture, 6 (4) : 43-60

Palni, L.M.S. (1996). Biodiversity Conservation Approaches: Ex situ (Role of Biotechnology). In: G.S. Gujral and V. Sharma (eds.), Changing Perspectives of Biodiversity Status in the Himalaya. The British Council, New Delhi. pp. 153-159.

Palni, L.M.S. (1996). Simple and environmental friendly techniques for the well-being of Himalaya and its inhabitants. In: Man Culture and Society in the Kumaun Himalayas (C.M. Agarwal, ed.) Shree Almora Book Depot, Almora. pp. 277-290.

Pandey, A. & L.M.S. Palni (1996). The rhizosphere effect of tea on soil microbes in a Himalayan monsoonal location. Biology & Fertility of Soils, 21(3) : 131-137.

Pangtey, Y.P.S., **S.S. Samant & R.S. Rawal** (1995). *Dryopteris pulvinaria* (Bedd.) O. Ktze. (Dryopteridaceae): an interesting addition to the fern flora of north-western Himalaya. Indian Journal of Forestry, 18(3): 251-252.

Pangtey, Y.P.S., **S.S. Samant, R.S. Rawal & U. Dhar** (1995). *Actinopteris radiata* (Sw.) Link. (Actinopteridaceae): A poorly known species in north-western Himalayan fern flora. Indian Journal of Forestry, 18(2): 172-173.

Purohit, K. & **S. S. Samant** (1995). Fodder trees and shrubs of Central Himalaya. Gyanodaya Prakashan, Nainital.

Ramakrishnan, P.S., **K.G. Saxena & K.S. Rao** (1995). Ecological evaluation of landuse systems for development planning in the Himalayas. In: Warikoo, K. (ed.), Society and Culture in the Himalaya. Har Anand Publications, New Delhi. pp. 17-43.

Rai, S.C. & E. Sharma (1995). Land-use change and resource degradation in Sikkim Himalaya: a case study from the Mamlay watershed. In: R.B. Singh and Martin J. Haigh (eds.), Sustainable Reconstruction of High Land and Head Water Regions. Oxford & IBH Pub. Co. Pvt. Ltd. New Delhi. pp. 265-278.

Rana, U. (1996). An endangered tree of the Central Himalaya. Himalaya: Man and Nature, 18(7): 40-44.

Rawat, D.S. & K. Kumar (1995). Landuse and cropping pattern of Central Himalaya. In: B.R. Pant & M.C. Pant (eds.), Glimpses of Central Himalaya: A Socio-economic and Ecological Perspectives, Radha Publication, New Delhi. pp. 309-316.

Rawat, D.S. & K. Kumar (1996). Problems and development of agriculture in hills of Uttar Pradesh. In: D.C. Pande (ed.), Dimensions of Agriculture in the Himalaya. Shree Almora Book Depot, Almora. pp. 34-45.

Rawat, J.K., S.K. Sohani & V. Joshi (1995). Application of computer for terrace grading design by plane method. Indian Journal of Soil Conservation, 23(1): 65-68.

Samal, P.K., R.V. Rama Rao & **R.C. Prasad** (1995). What is wrong with India's tribal development Planning? an analysis and approachual framework to strategy. In : M.K. Raha (ed.) Dimensions of Human society and culture. Gyan Publishing House. New Delhi. pp. 457-501.

Samal, P.K., C. Farber, **N.A. Farooquee & D.S. Rawat** (1996). Polyandry in Central Himalayan Community : An Eco-cultural Analysis. Man in India, 76 (1): 51-66.

Samant, S.S. & Y.P.S. Pangtey (1995). Diversity of ichthyotoxic plants of Kumaun Himalaya. Indian Journal of Forestry, 18(1): 80-86.

Samant, S.S. & Y.P.S. Pangtey (1995). Additions to a forest flora for Kumaun. Higher Plants of Indian Subcontinent, 5: 285-315.

Samant, S.S., R.S. Rawal & U. Dhar (1995). Epiphytic orchids of Askot Wildlife Sanctuary in Kumaun Himalaya, India: Conservation Imperatives. Environmental Conservation, 22(1): 71-74.

Saxena, K.G. & K.S. Rao (1995). Sustainable development in the Himalaya - a nebulous goal. In: Mishra, P.C., Behra, N., Senapati, B.K. & B.C. Guru (eds.), Advances in Ecology and Environmental Sciences. Ashish Publishers House, New Delhi. pp. 439-445.

Sharma, E., L.K. Rai, S. Lachungpa & R.P. Awasthi (1995). Status of medicinal plants and their cultivation potential in Sikkim. pp. 43-51.

In: R.C. Sundriyal and E. Sharma (eds.), Proceedings of a Project Design Workshop on Cultivation of Medicinal Plants and Orchids in Sikkim Himalaya. Bishen Singh Mahendra Pal Singh, Dehra Dun.

Sharma, Rita, E. Sharma & A.N. Purohit (1995). Dry matter production and nutrient cycling in agroforestry systems of mandarin grown in association with Albizia and mixed tree species. Agroforestry System, 29(2): 165-179.

Singh, S.P., **H.C. Rikhari & G.C.S. Negi** (1995). Community patterns in an alpine meadow of Indian Central Himalaya. Journal of Botanical Society, 74A: 529-538.

Singh, G.S. (1995). Socio-economic evaluation of different land use system in high altitudes of western Himalaya. In: R.B. Singh M.J. Haigh (eds.), Sustainable Reconstruction of Highland and Headwater Regions. Proceedings of IIIrd International Symposium on Headwater Control, New Delhi, India, 6-8 October 1995. pp. 127-137.

Sundriyal, R.C. (1995). Grassland forage production and management in the Himalaya: A review. Journal of Hill Research, 8(2): 135-150.

Sundriyal, R.C. (1995) Forage resources and animal maintenance: A watershed study case from Sikkim. In: N.E. West (ed.), Rangelands in a Sustainable Biosphere, Proceedings of the Fifth International Rangeland Congress, Salt Lake City, Utah, Society for Rangeland Management, Colorado, USA. pp. 545-546.

Sundriyal, R.C. & E. Sharma (eds) (1995). Cultivation of Medicinal Plants and Orchids in Sikkim Himalaya. Proceedings of a project design workshop. Bishen Singh and Mahendra Pal Singh, Dehra Dun, India, pp. 139.

Swarup, R. & **N.A. Farooquee** (1995). Conservation of Natural Resources : An Imperative for Himalayan Region. In: Joshi, M.P. & L.P. Joshi (eds.), Uttaranchal Himalaya. Shree Almora Book Depot, Almora. pp. 197-210.

5.4.2. Popular Articles by Faculty

Badola, H. K. (1995). Status of mining- a case study. Hima Paryavaran, 7(1): 10-11.

Badola, H. K. (1995). *Kanawar vanya abhyaranya, Himachal Pradesh, main jav vividhta evam uska sanrakshan* (in Hindi). In: U. Dhar (ed.), *Himalaya ki jav vividhta sanrakshan main janta ki bhagidari II*, GBPIHED, Kosi-Katarmal, Almora. pp. 28-30.

Bisht, S.S, B.P. Kothyari & L.M.S. Palni (1995). Rural biotechnology in the Himalaya: Fibre extraction from Grewia oppositifolia-a multipurpose tree. ENVIS Bulletin, 3 (1 & 2): 52-58.

Dhar, U. (1995). *Jeevan yapan hetu jav-vividhta (in Hindi)*. In: U. Dhar (ed.), *Himalaya ki jav vividhta sanrakshan main janta ki bhagidari II*, GBPIHED, Kosi- Katarmal, Almora. pp. 6-10.

Dhar, U. (ed.) (1995). *Himalaya Ki Jav Vividhta Sanrakshan Main Janta Ki Bhagidari II (in Hindi)*. GBPIHED, Kosi-Katarmal, Almora. pp. 60.

Jain, A.P. and J.C. Kuniyal (1995). Environmental Assessment in and around Valley of Flowers. ENVIS Bulletin, 3 (1&2): 59-62.

Joshi, V. & G.C.S. Negi (1995). Development of a land and water resource management demonstration site in Dugar Gad catchment, Garhwal Himalaya. Hima Paryavaran, 7(1): 14.

Joshi, V. & G.C.S. Negi (1995). Analysis of long-term weather data from Garhwal Himalaya. ENVIS Bulletin, 3 (1 & 2): 63-64.

Maikhuri, R.K. & R.L.Semwal (1995). *Satat Gramin Vikas mein Vanya Phalon ka Prabhavi Yogdan : Garhwal Himalaya Par Ek Vishayagat Adhyayan.* Occasional Publication No. 5. Himalayan Action Research Centre (HARC), Dehradun.

Negi, G.C.S. (1995). Agroforestry system in Central Himalayan mountains of India: A commentary. Himalayan Paryavaran, 3(1):12-17.

Pandey, A., Y.K. Rai, E. Sharma & L.M.S. Palni (1995). Microbes improve maize yield. Hima Paryavaran, 7(1): 11-13.

Pant, R., Jyoti Upreti & Subodh Airi (1995). *Padap uttak smbardhan (plant tissue culture) jav vividhta sanrakshan ki ek adhunik taknik* (in Hindi). In: *U. Dhar* (ed.), *Himalaya ki jav vividhta sanrakshan main janta ki bhagidari II*, GBPIHED, Kosi-Katarmal, Almora. pp. 48-52.

Prasad, R.C. (1995). Geographical information systems and ecological data. ENVIS Bulletin, 3 (1 & 2): 1-2.

Prasad, R.C. (1995). Classification schedule for environmental science. ENVIS Bulletin, 3 (1 & 2): 2-3.

Prasad, R.C. (1995). Bibliographical database on Himalaya. ENVIS Bulletin, 3(1 & 2): 92-112.

Rawal, R. S. (1995). *Podh ropan hetu prajatiyon ka chayan wa nursery prabandhan* (in Hindi). In: U. Dhar (ed.), *Himalaya ki jav vividhta sanrakshan main janta ki bhagidari II*, GBPIHED, Kosi-Katarmal, Almora. pp. 31-41.

Samant, S. S. (1995). *Askot vanya jeev abhyaranya ki jav vividhta* (in Hindi). In: U. Dhar (ed.) *Himalaya ki jav vividhta sanrakshan main janta ki bhagidari II*. GBPIHED, Kosi-Katarmal, Almora. pp. 11- 27.

Sharma, S., H.C. Rikhari & L.M.S. Palni (1995). Makkhan: An important agroforestry tree, but for the wrong reasons. Hima Paryavaran, 7(1): 13-14.

Siril, E. A., Indra Dutt & U. Dhar (1995) Tissue culture of Chinese Tallow (*Sapium sebiferum* Roxb.). Hima Paryavaran, 7(1): 11-12.

Singh, G. S. & K.S. Rao (1995). Traditional knowledge in Chhakinal watershed. ENVIS Bulletin, 3 (1 & 2): 6-12.

Upadhaya, R.C. & **R.C. Sundriyal** (1995). Seabuckthorn-A useful plant of high hills in Sikkim. SSS Newsletter, 8(4): 10-11.

5.5. PARTICIPATION IN SYMPOSIA/ CONFERENCES

Presentation in III Task force meeting at Department of Biotechnology, New Delhi. 1 March, 1995. **(U. Dhar)**

National Seminar on Community Forestry: Biodiversity of Forest Species. Society of Tree Scientists, New Delhi. 2 & 3 May, 1995. **(A.N. Purohit, G.C.S.Negi & Subrat Sharma).**

Bilateral Cooperation Programme on Mountain Environment and Development planned by G.B. Pant Institute of Himalayan Environment and Development and Norwegian Centre for International Agriculture Development (NORAGRIC), Norway. 5-14 July, 1995. **(R.K. Maikhuri).**

Fifth International Rangeland Congress, Salt Lake City, Utah, USA. 23-28 July, 1995. **(R.C. Sundriyal)**.

International Seminar on Sustainable Reconstruction of Highland and Headwater Regions : International Symposium on Headwater Control, New Delhi. 6-8 October, 1995. **(S.C. Rai, J.C. Kuniyal, S. Ghosh, U. Rana, K.K. Sen & G. S. Singh)**.

Landuse Planning in Hill Region and People's Participation. Organised by SHERPA and State Landuse Board (UP), Nainital. 27-28 October, 1995. **(B.P. Kothyari)**.

Second GBPIHED (CBD) training workshop on *Jav Vividhta Sanrakshan Main Janta Ki Bhagidari*, Narayan Nagar (Pithoragarh). 9-10 November, 1995 **(U. Dhar, H.K. Badola, S.S. Samant, R. S. Rawal, S. Airi, Jyoti Upreti, E. A. Siril, I. D. Bhatt & R. P. Pant)**

Workshop on Himalayan eco-development and natural disaster reduction, New Delhi. 27-28 November, 1995. **(P.P. Dhyani)**.

Asian Science and Technology Congress on Managing Biodiversity for Sustainable Development organised by Federation of Asian Scientific Academies and Societies (FASAS), Kuala-Lumpur, Malaysia. 5-7 December, 1995. **(R.K. Maikhuri)**.

National Symposium on Frontiers in Applied Environmental Microbiology, Cochin Univ. of Science & Technology, Kochi, Kerala. 11-13 December, 1995. **(Anita Pandey)**.

Planning 'Workshop on Community Based Research and Extension for Rehabilitation of Degraded Lands, organised by ICIMOD, SDC, IDRC, Kathmandu. 18-22 March, 1996. **(B.P. Kothyari)**.

National Seminar on *Jal Vigyan Evam Jal Sansadhan*. National Institute of Hydrology, Roorkee. 15-16 December, 1995. **(V. Joshi)**.

National Symposium on Forage Production System for Sustainable Agricultural Development, jointly organised by Indian Grass and Fodder Research Institute and Range Management Society of India, Jhansi. 21-23 December, 1995. **(S.C. Ram)**.

Pacific Asia Travel Agents (PATA) meet and conference on ecotourism prospects and biodiversity maintenance in the Himalayan region, Kathmandu, Nepal. 13-15 January, 1996. **(E. Sharma)**.

International Conference on Disasters and Mitigation, Anna University. Madras. 19-22 January, 1996. **(V. Joshi)**.

National Conference on Environmental Education: Protection of the Atmosphere. Indian Environmental Society, New Delhi. 24-25 January, 1996. **(G.C.S. Negi)**.

National Symposium on Environmental Strategies for Sustainable Development, G.B. Pant Univ. of Agriculture and Technology, Pantnagar, U.P. 1-3 February, 1996. **(H.C. Rikhari)**.

National Seminar on Seed Technology, HNB Garhwal University, Srinagar. 20-21 February, 1996. **(C.P. Kuniyal & Hemantlata)**.

National Symposium on Modern Treads in Plant Physiology. G.B. Pant University of Agriculture and Technology, Pantnagar. 18-20 March, 1996. (**S. Nautiyal**).

National Symposium on Modern Trends in Plant Physiology, G.B. Pant Univ. of Agriculture & Technology, Pantnagar, U.P. 18-20 March, 1996. (**L.M.S. Palni, M.S. Bisht, Poonam Vyas, S.S. Bisht & S. Bhuchar**). Awarded IInd Prize for Poster Presentation.

International Conference on Ecohydrology of High Mountain Areas, UNESCO & ICIMOD, Kathmandu, Nepal. 23-28 March, 1996. (**V. Joshi**).

International Conference on Ecohydrology of High Mountain Areas and Regional Workshop on Hydrology of Hindu-Kush Himalayan Region, Organized by ICIMOD and UNESCO at Kathmandu, Nepal. 23-28 March, 1996. (**S.C. Rai**).

Eleventh Annual Landscape Ecology Symposium, Galveston, Texas, U.S.A. 26-30 March, 1996. (**Subrat Sharma**).

National Workshop on Biodiversity Conservation in Managed Forests and Protected Areas, IIFM Bhopal. 29 Nov. - 1 Dec. 1995. (**R.S. Rawal**).

ICIMOD and GBPIHED policy level GIS workshop. Almora, 16 January 1996. (**P.P. Dhyani**).

5.6. TRAINING COURSES/WORKSHOPS

Workshop on Theory and Methodology for Physiological and Molecular Basis of Stress Resistance in Crop Plants. Water Technology Centre, I.A.R.I., New Delhi. 3-24 April, 1995. (**S.K. Nandi**).

Summer School on Biodiversity, Inventory, Monitoring and Information Systems. J. N. C. A. S. R. and C.E.S., Indian Institute of Science, Bangalore. 4-14 April, 1995. (**S.S. Samant**).

Biodiversity Conservation Network (BCN), Training cum Monitoring Workshop on Biodiversity Conservation and Commercial Utilization of Natural Resources for South Asia organized by Tata Energy Research Institute, Bangalore. 22-27 May, 1995. (**R.K. Maikhuri & R.C. Sundriyal**).

CIDA-SICI Partnership Project Workshop on Sustainable Development of Mountain Environments in India and Canada, Manali (HP). June 30 to July 1, 1995. (**H.K. Badola, A.P. Jain, J.C. Kuniyal & S.C. Ram**).

Workshop on Soil Testing for Iodine (sponsored by Unicef), Kosi-Katarmal. 18 & 19 July, 1995. (NGOs, Unicef Official, and Institute staff; outside experts, namely Prof. B. Mishra, Dr. P.C. Srivastava and Dr. L.S. Bisht also attended and gave invited lectures).

Three days on-site training programme on nursery development, tree plantation techniques and natural resource conservation and management to villagers, rural women, ex-army personnel & NGOs, Arah village, Almora. 15-17 April, 1995. (**P.P. Dhyani, B.P. Kothyari & R.G. Singh**).

Three days on-site training programme on nursery development, tree plantation techniques and natural resource conservation and management to villagers, rural women, ex-army

personnel & NGOs at Bhiri-Banswara, Chamoli Garhwal. 12-14 June 1995. (**P.P. Dhyani, S.K. Bhadula, R.K. Maikhuri, G.C.S. Negi, B.P. Kothyari & R.G. Singh**).

International workshop on Statistical Methods in Hydrometeorology, National Institute of Hydrology, Roorkee. 21-24 August, 1995. (**S.C. Rai, G.C.S. Negi & Kireet Kumar**).

Workshop on Snow-melt run-off modelling at National Institute of Hydrology, Roorkee (U.P.). 11-15 September, 1995. (**A.P. Krishna & V. Joshi**).

Workshop on "Towards Sustainable Forestry in the U.P. Hills", Organized by Overseas Development Administration (U.K.) and U.P. Forest Department, Nainital. 18-20 October, 1995. (**Ranjan Joshi**).

Three days on-site training programme on nursery development, tree plantation techniques and natural resource conservation and management to villagers, rural women, ex-army personnel & NGOs at Hanumanchatti, Chamoli Garhwal from 30 Oct. - 1 November 1995. (**P.P. Dhyani, R.K. Maikhuri, B.P. Kothyari, G.C.S. Negi & R.G. Singh**).

Geographic Information Systems and Geographic Positioning Systems Applications in Natural Resources Management and Environmental Monitoring Training course for Natural Resource Management, In collaboration with GBPIHED, Kosi-Katarmal and ICIMOD, Kathmandu, 6-25 November, 1995. (**J.C. Kuniyal & V. Joshi**).

Executive Development Programme on Environmental Impact Assessment of Mining Projects, Centre of Mining Environment, Indian School of Mines, Dhanbad. 4-9 December, 1995. (**J.C. Kuniyal**).

Policy level Workshop on Geographical Information System (GIS) organized by GBPIHED and ICIMOD, Almora. 16 January, 1996. (**P.P. Dhyani**).

Eco-camps organised by Department of Forestry, HNB Garhwal University, Srinagar (Garhwal), for school children at GIC Loali (Pauri) and Ratura (Chamoli). February, 1996. (**R.K. Maikhuri & G.C.S. Negi**).

Project Assessment Workshop on Great Himalayan National Park, Shamshi-Kullu (HP). 2 February, 1996. (**H.K. Badola, J.C. Kuniyal, S.C. Ram**).

Organized and participated in "Sikkim Biodiversity and Ecotourism Workshop cum Training for Travel Agencies and Guides", Gangtok. 12-16 February, 1996. (**E. Sharma, R.C. Sundriyal & S.C. Rai**).

Nursery and Plantation Technology Training Programme organized for village people. HAPPRC, HNB Garhwal University, Srinagar (Garhwal). 28 February, 1996. (**R.K. Maikhuri & G.C.S. Negi**).

Workshop on "Environmental Orientation in School Curriculum in Sikkim", organized by State Institute of Education, Govt. of Sikkim and G.B. Pant Institute of Himalayan Environment & Development. 6-10 March, 1996. (**E. Sharma, R.C. Sundriyal, S.C. Rai & A.P. Krishna**).

Workshop on "Global Change Impacts on Mountain Hydrology and Ecology", Kathmandu, Nepal. 30 March - April 2, 1996. (**S.C. Rai**).

Planning phase "Sikkim Biodiversity and Ecotourism" workshop organized by the GBPIHED and the Mountain Institute, USA. The workshop was participated by the State Government concerned departments, Travel Agents Association of Sikkim, The Green Circle and NGOs. (**A.N. Purohit, E. Sharma, A.P. Krishna, R.C. Sundriyal, S.C. Rai, Y.K. Rai & L.K. Rai**).

5.7. MEETINGS

Meeting on Cultivation of Medicinal Plants and Orchids in Sikkim Himalaya at the Planning Commission, Government of India, New Delhi. 5th April, 1995. (**E. Sharma**).

"Interaction on waste management & environment", Manali (HP). 6 April, 1995. (**H. K. Badola**).

"Green Manali- Clean Manali". Manali (HP), 5 June, 1995. (**H. K. Badola**).

Discussed issues of common interest with officials of WWF-Nepal, IUCN-Nepal, ICIMOD and Makalu-Barun Conservation Project-Nepal during 15-19 January, 1996. (**E. Sharma**).

TECHNICAL REPORTS

Choudhury, D., S. Changkija, R. Singha, A.K. Sinha, R. Amutha, A. Mitra, and S. Dutta (1996). Biodiversity conservation and integrated development of villages in and around Mawthadraishan Ridge, west Khasi hills, Meghalaya. DPR on formulation of schemes, submitted to NEC, Shillong.

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

22, Paltan Bazar
(Above Frontier Jewellers)
Dehra Dun - 248 001
Tel: 0135-654941,658255,655368
Fax: 0135-623039,624008

To
The Director
G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
Kosi,
Almora - 263 643

Dear Sir,

We have examined the balance sheet of **G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT** as at 31st March 1996 and the Income and Expenditure account for the year ended on that date which are in agreement with the books of account maintained by the said Institution.

We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purpose of the audit. In our opinion, proper books of account have been kept by the head office and the branches of the above named institution so far as appears from our examination of the books, and proper returns adequate for the purposes of audit have been received from units.

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

(i) in the case of the Balance Sheet, of the state of affairs of the above named institution as on March 31, 1996 and

(ii) in the case of Income and Expenditure Account, of the income of its accounting year ending on March 31, 1996.

(iii) in the case of Receipt and Payment Account, of the receipts & payments during the accounting year ending on March 31, 1996.

For **M/S HARISH C. KAPOOR & CO.**
Chartered Accountants

Dated : August 20, 1996
Place : Dehra Dun.

(Sd/-)
(HARISH C. KAPOOR)
F.C.A.

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NOTES FORMING PART OF THE STATEMENT OF ACCOUNTS FOR THE YEAR ENDING ON MARCH 31, 1996 AND ANNEXED TO THE BALANCE SHEET OF EVEN DATE

1. Books of accounts have been maintained on cash basis subject to para 4 below.
2. No depreciation on Fixed assets has been provided in the accounts and value shown at cost.
3. All purchase of consumables, laboratory expenses, chemicals, glassware, stores & stationery have been charged to Income & Expenditure Account at the time of purchase.
4. Interest on Fixed Deposits has been provided on accrual basis.
5. Full form of short names of projects reflected in the statement of accounts is as under :

NORAD	:	Norwegian Agency for Development Corporation.
ICIMOD	:	International Centre for Integrated Mountain Development.
TSBF	:	Tropical Soil Biology Fertility.
IERP	:	Integrated Eco-development Research Programme.
ENVIS	:	Environmental Information System.
DST	:	Department of Science & Technology.
CSIR	:	Council of Scientific and Industrial Research.
BIOTECH	:	Department of Biotechnology.
NEC	:	North Eastern Council.
NWDRA	:	National Watershed Development project for Rainfed Areas.
UNDP	:	United Nation's Development Programme.
UNESCO	:	United Nation's Educational Scientific and Cultural Organization.
UNICEF	:	United Nation's Children Fund.

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6. Stock registers of assets have been maintained by the institution for movement of assets, stores, vehicles and other consumables, which have been physically verified at regular intervals.

7. During the year, Provident Fund liabilities and investments of the Institute have been incorporated in the statement of accounts.

8. Fixed Assets except vehicles have no insurance cover to provide security against any loss. Considering the accumulated value of assets, appropriate Insurance cover be obtained.

9. Annexure `A' to `J' and `1' to `31' are integral part of Statements of accounts prepared for the year.

For **M/S HARISH C. KAPOOR & CO.**
Chartered Accountants

(Sd/-)
(HARISH C. KAPOOR)

Dated : August 20, 1996
Place : Dehra Dun.

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

Balance Sheet as on March 31, 1996

PARTICULARS	ANN	AMOUNT	AMOUNT	AMOUNT
SOURCE OF FUNDS :				
* ***General Fund:***				
Last Balance:			1,089,237.14	
Add:Additions For the Year:			380,262.00	1,469,499.14
* ***Endowment Fund:***				
Last Balance:			1,762,151.01	
Add:Interest Earned:			201,071.80	1,963,222.81
* ***Fixed Assets Fund:***				
Last Balance:		47,743,961.31		
Add:Additions For the Year:		11,053,841.00	58,797,802.31	
Less: Sale During the Year:			0.00	58,797,802.31
* ***Construction Fund - CCU:***				
Last Balance:		87,406,377.00		
Add:Additions For the Year:		21,500,000.00	108,906,377.00	
Less: Transf. during the Year:			0.00	108,906,377.00
* ***Provident Fund:***				
Last Balance:		1,242,592.40		
Add:Additions For the Year:		699,182.00	1,941,774.40	
Less Payment during the Year:			0.00	1,941,774.40
* ***Project Funds:***	1			
Research & Development Fund:			2,509,946.79	
Construction Fund:			2,968,942.00	
NEC Shillong Fund:			(6,981.00)	
IERP Project Fund:			3.49	
ENVIS Project Fund:			170,770.00	
DST (SKB) Project Fund:			397.00	
NWDRA Project Fund:			129,935.00	
DST (RSR) Project Fund:			1,032.00	
DST (RKM) Project Fund:			5,869.00	
CSIR (HCR/GCSN)Project Fund:			4,165.00	
BIOTECH (I) Project Fund:			91,613.00	
BIOTECH (II) Project Fund:			(72,950.00)	
BIOTECH (III) Project Fund:			3,857,127.00	
UNICEF Project Fund:			9,624.00	
IEG Project Fund:			74,160.00	
UNDP (Haigad) Project Fund:			(21,522.00)	
Balance Carried Forward:			**9,722,131.28**	**173,078,675.66**

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

Balance Sheet as on March 31, 1996

PARTICULARS	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward :				**173,078,675.66**
Project Funds (Brought Forward):			9,722,131.28	
CSIR (RCS) Project Fund:			110,938.00	
DST (SKN) Project Fund:			517,004.00	
NORAD Project Fund:			(1,255,332.79)	
ICIMOD Project Fund:			132,189.05	
TSBF Project Fund:			43,232.00	
INDO CANADIAN Project Fund:			104,085.00	
ICIMOD SALT Project Fund :			111,935.00	
ICIMOD ISMA Project Fund:			446,269.00	
GIS TRAINING Programme Fund:			116,965.00	
MACARTHER UNESCO Project Fund:			19,941.00	
ECO TOURISM Project Fund:			105,660.00	10,175,016.54
* *Other Liabilities :*				
Group Saving Link Insurance :			1,487.15	
CPF Payable:			4,214.00	
Salary Payable:			5,466.70	
TDS Payable:			671.00	
Medical Claim Payable:			230.00	12,068.85
TOTAL Rs.				**183,265,761.05**
APPLICATION OF FUNDS:				
* *Fixed Assets:*	**30**			58,797,802.31
* *Deposits with:*				
CCU for Construction:			108,906,377.00	
SP.LAO for Land:			80,000.00	108,986,377.00
* *Security Deposits:*				32,721.00
* *Closing Balances:*	**31**			15,448,860.74
TOTAL Rs.				**183,265,761.05**
				(0.00)

(Sd/-)
(Finance Officer)

(Sd/-)
(D.D. Officer)

(Sd/-)
(Director Incharge)
Dated : August 20, 1996
Place : Dehra Dun

As per our separate report of even date.

For M/S HARISH C. KAPOOR & CO.
Chartered Accountants

(Sd/-)
(HARISH C. KAPOOR)

HARISH C. KAPOOR & CO.
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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KOSI (ALMORA)

Income & Expenditure Account for the Year Ending on March 31, 1996.

PARTICULARS	ANN	AMOUNT	AMOUNT	AMOUNT
INCOME				
Grants in Aid:				
Designated Project Grants:				
* Research & Development and Other Expenses:			18,200,000.00	
* Construction Work:			24,390,000.00	
* NEC Shillong:			0.00	
* IERP:			3,855,396.00	
* ENVIS:			300,000.00	
* DST (SKB):			0.00	
* NWDRA:			100,000.00	
* DST (RSR):			0.00	
* DST (RKM):			20,000.00	
* CSIR (HCR/GCSN):			74,843.00	
* BIOTECH (I):			187,000.00	
* BIOTECH (II):			432,000.00	
* BIOTECH (III):			495,000.00	
* UNICEF:			0.00	
* IEG Project:			75,000.00	
* UNDP (Haigad) Project:			64,000.00	
* CSIR (RCS) Project:			233,600.00	
* DST (SKN) Project:			550,000.00	
* NORAD Project:			0.00	
* ICIMOD Project:			436,888.00	
* TSBF Project:			161,278.00	
* INDO CANADIAN Project:			781,951.00	
* ICIMOD SALT Project:			621,572.00	
* ICIMOD ISMA Project:			0.00	
* GIS TRAINING Programme:			270,000.00	
* MACARTHER UNESCO Project:			548,868.00	
* ECO TOURISM Project:			155,660.00	51,953,056.00
Less: Transferred to Designated Funds:				
* Research & Development and Other Expenses:			18,200,000.00	
* Construction Work:			24,390,000.00	
* NEC Shillong:			0.00	
* IERP:			3,855,396.00	
* ENVIS:			300,000.00	
* DST (SKB):			0.00	
* NWDRA:			100,000.00	
* DST (RSR):			0.00	
Balance Carried Forward:			**46,845,396.00**	**51,953,056.00**

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

Income & Expenditure Account for the Year Ending on March 31, 1996.

PARTICULARS	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:				**51,953,056.00**
Balance of Trf. to Designated Funds (Brought Forward):			46,845,396.00	
* DST (RKM):			20,000.00	
* CSIR (HCRAGCSN):			74,843.00	
* BIOTECH (I):			187,000.00	
* BIOTECH(II):			432,000.00	
* BIOTECH (III):			495,000.00	
* UNICEF:			0.00	
* IEG Project:			75,000.00	
* UNDP (Haigad) Project :			64,000.00	
* CSIR (RCS) Project:			233,600.00	
* DST (SKN) Project:			550,000.00	
* NORAD Project:			0.00	
* ICIMOD Project:			436,888.00	
* TSBF Project:			161,278.00	
* INDO CANADIAN Project:			781,951.00	
* ICIMOD SALT Project:			621,572.00	
* ICIMOD ISMA Project:			0.00	
* GIS TRAINING Programme:			270,000.00	
* MACARTHER UNESCO Project:			548,868.00	
* ECO TOURISM Project:			155,660.00	51,953,056.00
				0.00
Interest From Banks:				294,421.00
Other Income:				
* Licence Fee:			10,412.00	
* Water Testing Fee:			1,500.00	
* Nursery:			450.00	
* Miscellaneous:			73,479.00	85,841.00
Designated Grants Utilised:				
* Research & Development and Other Expenses:			19,748,856.69	
* Construction Work:			21,501,638.00	
* NEC Shillong:			50,451.00	
* IERP:			3,855,395.00	
* ENVIS:			125,413.00	
* DST(SKB)			849,603.00	
* NWDRA:			72,380.00	
* DST (RSR):			0.00	
Balance Carried Forward:			**46,203,736.69**	**380,262.00**

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

Income & Expenditure Account for the Year Ending on March 31, 1996.

PARTICULARS	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:				**380,262.00**
Desig. Grants Utilised Contd:			46,203,736.69	
* DST (RKM):			55,065.00	
* CSIR (HCR/GCSN):			74,843.00	
* BIOTECH (I):			370,675.00	
* BIOTECH (II):			1,026,865.00	
* BIOTECH (III):			694,810.00	
* UNICEF:			99,769.00	
* IEG Project:			840.00	
* UNDP (Haigad)Project:			168,270.00	
* CSIR (RCS) Project:			122,662.00	
* DST (SKN) Project:			32,996.00	
* NORAD Project:			71,802.00	
* ICIMOD Project:			278,019.00	
* TSBF Project:			480,432.00	
* INDO CANADIAN Project			717,717.00	
* ICIMOD SALT Project:			726,203.00	
* ICIMOD ISMA Project:			190,416.00	
* GIS TRAINING Programme:			153,035.00	
* MACARTHER UNESCO Project:			528,927.00	
* ECO TOURISM Project:			50,000.00	52,047,082.69
TOTAL INCOME (A):				52,427,344.69
EXPENDITURE:				
Project Expenditure:				
* Research & Development and Other Expenses:	2		10,970,801.69	
* Construction Work	3		1,638.00	
* NEC Shillong	4		50,451.00	
* IERP:	5		3,855,395.00	
* ENVIS:	6		125,413.00	
* DST (SKB):	7		41,039.00	
* NWDRA:	8		72,380.00	
* DST (RSR):	9		0.00	
* DST(RKM):	10		55,065.00	
* CSIR (HCR/GCSN):	11		74,843.00	
* BIOTECH (I):	12		269,387.00	
* BIOTECH (II):	13		719,134.00	
* BIOTECH (III):	14		402,219.00	
* UNICEF:	15		99,769.00	
* IEG:	16		840.00	
* UNDP (Haigad) Project:	17		104,870.00	
Balance Carried Forward			**16,843,244.69**	

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

Income & Expenditure Account for the Year Ending on March 31, 1996.

PARTICULARS	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:			**16,843,244.69**	
Project Expenditure Continued:				
* CSIR (RCS) Project:	18		51,672.00	
* DST (SKN) Project:	19		32,996.00	
* NORAD Project:	20		71,802.00	
* ICIMOD Project:	21		278,019.00	
* TSBF Project:	22		199,957.00	
* INDO CANADIAN Project:	23		665,705.00	
* ICIMOD SALT Project:	24		717,843.00	
* ICIMOD ISMA Project:	25		190,416.00	
* GIS TRAINING Programme:	26		153,035.00	
* MACARTHER UNESCO Project:	27		238,552.00	
* ECO TOURISM Project:	28		50,000.00	19,493,241.69
Capital Exp. Trf to CCU:				21,500,000.00
Capital Expenditure:				
* Research & Development:				
Library:		2,209,113.00		
R & D Equipments:		5,182,604.00		
Office Equipments:		152,750.00		
Vehicle:		555,797.00		
Furniture:		677,791.00	8,778,055.00	
* BIOTECH (I):			101,288.00	
* BIOTECH (II):			307,731.00	
* BIOTECH (III):			292,591.00	
* UNDP (Haigad) Project:			63,400.00	
* CSIR (RCS) Project:			70,990.00	
* DST (SKN) Project:			808,564.00	
* TSBF Project:			280,475.00	
* INDO CANADIAN Project:			52,012.00	
* ICIMOD SALT Project:			8,360.00	
* MACARTHER UNESCO Project			290,375.00	11,053,841.00
TOTAL EXPENDITURE (B):				**52,047,082.69**
EXCESS OF INCOME OVER EXPENDITURE [(A)-(B)]:				**380,262.00**

(Sd/-)
(Finance Officer)

(Sd/-)
(D.D. Officer)

(Sd/-)
(Director Incharge)
Dated : August 20, 1996
Place : Dehra Dun

As per our separate report of even date.

For M/S HARISH C. KAPOOR & CO.
Chartered Accountants

(Sd/-)
(HARISH C. KAPOOR)

HARISH C. KAPOOR & CO.
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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KOSI (ALMORA)

Receipt & Payment Account for the Year Ending on March 31, 1996.

PARTICULARS	ANN	AMOUNT	AMOUNT	AMOUNT
RECEIPTS				
Opening Balance:	29		11,985,071.27	
Add: Prev. year adjustment:			247,362.00	12,232,433.27
Add: Grants in Aid:				
* Research & Development and Other Expenses:			18,200,000.00	
* Construction Work			24,390,000.00	
* NEC Shillong:			0.00	
* IERP:			3,855,396.00	
* ENVIS:			300,000.00	
* DST (SKB):			0.00	
* NWDRA:			100,000.00	
* DST (RSR):			0.00	
* DST (RKM):			20,000.00	
* CSIR (HCR/GCSN):			74,843.00	
* BIOTECH (I):			187,000.00	
* BIOTECH (II):			432,000.00	
* BIOTECH (III):			495,000.00	
* UNICEF:			0.00	
* IEG Project:			75,000.00	
* UNDP (Haigad) Project			64,000.00	
* CSIR (RCS) Project:			233,600.00	
* DST (SKN) Project:			550,000.00	48,976,839.00
Interest from Bank:				
* Institute			294,421.00	
* Endowment Fund:			201,071.80	495,492.80
Other Receipts:				
* Security Deposit			34,602.00	
* Group Savings Link Ins.:			1,287.00	
* Licence Fee:			10,412.00	
* Water Testing Fee:			1,500.00	
* Nursery:			450.00	
* Miscellaneous:			73,479.00	
* CPF Recoveries:			1,240.00	122,970.00
TOTAL RECEIPTS Rs....				**61,827,735.07**

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

Receipt & Payment Account for the Year Ending on March 31, 1996

PARTICULARS	ANN	AMOUNT	AMOUNT	AMOUNT
PAYMENTS:				
Project Payments:				
* Research & Development and Other Expenses:	2		10,740,408.39	
* Construction Work:	3		21,501,638.00	
* NEC Shillong:	4		50,451.00	
* IERP:	5		3,855,395.00	
* ENVIS:	6		125,413.00	
* DST (SKB):	7		41,039.00	
* NWDRA	8		72,380.00	
* DST (RSR):	9		0.00	
* DST (RKM):	10		55,065.00	
* CSIR (HCR/GCSN):	11		74,843.00	
* BIOTECH (I):	12		269,387.00	
* BIOTECH (II):	13		719,134.00	
* BIOTECH (III):	14		402,219.00	
* UNICEF:	15		99,769.00	
* IEG Project:	16		840.00	
* UNDP (Haigad) Project:	17		104,870.00	
* CSIR (RCS) Project:	18		51,672.00	
* DST (SKN) Project:	19		32,996.00	38,197,519.39
Capital Expenditure:				
* Library			2,209,113.00	
* R & D Equipments:				
* RESEARCH & DEVELOPMENT:		5,182,604.00		
* BIOTECH (I):		101,288.00		
* BIOTECH (II):		307,731.00		
* BIOTECH (III):		292,591.00		
* CSIR (RCS) Project:		63,400.00		
* DST (SKN) Project:		70,990.00		
* DST (SKM) Project:		808,564.00	6,827,168.00	
* Office Equipments:			152,750.00	
* Furniture:			677,791.00	
* Vehicle:			555,797.00	10,422,619.00
Security Paid:				95,991.00
F.C. Inter Account:				8.00
Balance Carried Forward:				**48,716,137.39**

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

Receipt & Payment Account for the Year Ending on March 31, 1996

PARTICULARS	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:				48,716,137.39
Closing Balance:				
* Cash & Bank Balance:				
Cash in Hand (IC A/C):				
Almora:		7,568.00		
Srinagar:		1,398.49		
Sikkim:		115.81		
Kullu:		6,420.26		
Dimapur:		6,164.19	21,666.75	
Cash at Bank (IC A/C):				
CBI Kosi A/C No. CD-14:		1,218,180.25		
SBI Almora A/C No. 22752:		8,790,235.25		
SBI Almora A/C No. 23884:		11,660.81		
SBI Tadong A/C No. CA/4/85:		189,418.21		
SBI Kullu A/C No. 50201/7:		34,830.72		
SBI Srinagar A/C No. 3/615:		6,267.72		
SBI Dimapur A/C No. C&I/6/22:		419.42	10,251,012.38	
* Advances:				
House Building Advance:			98,024.00	
Festival Advance:			5,400.00	
Units of Institute:				
Srinagar:		10,040.00		
Sikkim:		0.00		
Dimapur:		0.00		
Himachal Pradesh:		1,000.00	11,040.00	
* Fixed Deposits:				
With SBI-Endowment Fund:			1,951,562.00	
* Due-Staff/Others (IC A/C):				
Director-IARI		26.50		
G.C.S. Negi (CSIR):		2,000.00		
A.S. Parihar:		389.00		
J.S. Bisht:		1,200.00		
G. Media:		92,500.00		
R.C. Prasad:		249.00		
R.K. Nanda & Sons:		28,517.00		
Pertech Computers:		2,000.00		
Air Port Handling Services:		6,000.00		
Employment News:		10,100.00		
Balance Carried Forward:		**142,981.50**	**12,338,705.13**	**48,716,137.39**

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

22, Paltan Bazar
(Above Frontier Jewellers)
Dehra Dun - 248 001
Tel: 0135-654941, 658255, 655368
Fax: 0135-623039, 624008

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

Receipt & Payment Account for the Year Ending on March 31, 1996

PARTICULARS	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:		**142,981.50**	**12,338,705.13**	**48,716,137.39**
Elron Instruments Pvt. Ltd:		7,467.00		
ECIL, New Delhi:		408,242.00		
ECIL, New Delhi (Biotech-I):		204.00		
Sigma Aldrich Chemicals:		10,590.00		
Conv. National Symposium:				
G.B.P. University (Biotech-III):		10,000.00		
Civil Construction Unit: (ME & F):		61,800.00		
Siltap Chemicals Ltd (Biotech-III):		16,320.00		
Director FRI, Dehra Dun (ENVIS):		12,800.00		
R.C. Sundriyal (CSIR-RCS):		10,000.00		
Employment News (DST-SKN):		6,500.00		
CPF Account:		129.00		
N.R.S.A. Hyderabad:		11,200.00		
Shivalik Agro Products:		677.00		
Klenzaids Con. Controls Pvt Ltd:		57,175.00		
M.P.C.B.		16,382.00		
Group Sav. Link Ins:		425.05	772,892.55	13,111,597.68
TOTAL PAYMENTS Rs.....				**61,827,735.07**
				0.00

(Sd/-)
(Finance Officer)

(Sd/-)
(D.D. Officer)

(Sd/-)
(Director Incharge)

Dated : August 20, 1996
Place : Dehra Dun

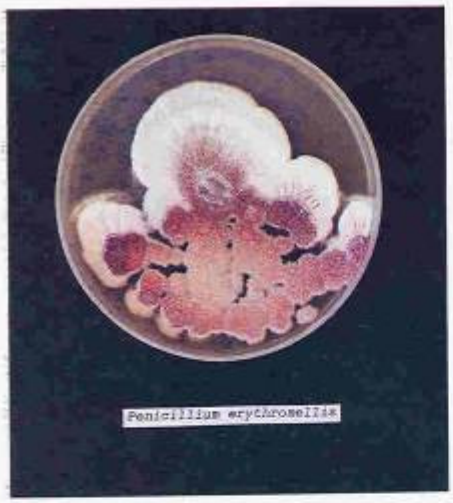
As per our separate report of even date.

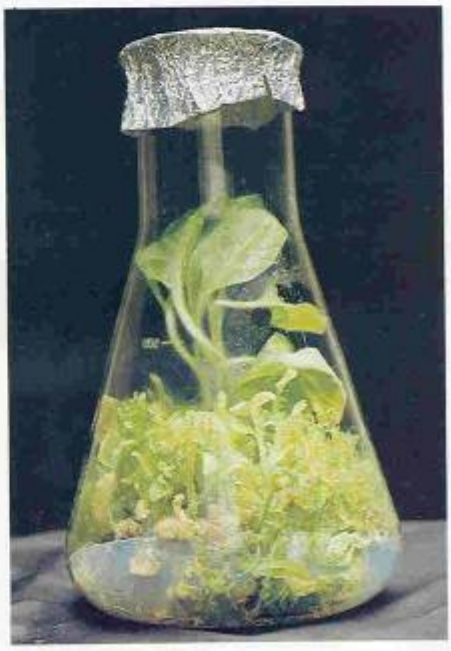
For M/S HARISH C. KAPOOR & CO.
Chartered Accountants

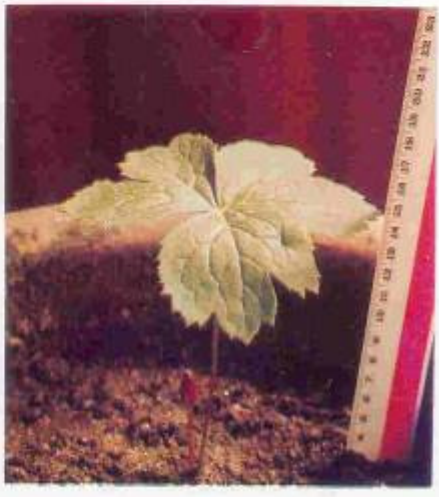
(Sd/-)
(HARISH C. KAPOOR)

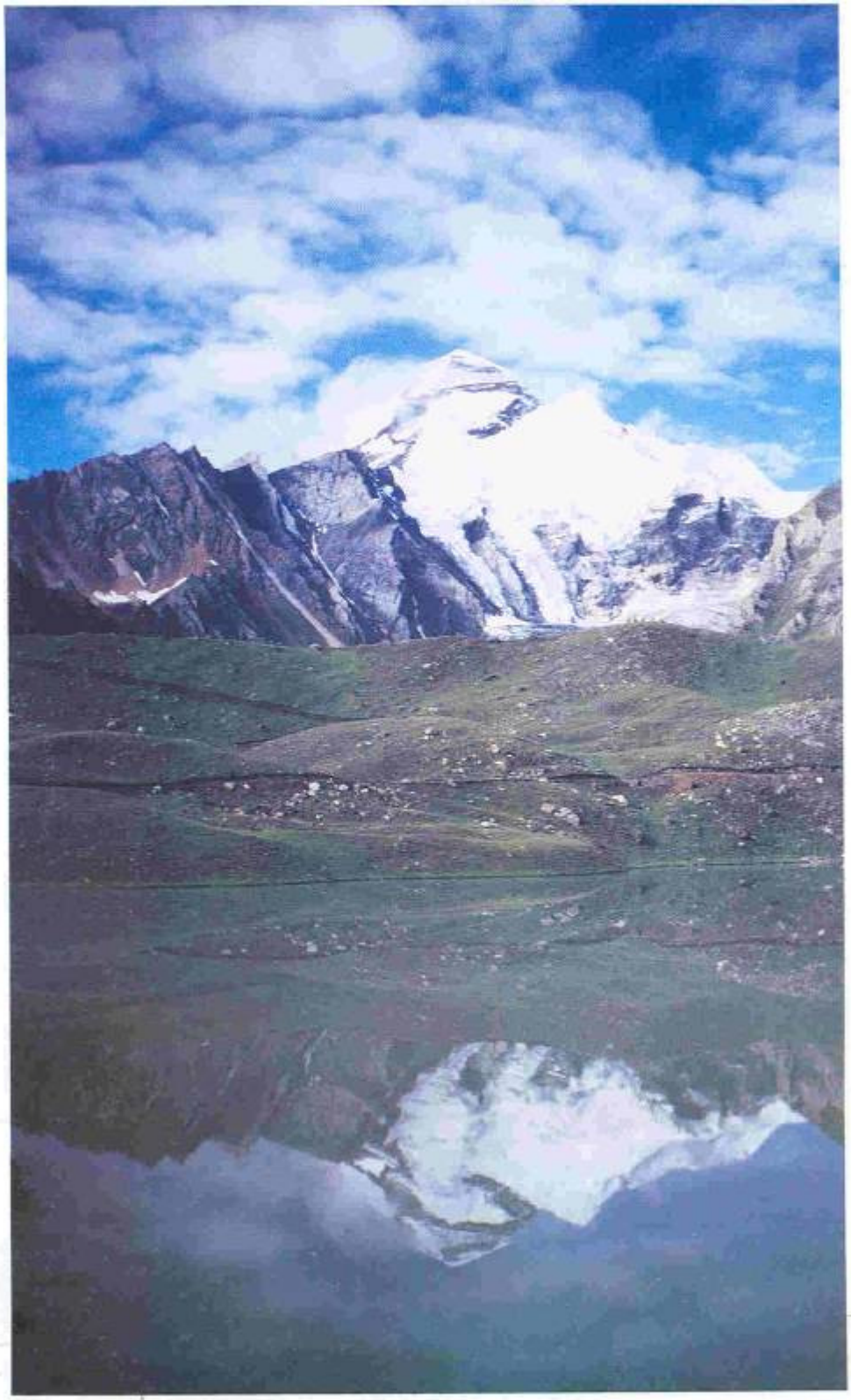

बद्रीवन-पुनः स्था


पर्यावरण प्रशिक्षण शिविर


Penicillium erythromellis







INSTITUTIONAL PUBLICATIONS

1991

* Agriculture Economy of Himalayan Region, Vol I Kumaun.

1992

* Himalayan Environment & Development: Problems and Perspectives
* Integrated Watershed Management: A Case study of Sikkim Himalaya
* Action Plan for Himalaya

1993

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

1994

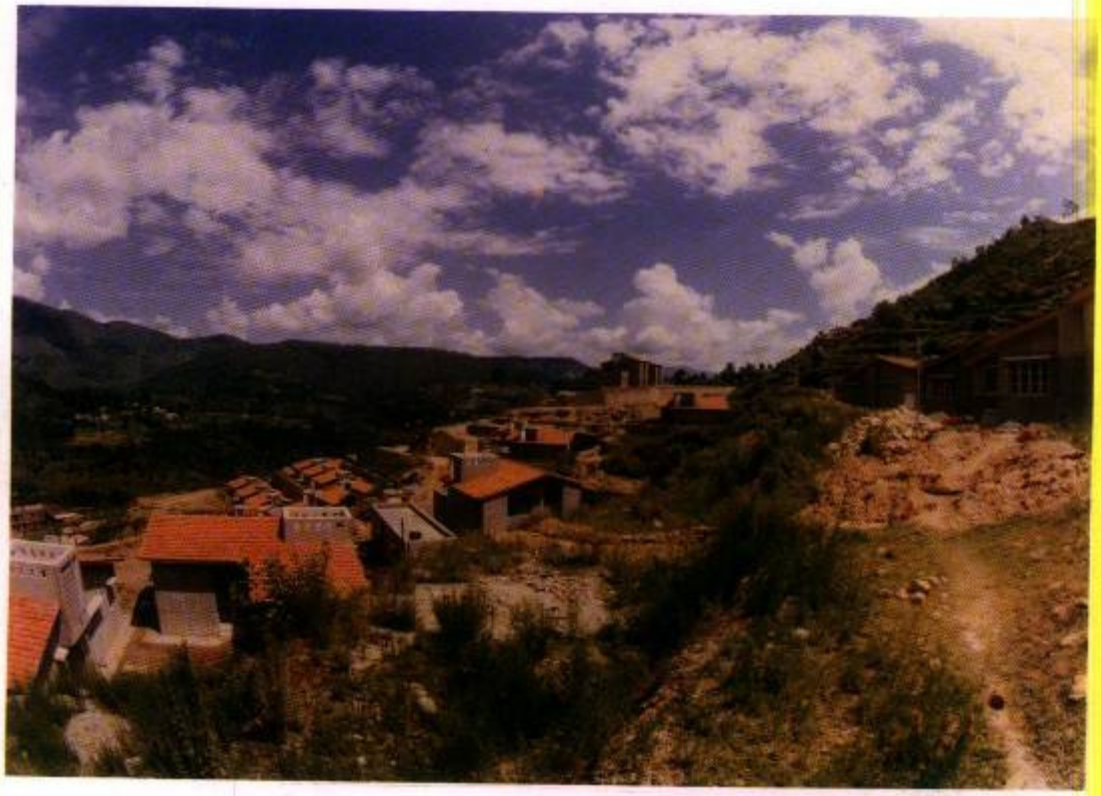
* Environmental Friendly Hill Development: An Approach for District Chamoli
* Sustainable Rural Development: Opportunity and Constraints
* Myrica esculenta Box Myrtle (Kaiphal) : A promising underexploited tree crop of the Himalaya
* Hydropower Management for Sustainable Rural Development in Remote Unelectrified zones of Himalaya
* Sustainable Development and Rehabilitation of Degraded Village Lands in Himalaya
* Medicinal Plant of the Sikkim Himalaya: Status, Uses and Potential

1995

* Fodder Trees and Shrubs of Central Himalaya
* Cultivation of Medicinal Plants and Orchids of Sikkim Himalaya

REGULAR PUBLICATIONS

Hima-Paryavaran (Newsletter-Biannual)
ENVIS Bulletin (Biannual)
Annual Report



Institute's Campus at Katarmal, Almora