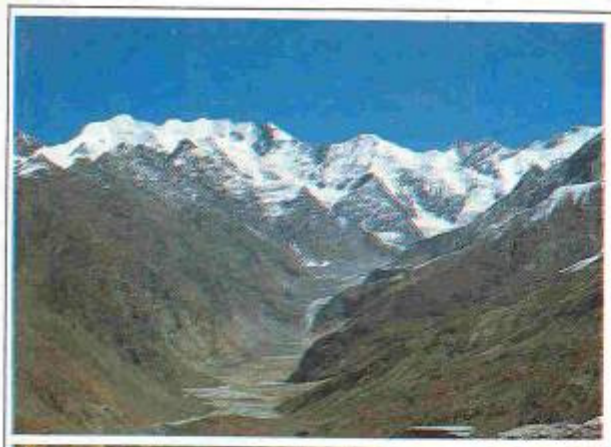

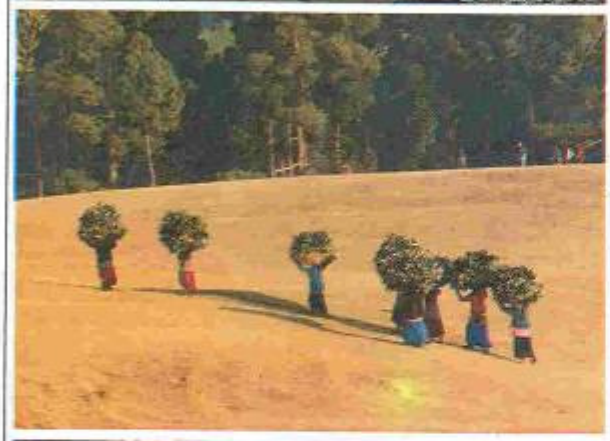

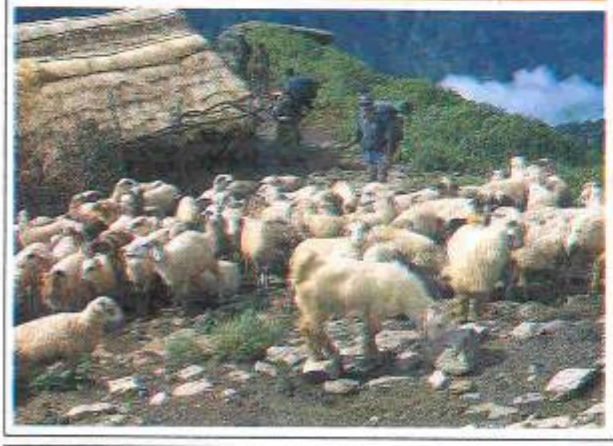

ANNUAL REPORT

1996-97

G. B. Pant Institute of Himalayan Environment and Development

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

Kosi, Almora - 263 643

INDIA

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ANNUAL REPORT

1996-97

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
INDIA

CONTENTS

THE YEAR 1996-97 : AN OVERVIEW

The inauguration of the main Building Complex of the Institute at Katarmal, VI G.B. Pant Memorial Lecture and a number of academic activities of the Institute were the notable events of the year 1996-97. The Institute has established an edifice to undertake the Himalayan task of further advancing its visibility through significant research and development outputs. Though, the Institute has already made significant contributions and has made inroads into complex Himalayan issues, the time has come for consolidating and strengthening its activities. Hence, the Institute has prioritised the logical understanding of ground realities, developing and demonstrating appropriate technologies for environmentally sound development, together with influencing the decision making processes at all levels. In this regard, the traditional local knowledge has to be understood in the right perspective with scientific methods to fill an important niche from the view point of location specific planning for development.

We have now moved from package development and testing to actual participation with the support of people, based on the feasibility of their requirements. The work done in Mamlay, Dugar Gad and Haigad watersheds, restoration of degraded land in Arah village, demonstration of SALT principles in Nagaland, capacity building of local inhabitants through promotion of ecotourism and biodiversity conservation in Khangchendzonga National Park, Sikkim, participation of school children in conservation efforts, programme on restoration of Badrivan, indepth study of transhumance in a number of Himalayan states, coming up with recommendations for the use of State Land Use Board in the context of hilly areas of Uttar Pradesh, and finalization of an Action Plan on Himalaya Biodiversity are some of the notable achievements. The milestone events, mentioned in subsequent pages in this report, clearly specify the important achievements made in 1996-97. During this period Shri N.R. Krishnan, Chairman of the Governing Body of the Institute and Secretary Ministry of Environment and Forests retired from service and the Institute would like to place on record our sincere appreciation and thanks for his guidance and help.

L.M.S. PALNI

Director

MAJOR ACHIEVEMENTS

The Institute has now shifted to its New Campus at Katarmal, Almora with the main block housing laboratories, scientific and office staff. Besides seminar and conference halls it has a guest house and residential quarters.

Integrated watershed management practices have been introduced in Dugar Gad, Mamlay and Haigad watersheds in Garhwal, Sikkim and Kumaun Himalaya respectively.

Natural resource management strategies for protected area management have been studied in respect to Nandadevi Biosphere Reserve, and medicinal plant cultivation with people's participation has been found encouraging.

Studies on traditional crop germplasm losses from 11 watersheds of Ganges catchment indicated alarming trends of germplasm and traditional knowledge erosion.

Indepth study of transhumance in a number of Himalayan states have indicated priorities for development of high altitude societies.

Demographic, economic, cultural and developmental status and trends including (KAP) Knowledge, Aptitude and Perception have been derived for the tribal communities of Central Himalaya.

Participatory approach on Biodiversity conservation through active participation of Educational Institutions has been implemented successfully in Pitoragarh district of Kumaun.

Inventories on selected Angiosperm families (12 families) have been completed.

Capacity building of local inhabitants through promotion of ecotourism and biodiversity conservation in Khangchendzonga National Park, Sikkim has been very encouraging.

Tissue culture protocols for regeneration of a number of important Himalayan species have been standardised; methods of biocomposting and the use of microbial inoculants for improved plant performance have shown encouraging results.

Recommendations for the use of State Land Use Board in the context of hilly areas of Uttar Pradesh have been compiled and widely circulated.

1. INTRODUCTION

The reporting year 1996-97 is the eighth financial year of research and development activities being carried out by the Institute at various locations in Himalaya, in tune with regional issues and endeavouring to seek practical and workable solutions to specific problems and generating new knowledge and technologies. These activities include programmes supported through core funds of the Institute and projects financed by external agencies, both national and international. The Institute is also supporting activities of various partner Institutions in various Himalayan states through IERP Programme. The Science Advisory Committee of the Institute provides approval, general guidance and help for all programmes *ab initio*. Presently the activities of the Institute are centered around six designated core programmes. Some projects were successfully concluded during the year, summaries of these are placed at appropriate places in the text; in due course detailed documents will be published for wider disseminations. The progress made during the year 1996-97 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 anybody interested in the well being of the Himalaya and its people; inputs would be gratefully received.

2. MILESTONE EVENTS

The Institute celebrated its Sixth Annual Day Function in the New Campus of the Institute at Katarmal, Almora on November 2, 1996; on this occasion the main block housing laboratories, scientific and office staff was inaugurated by Shri T.K.A. Nair, Chairman Governing Body of the Institute and Secretary Ministry of Environment and Forests, Govt. of India. The function was attended by many dignitaries which included HE Shri B.D. Pande (ICS), Ex Governor (Punjab and West Bengal); Prof. S.K. Joshi, Former Director General (CSIR); Shri Vinod Vaish, Additional Secretary, Ministry of Environment and Forests, Govt. of India and distinguished members of the Board of Governors of the Institute. The highlight of the function was VI G.B. Pant Memorial Lecture entitled "Some issues related to the Sustainable Development of the Himalayan Region" delivered by Prof. S.K. Joshi. He outlined the role of science and technology in the education and training of the rural areas, and in the development of agriculture and horticulture. Later, three publications of the Institute, namely Land Utilization in the Central Himalaya: Problems and Management Options, Tribal development: Options, Water Management in Himalayan Ecosystem, plus a documentary film namely "In Harmony with Nature", were released. The Governing Body of the Institute met on November 1, 1996 and reviewed the developments in the Institute and took several decisions for furthering the objects of Himalayan environment and development.

Science Advisory Committee met on March 17-18, 1997 under the chairmanship of Prof. J.S. Singh, and evaluated the ongoing research and development activities of various core programmes and provided valuable inputs and guidance for the finalization of the Ninth Plan document. The Committee recognised the difficulties faced and constraints under which the R & D activities of the Institute are being carried out and suggested some useful changes and additions to strengthen its activities.

3. RESEARCH AND DEVELOPMENT PROGRAMMES

In order to achieve the sustainable development of the Indian Himalaya, research and development programmes of the Institute

have been based on a multi-disciplinary and holistic approach with particular emphasis on interlinking of natural and social sciences. In this effort special attention is placed on the preservation of fragile mountain ecosystems, indigenous knowledge and customs. A conscious effort is made to ensure participation of the local population for long term acceptance and success of various programmes. The R & D activities of the Institute are centered around six core programmes, viz., Land and Water Resource Management, Sustainable Development of Rural Ecosystems, Ecological Economics and Environmental Impact Analysis, Environmental Physiology and Biotechnology and Institutional Networking and Human Investment. The achievement of goals and progress made in various projects during the year has been placed under appropriate core programmes in the text. The project implementation sites are carefully selected keeping in view the heterogeneous heritage of the Himalaya along with 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. To meet the targets, and accomplish the objectives well equipped laboratories and computer facilities have been established. Rigorous data collection, development modification and demonstration of science and technology inputs, including technology packages of the Institute, are underlying elements of all project activities. While a number of projects were completed during the year, a few new projects were also initiated; most projects are now in their second or third year of operation. Highlights of the progress made during the year 1996-97, 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, 1994-1997)

Background

The second phase of the project has been initiated in the year 1994 as a follow up action with a view to develop a model at the farm level for demonstration. Based on the results of first phase of the study as well as farmer's priorities, agroforestry models have been proposed at two different villages (one each in subtropical and temperate zones) of the watershed. Various interventions in the form of technology packages, such as intensification of traditional crops, strengthening of fodder components, (Table I) biocomposting, use of symbiotic nitrogen fixers and root associated diazotrophs for crop improvement, germination and growth of rare and potential wild edible species, and introductory trials of some high value cash crops and resource management have been made. Apart from the above, studies relating to two basic resources (soil and water) are also being carried out at the watershed level for better utilization and management. The natural resources of the watershed have been studied in greater detail using satellite digital data, and a complete resource inventory is being made. A monitoring of landslide stabilization is also made.

Results and Achievements

1. Oyster mushroom *(Pleurotus sajor-caju)* was grown at the watershed in three different elevations, viz., 600, 1000 and 1250 m amsl. Initial growth was found best at 1000 m with an average crop yield of two kilogram per unit area. Further experiment using bamboo stickwork as support instead of disposable polythene was made. The bamboo support was found to be economically more viable than the

Table 1. Common fodder species, their unit leaf area (cm²), number of pruning and time, average yield and mode of perennation in the villages of the Mamlay watershed, south Sikkim

Local name	Botanical name	Unit leaf area (cm²)	Relative density (%)	No. of cuttings/ year	Time of pruning	Average yield /tree (kg)	Mode of perennation	Preference
Nebara	*Ficus hookerii*	270±67	8.3-35.8	1	Dec-Mar	60-70	Seeds & stem cutting	++++
Nebara- sano	*Ficus roxburghii*	203±85	5.3-23.0	1	Dec-Mar	70-80	Seeds & stem cutting	++++
Kutmero	*Litsaea polyantha*	115±48	1.7-40.5	1	Jan-Apr	100-120	Seedlings from forests	++++
Chuletro	*Brassaiopsis mitis*	354±63	3.25	2	Jun-Jul & Nov-Dec	60	Seed & stem cutting	+++
Kabra	*Ficus benguensis*	83±27	2.10-3.0	1	Apr-May	100-200	Stem cutting	++++
Bhate bar	*Ficus benguelensis*	349±101	1.08-3.97	1	Jun-Aug	200-300	Stem cutting	++++
Khari	*Celtis tetrandra*	41±18	2.80-8.50	1	Feb-Apr	70-100	Seeds	+++
Gogun	*Saurauia nepaulensis*	188±81	8.35-17.10	2	Jul-Aug & Feb-Apr	100-130	Stem cutting/ not cutting	++++
Syalphusre	*Grewia oppositifolia*	96±30	2.2-5.41	1	Jul-Oct	25-45	Seed	++
Khanu- Khasre	*Ficus hirta*	287±68	2.22-6.34	1	Mar-Apr	120-180	Seed & seedlings from forests	++++
Dudhilo	*Ficus nemoralis*	76±43	1.70-12.88	2	Aug & Mar-Apr	100-150	Seed & seedling from forests	++++
Paiyun	*Prunus cerasoides*	41±21	1.85-3.40	1	Mar-Apr	30-50	Seeds/ collection from forest	+
Chiple	*Pouzolzia hirta*	101±21	2.16	1	Dec-Feb	10-15	Grows in forest	++++
Khanu-lutey	*Ficus clavata*	51±15	0.93-3.16	1	Mar-May	90-140	Seedlings from forest	++
Tanki	*Bauhinia*	130±48	1.0-4.17	1	Feb-May	30-70	Seed	++++
Siltimur	*Litsaea citrata*	32±12	0.77	1	Mar	20-25	Seed	++
Badar	*Artocarpus lakoocha*	113±39	0.93	1	Aug-Nov	150-200	Seed	++++
Chilaune	*Schima wallichii*	83±25	0.70	1	Mar	30-60	Seed	+
Kimbu	*Morus laevigata*	106±22	0.59	1	Jun-Aug	15-20	Stem cutting	++++
Malata- thulo	*Macaranga pustulata*	49±20	0.33	1	Mar-Apr	20-35	Seed	+
Kirate/ Khanakpa	*Exbucklandia populnea*	75±28	0.25	1	Jun-Sept	40-80	Seed	++
Tusarey	*Debregeasia velutina*	139±33	0.18	1	Feb-March	10-15	Seed cutting	++
Labar	*Ficus elastica*	229±48	0.79	1	Jan-Feb	120-200	Seed cutting	++

conventional non-biodegradable polythene bags. The bamboo supports also occupied less space than the polythene bag culture.

2. Cardamom curing kiln prototype was designed by modification of the traditional one and test operationalised which has a fuelwood-to-dried capsule ratio of 3:4 (Fig.1). About 100 kg fresh cardamom capsules were dried to obtain 25 kg of cured product within six hours. Twin-kiln was designed to economise fuel and curing time. This being a function of evaporation from the capsules the chimneys were used to enhance the evaporation rate. The cost of kiln would come around Rs. 5000 per unit and operational cost was worked out to be Rs. 960 for 100 kg of dried product.

Fig. 1. Twin-kiln prototype for large cardamom curing designed at Pangthang

3. Land classification has already been done for the status assessment of land-use/land cover and for understanding the utilization pattern. The land-use/landcover information of the watershed derived from satellite data interpretation has been supplemented by ground-truth field studies. The information on forest cover, agricultural land, water bodies/ streams, other land-use/ land cover categories alongwith soil-physiographic characteri stics have been completed.

4. A landslide caused due to diversion of an existing stream as a result of road construction was surveyed. Also documented the landslides along the Namchi-Vok road being constructed within the watershed, about 19 landslides have been observed. Analysis in terms of long term negative and positive environmental and socio-economic impacts of these landslides is under progress. A landslide has been selected and intensively worked for stabilising it using jute/coir nets and by planting species which promote soil binding (Fig. 2).

5. The average annual precipitation for the

Fig.2. Bioengineering stabilisation with jute/coir netting as a surface protection measure being used in a landslide affected site in Mamlay watershed

five years period was 1235 mm in low hills to 2016 mm in high hills. The overland flow was estimated to be highest in cropped area (10.86%) and lowest in cardamom agroforestry (2.8%). Soil loss was greatest in cropped area to be 525 kg/ha follwed by mandarin based agroforestry 31 kg/ha, sub-tropical natural forest 27 kg/ha, bare land 25 kg/ha, large cardamom based agroforestry 23 kg/ha and temperate natural forest 22 kg/ha was recorded.

6. The nutrients as total nitrogen, organic carbon and total phosphorus were estimated in eroded soil from all land-uses. Total nitrogen loss through eroded soil was recorded highest in temperate natural forest 4.33 mg/g, and lowest in cropped area 2.83 mg/g. The organic carbon was highest in sub-tropical natural forest 42 mg/g and smallest in bare land 33 mg/g. Total phosphorus were also lost considerably in the form of eroded soil. Phosphate phosphorus loss through overland flow was recorded as the highest in cardamom based

agroforestry 0.16 mg/l followed by sub-tropical natural forest 0.15 mg/l, cropped area 0.14 mg/l and the lowest was recorded in temperate natural forest 0.11 mg/l. But the total nitrogen loss through overland flow was estimated very high in cropped area 3.27 mg/l and the lowest in sub-tropical natural forest 1.87 mg/l. The relationship between soil loss and nitrogen loss ($r= 0.97$, d.f. = 20, $p< 0.001$), soil loss and organic carbon loss ($r= 0.95$, d.f. = 20, $p< 0.001$), and soil loss and total phosphorus ($r= 0.91$, d.f. = 20, $p< 0.001$) were positively significant.

3.1.2. Soil, Water and Nutrient Conservation in Upland Farming Systems of a Watershed in Sikkim (1995-1997)

Background

Based on the land-use mapping of a watershed in Sikkim, the project aims to identify available resources and physical constraints. The main problem of upland farming systems is erosion; this has been 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 which has been evaluated. The upland farming system in Sikkim is an integrated system with linkages between forests, agroforestry, agriculture, livestock and other components of the environment. Ecologically and economically important species have been selected and tried for promotion.

Objective

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

2. Use of N_2-fixing species and estimation of nitrogen accretion in upland farming systems.

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

Results and Achievements

1. Soils of most of the land-uses were acidic in the Khanikhola (Melli Dara-Paiyong) watershed. Average soil moisture levels ranged from 10-20% under different crop combinations, 20-30% under forest conditions, 7-11% under *Albizia* agroforestry system and 25-36% under large cardamom agroforestry. Nutrient levels of soils from different land-uses were estimated and nitrogen and phosphorus levels under N_2-fixing *Albizia* agroforestry were higher by 1.5 and 2.2 times respectively, than open cropped area. *Albizia stipulata* fixed 43 µmol N/g nodule dry weight/day. N_2-fixing *Albizia* accelerated nitrogen and phosphorus cycyling.

2. Most commonly used bund species in the watershed are bamboos, *Thysanolena maxima*, Napier grass and Guatemala grass. The former two species are native while the latter two are introduced species. A few farmers use some shrub and trees also. *Erythrina* sp. is used for biofencing purposes which is also a nitrogen fixer. Bund species substantially reduce soil erosion 50% and help in water conservation. *Thysanolaena* grass is maintained and preferred by the farmers as this species provides fodder and broom, and also helps in soil conservation on steep slopes. The crude protein in case of

Thysanolaena sp. vary from 10-12%. The leaves of this species also consists about 0.15-0.22% phosphorus and 0.76% calcium.

3. A PRA exercise on the choice and use of fodder species, fuelwood and timber trees were made. Now, the preference list is available for raising these species in the nursery. Nursery techniques for raising some of the difficult species were developed.

4. Biocomposts are indispensable for subsistence mountain farming system where rate of soil erosion is high, nutrient loss is high and its replenishment is slow causing the degradation in soil fertility. In such situations, biocomposting would be highly useful. Keeping this in mind, 26 combinations of composts were prepared (in collaboration with Saint Alphonsus Agriculture and Social Centre, Kurseong) and examined for their nutrient levels. Table 2 shows different ingredients of composts and their organic carbon levels, total nitrogen, available phosphorus, exchangeable potassium and pH. Soils are acidic and phosphorus limited, therefore, nitrogen/phosphorus ratios were calcuated to examine the availability of these nutrients in composts. Composts with *Eupotarium* sp. weed, poultry wastes, paper, vegetables wastes and egg shells as ingredients proved good for raising plants. Biocomposting techniques were demonstrated to the farmers and all the ingredients are available in the villages which make the technology acceptable and workable.

Table 2. Nutrient levels of composts. [Values are mean ± 1 S.E. (n=3)]

Compost type[a]	*Organic carbon (%)*	*Total nitrogen (%)*	*Available phosphorus (%)*	*Exchangeable potassium (%)*	*pH*	*C/N ratio*	*N/P ratio*
A	1.33 ± 0.07	0.20 ± 0.01	0.002 ± 0.001	0.191 ± 0.005	6.31	6.65	100.00
B	5.30 ± 0.03	1.49 ± 0.02	0.034 ± 0.002	0.840 ± 0.003	7.46	3.56	43.80
C	4.05 ± 0.05	0.64 ± 0.02	0.018 ± 0.003	0.573 ± 0.001	7.41	6.33	35.56
D	5.06 ± 0.05	0.99 ± 0.02	0.038 ± 0.002	0.761 ± 0.001	8.16	5.11	26.05
E	4.05 ± 0.12	1.18 ± 0.06	0.061 ± 0.002	0.666 ± 0.017	7.03	3.43	19.34
F	3.02 ± 0.03	0.73 ± 0.02	0.083 ± 0.002	0.726 ± 0.004	7.50	4.14	8.80
G	5.37 ± 0.07	0.95 ± 0.02	0.120 ± 0.003	0.716 ± 0.020	7.12	5.65	7.92
H	5.22 ± 0.06	0.76 ± 0.01	0.150 ± 0.003	0.946 ± 0.002	8.40	6.87	5.07

[a]Ingredients: A = soil (100%); B =*Eupatorium* sp. weed (100%); C = *Eupatorium* sp. (11.5%), poultry wastes (57.7%), other plants (7.7%), cowbarn waste (19.2%) and kitchen waste (3.9%); D = *Eupatorium* sp. (19.1%), poultry wastes (38.2%), soil (38.2%) and paper (4.5%); E = *Eupatorium* sp. (8.6%), poultry wastes (25.9%), soil (25.9%), paper (5.5%), other plants (18.5%), cowbarn wastes (10.2%) and vegetable wastes (5.5%); F = *Eupatorium* sp. (16.9%), poultry wastes (16.9%), soil (33.8%), paper (7.9%), cowbarn wastes (16.9%), vegetable wastes (6.8%) and egg shells (1.0%); G = *Eupatorium* sp. (14.7%), poultry wastes (29.3%), soil (29.3%), paper (5.87%), old compost (14.7%), vegetable wastes (4.4%) and egg shells (1.8%); and H = poultry wastes (47.2%), soil (47.2%) and paper (5.5%).

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. The first phase of the project work was concluded with administrative and scientific reportings to donors.

2. Monitoring team visit and farmers training programme were the important aspects of the programme during the year. Out of 30 farmers three were women farmers who were trained under this programme.

3. Monitoring of soil losses through water will continue for one more year to confirm the results, which indicated the treatments do help in conserving the soil from losses. Among the treatments SALT - 2 proved to be more efficient due to varied ground cover and intense hedge rows.

4. All treatment showed improvement in soil physico chemical parameters.

5. The economic viability of the treatments is being worked out for recommending these for extension purpose.

3.1.4. Integrated Watershed Management: Case Studies in Garhwal Himalaya

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

Results and Achievements

1. Annual runoff from Dugar Gad catchment (17.6 % of the total rainfall) was low as compared to Srikot Gad (24.6 %). However, soil loss from both the catchments was similar (6.4 vs 6.1 t/ha/yr). The nitrogen concentration in Dugar Gad stream flow (0.18 %) incurs an annual loss of 6.08 kg nitrogen per ha catchment area.

2. In Dugar Gad, water infiltration under chir pine forest was highest (10.5 cm/hr), compared to crop fields (10.0 cm/hr), wasteland (9.4 cm/hr) and grazing land (2.5 cm/hr), in winter.

3. In Dugar Gad, 4 ha community land was planted with 2997 MPTs (16 species) following participatory approach with catchment people.

4. Increase in discharge of a near-extinct spring by 215 l/d during summer 1996 (as compared to summer 1995), may be due to higher rainfall in summer 1996 (Fig.3) and vegetative and engineering measures employed.

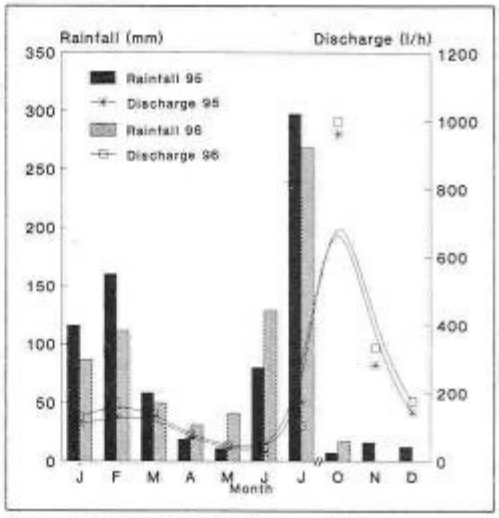

Fig. 3. Increase in spring discharge in 1996

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

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

Results and Achievements

1. In four districts of Garhwal (except Dehra Dun) total length of canals (2494.3 km), Kuhl (3147 km) and 54 pump sets, 333 hydrams and 8030 hauj/tanks cover 59987.9 ha CCA. However, the actual irrigated area is much less than the CCA.
2. Geohydrological investigations on seven springs of Dugar Gad and Srikot Gad catchments put them into (i) colluvial related (seasonal); and (ii) joint/fault related (perennial) categories (Figs. 4 a & b) Springs have enough potential to meet drinking water demand of the catchment people.
3. Khanda canal can irrigate all its 6.7 ha CCA provided capacity of the canal head is raised twice and maintenance of the canal is ensured. Detailed study of this canal suggests that management plan for optimal water use would require considerations on scope of intensive cultivation, distance from the village and market potential.

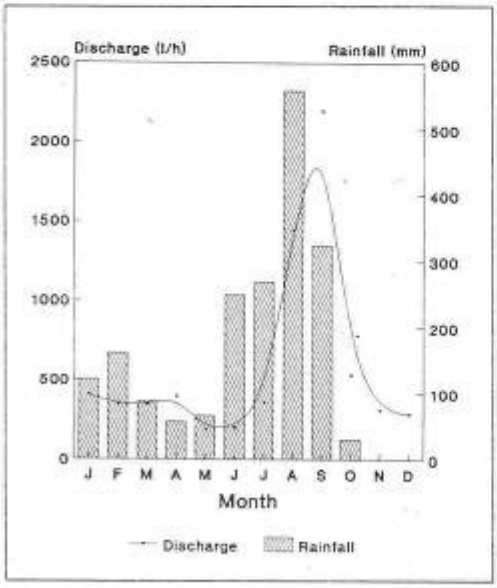

Fig. 4a. Fracture/joint springs are less affected by rainfall

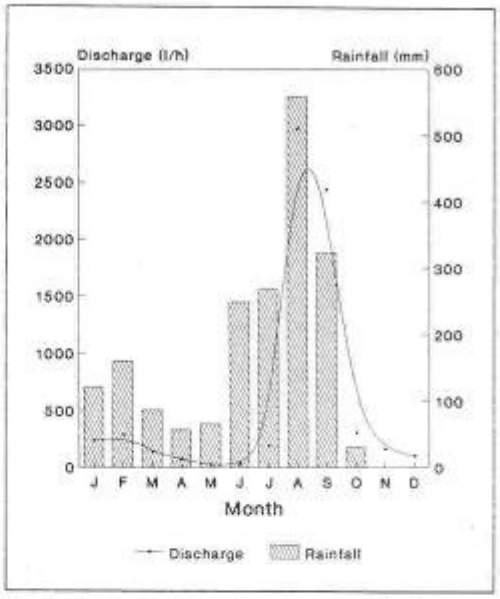

Fig. 4b. Colluvial related springs are more affected by rainfall

4. Matela gad catchment (622.04 ha) located in the Almora district of U.P. hills (29°36'42"to 29°38'32"N latitude and 79°37'43"to 79°39'38"E longitude) was selected for detailed investigation and field trials (Fig 1). The three broad land use categories viz., forest, barren, and arable land as well as the total area of the clusters is given in Table 3. Out of the total area of 622.04 ha, the barren land forms the major portions (48.13%) followed by arable land (45.63%) and forest land (6.24%). Irrigation facilities are negligible in the catchment. The irrigated area is only 3.92% and remaining 96.58% arable land is unirrigated at present.
5. In Matela gad catchment the drinking water is obtained from springs and tap supply. Percentage of population served has been given in Table 4. The highest population (67.93%) is served by tap supply and remaining population (32.07%) depend on springs.

Table 3. Landuse Pattern of Matela Catchment, 1991

Categories	*Area (ha)*	*Area (%)*
Forest Land	38.85	6.24
Barren Land	299.39	48.13
Arable Land	283.8	45.63
Irrigated Land	9.72	3.92
Unirrigated Land	274.08	96.58

Source: Land Record Office, Almora

Table 4. Source of Drinking Water in Matela Catchment, 1997

Source	*Population served*		*Families served*	
	Nos.	*%*	*Nos.*	*%*
Springs	1067	32.07	206	31.16
Tap supply	2260	67.93	455	68.84

Source: Field Observation, 1997.

3.1.6. Badrivan Restoration Programme

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

Results and Achievements

1. The central nursery of promising high altitude trees/shrubs at Hanumanchatti (12 kms. before Badrinath Dham) was strengthened and developed further during the year. The nursery was enriched by 30,000 seedlings of various high altitude trees/shrubs (*Betula utilis* - 4952, *Prunus cornuta* - 4723, *Pinus excelsa* - 2561, *Alnus* sp. - 2008, *Popular ciliata* - 4343, *Juglans regia* - 660, *Hippophae salicifolia* - 3960, *Salix elegans* - 2628, Others - 4165) during the year. Out of the total number of seedlings of various high altitude trees/ shrubs raised at Hanumanchatti up to November 1996 (i.e. 41,066), five thousand and five hundred (5,500) seedlings of various high altitude trees/ shrubs were used for plantation at different sites in Badrinath valley during the year whereas six thousand and five hundred (6,500) seedlings of various high altitude trees/ shrubs were distributed, free of cost, to various NGOs, army units, village level organisations, villagers, farmers and rural women for plantation purpose. Twenty nine thousand and sixty six (29,066) seedlings of fourteen promising high altitude trees/shrubs were available in the nursery before the winter closure of the site (i.e. November 1996). The nursery of promising high altitude trees/shrubs, with two polyhouses and one water harvesting tank, became fully functional at Hanumanchatti during the year.

2. Inspired by the activities initiated under Badrivan Restoration Programme at Badrinath Dham, the Sikh Regiment, Rudraprayag (Chamoli Garhwal), initiated the establishment of Khalsavan: A part of Badrivan in the premises of Sikh Regiment at Mana Camp in Badrinath Dham under the guidance of INHI Core of the Institute. To start with, in the second week of August 1996 three thousand (3,000) seedlings for the said purpose from Hanumanchatti nursery were provided to the Jawans of Sikh Regiment. Inspired by the philosophy of Badrivan Restoration Programme the Granthi of the said regiment on November 17, 1996 distributed over 100 seedlings of *Juglans regia* (Akhort) to the army jawans in the premises of Gurudwara at Mana Camp for plantation. The officials of Paramarthlok at Badrinath Dham initiated earlier the establishment of Parmarthlokvan: A part of Badrivan whereas the officials of Garhwal Scouts initiated earlier the establishment of Manavan: A part of Badrivan in the premises of Garhwal Scouts at Badrinath Dham.

3. On the request of the local inhabitants of Badrinath Dham Plant Distribution Ceremony (I. Bhojpattar) was organised at Badrinath Dham on 16th September 1996. Over 550 well established seedlings of

Bhojpattar (*Betula utilis*, a sacred high altitude tree) was transferred from Hanumanchatti nursery to the Badrinath Dham and distributed among the inhabitants, priests and saints of Badrinath Dham. Scientific and technical inputs were also provided to the concerned persons.

Fig. 5. *Bhojpattar* distribution ceremony at Badrinath Dham

4. Third Ritual Distribution of Tree Seedlings and Plantation Ceremony under Badrivan Restoration Programme was organised at Hanumanchatti (12 kms. before Badrinath Dham) on 19th September 1996. This ceremony was organised after receiving an invitation from the villagers of Hanumanchatti and officials of Khiron Auth Van Panchayat, Chamoli Garhwal, U.P. The ceremony was inaugurated by Brigadier Dalvir Singh (VrC., VSM), Commander, 9(I) Mountain Brigade Group, Joshimath and presided over by Dr. Edwin Bernbaum, Senior Fellow, The Mountain Institute, Franklin, West Virginia, USA. Establishment of Hanumanvan on a sacred mountain at Hanumanchatti was initiated during the occasion. Almost 600 participants from all walks of life attended the ceremony. Prof. A.N. Purohit, Swami Manglanand, Sri Sri Tridandi Srimannarayan Ramanujah Jeear Swami, Sri Sri 1008 Naga Baba Hanumangiri (Uche Hath Wale), Col. E. Macherius and Col. M.S. Wallia were among the main dignitaries. Shri Ansuya Prasad Bhatt, the Chief Priest Hanumanchatti, delivered a talk on religious importance of Hanumanchatti shrine at this occasion and blessed the tree seedlings in the premises of Hanuman Temple. Subsequently, Sri Sri 1008 Naga Baba Hanumangiri (Uche Hath Wale) distributed tree seedlings in temple premises as 'Brikshya Prasada' to the participants including pilgrims from Andhra Pradesh, Madhya Pradesh and Bihar, local priests from Badrinath Dham; saints, army personnel from different units; NGOs; officials of High Altitude Plant Physiology Research Centre, Srinagar, Badrish Panda Panchayat, Badrinath, Panch Puspa Kalyan Sansthan, Urgam, Jai Bharat Sewa Samiti, Srinagar and Mahila Mangal Dal, Panda Kashwar; villagers from Bamani, Mana, Nangani, Radang, Indradhara, Patya, Auth, Benakuli, Lambagarh, Pandukeshwar, Hanumanchatti and Urgam villages; school children and local people. Willingness to contribute (donations) for the care and maintenance of the plants was expressed by various peoples. Therefore, a Donation Box was kept in the temple premises in between 8 a.m. to 11 a.m. An amount of 4849/- was obtained in the Donation Box and was handed over to the Head of Khiron-Auth Van Panchayat for the care and maintenance of plants. Fully inspired by the philosophy of Badrivan Restoration Programme and its activities, the officials of Khiron-Auth Van Panchayat, Hanumanchatti (Chamoli Garhwal) provided 6.5 ha sacred land, free of cost, to the Institute for 5-10 years for the development of Hanumanvan at Hanumanchatti.

5. All the project sites at Badrinath Dham were maintained carefully and site development work was carried out there. During the year, five thousand and five hundred (5,500) well established and hardened seedlings of various high altitude trees/shrubs were planted at different

project sites in Badrinath valley before the winter closure of the valley (i.e. November 96). Out of these seedlings, four thousand and eight hundred (4,800) seedlings were observed well survived in Badrinath valley (i.e. 87% survival) before the closure of the valley (i.e. November 96).

6. Survival potential of the *Alnus* saplings, which were planted in Badrinath valley during 1995-96, was also monitored in April 1996 and 80% saplings were observed well survived. However, it was observed 65% in the saplings of those species that were planted earlier by Garhwal Scouts at Mana Camp in Badrinath Dham and protected by tin made triangular devices. For the protection of survived seedlings from high intensity of snow fall etc. during the closing period of Badrinath valley (i.e. from the middle of November to the middle of April/May) protection measures in and around the seedlings of trees were applied in the last week of November 1996 for better survival of the seedlings.

7. On behalf of the Mountain Institute, USA Dr. Edwin Bernbaum visited Badrinath in September 1996 for finding out the success of Badrivan Restoration Programme and for assessing its future needs and possibilities. Based on the assessment of the programme the Mountain Institute of America wished to work with the Institute in a collaborative effort for developing guidelines for replicating the approach initiated at Badrinath Dham at other sites in the Himalaya as well as in the world. Meanwhile, The Mountain Institute of America is intending to distribute the assessment report via Mountain Forum, a global network of people interested in mountain issues, for replication of the philosophy of Badrivan Restoration Programmes at different sacred sites of the world.

8. The basic philosophy of Badrivan Restoration Programme, which was proposed earlier and subsequently tested at Badrinath Dham and Hanumanchatti, was highly appreciated in a brainstorming meeting that was organised by UNESCO in Paris on "Sacred Sites: Cultural Integrity and Biological Diversity" from December 2 to 3, 1996.

3.2. SUSTAINABLE DEVELOPMENT OF RURAL ECOSYSTEM

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

(a) Natural Resource Management for Sustainable Development

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

Results and Achievements

For Himachal case study:

1. Heavy litter deposits on the conifer forest floor of Tichinal watershed area did not allow ground regeneration. However, broad leaved and mixed forest conditions regeneration of tree species was found. Amount of litter on forest floor was least during October. Fresh litter deposits starts on the old one in the month of November every year.

2. Survey conducted in 23 villages of Tichinal watershed showed that the highest and the lowest energy output/input ratio for agricultural systems was 4.29 in Chorgram and 1.11 in Bakhali. Such trends were obtained in about ~31% villages lying in the elevation range of <1800m. When the monetary efficiency cropping system was considered, the highest values were obtained for mustard (5.35) and mash (4.53) in Koshuie village

and lowest for paddy (1.12) in Chowkidhar and for barley (1.13) in Bakhali.

3. 52% villages occurred between 1800 2200m elevation. Crops like finger millet (3.86) in Chesta, amaranths (2.47) in Nadgram, barley (2.44) in Janahal have relatively high energy output/input ratio. The monetary efficiency for bean (2.67) and mash (2.04) was high in Trehnseri and Chesta villages. Barley (1.02) in Trehnseri, paddy (1.04) in Chesta and amaranths (1.11) in Kote had a marginal level of monetary efficiency (just nearly 1 output/input ratio) which indicated no profit and no loss.

4. Only about 17% villages occured in >2200m elevation micro physio agro climatic zone. None of the villages had high energy output/input agricultural systems. Crops like mash in Rolgi (2.96; the highest settlement) and Shangli (2.15); barley (1.83), maize (1.31) and buckwheat (1.00) in Lote village had monetary efficiency >1.00. Cash oriented crops like potato, pea and chilies were found to be economically inefficient in all villages except Bakhali, a low lying village. In general, the least energy efficiency was as low as 0.004 for tomato in Shangli (>2200m) and 0.10 for potato in Shaked (<1800m) throughout the watershed. Accordingly, monetary efficiency was also found as low as 0.4, 0.7 and 0.7 for onion in Trehnseri, Bhandigram and Kanwa and 0.6 for tomato in Nadgram village (1800 2200m). The values for major food crop (maize) was obtained as low as 0.12 for Kharka (1800 2200m) and 0.16 in Devgram (>2200m).

For U.P. Himalaya case study:

1. Resource status mapping based on secondary information has been partially completed.
2. Land use changes at macrolevel was deleniated and microlevel differentiation for level II classification has started.
3. Compilation of socio-economic data has been completed. A preliminary field study was conducted to verify the data base accuracy.
4. Impact of development programme on resource availability and management was assessed in selected villages.

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

Results and Achievements

1. In Garhwal case study among the various species studied, maximum litter fall (2503 kg/ha/yr) was recorded for *Ficus glomerata* and minimum (853 kg/ha/yr) for *Ficus roxburghii* in agroforestry model. In restoration model litter fall was recorded significantly higher (4325 kg/ha/yr) for *Alnus nepalensis* than *Albizia lebbek* (396 kg/ha/yr). Litter decomposition pattern showed higher rate for nitrogen fixing species than non-nitrogen fixing species.

2. A majority of the traditional crops exhibited higher productivity on the plots where 75% canopy removal was done. The light penetration to ground similar to the natural systems existing in the region is expected through this treatment.

3. *Boehmeria rugulosa* followed by *Celtis australis, Sapium sebiferum, A. lebbek, Grewia oppositfolia* have exhibited more copicing ability than other species examined in the study.

4. In the V year after plantation the biomass on the agroforestry model was observed significantly higher (23 t/ha) than restoration model (10 t/ha) due to better management possibilities.

5. The physico-chemical characteristics of the soils in agroforestry and restoration models showed improvement (Table 5).

Table 5. Changes in some physico-chemical properties of soil after rehabilitation

Soil characteristics	*Agroforestry Model*		*Restoration Model*	
	At the time of Plantation	*In the 5th year of Plantation*	*At the time of Plantation*	*In the 5th year of Plantation*
pH (%)	6.59 + 0.22	6.21 + 0.18	6.21 + 0.18	6.20 + 0.23
Moisture	10.25 + 3.26	15.72 + 7.72	5.92+ 2.72	7.27 + 2.70
WHC (%)	26.14 + 4.15	37.04 + 3.43	16.82 + 2.5	27.20 + 3.09
OC (%)	0.95 + 0.40	1.57 + 0.30	0.71 + 0.21	1.17 + 0.53
N (%)	0.40 + 0.01	0.05 + 0.01	0.02 + 0.01	0.04 + 0.02

WHC = Water holding capacity

6. In Himachal case study, (Tichinal watershed) a total of 52 plant species were found to be used as fodder. Only 2 plant species were found available for grazing by animals throughout the year. Of the 25 major fodder species, 68% were trees, 28% bushes and 4% wines.

7. Under temperate climatic condition of agroforestry systems, *Quercus dilatata* (moru), *Quercus incana* (baj), *Salix sp.*, and *Morus serrata* (kray) were important fodder species.

8. Lopping impact on *Grewia oppositifolia* (beol) was studied in terms of fodder production. It was found that after lopping on 0-year old branches, leaf area per leaf was increased 1.45 times but number of leaf per branch and total leaf area per branch was decreased 0.41 and 0.59 times, respectively as compared to 1-year old branches. Total leaf weight per branch of 0- year old branches was decreased 0.33±0.027 times as compared to 1-year old branches. Per branch weight, branch diameter and number of sub-branches were also reduced 0.50±0.16, 0.84±0.09 and 0.72±0.04 times, respectively on 0-year old branches as compared to 1-year old branches. Drupes were profusely found on the 1-year old branches only with average number of 68.2±15.48 per branch.

9. Preliminary survey of indigenous agroforestry systems of Himachal Himalayas showed that under sub-tropical agro-climatic conditions (below 800m), *Acacia catechu* (kattha), a major tree crop was grown as cash crop. Under sub-temperate agro climatic conditions (800m to 1800m), *Grewia oppositifolia* was the most important tree species and was maintained for fodder, fuelwood and domestic fiber. Under temperate agro-climatic conditions (1600m to 3200m), two species of Oak (*Quercus dilatata* and *Q. incana)* were found along the edge of terraces basically for winter fodder. Under alpine conditions (above 3200m), tree species like *Salix sp.* and *Populus sp.* are cultivated with local techniques under extremely harsh climatic conditions (upto 40°C temperature during winters). Rate of survival, establishment and growth under this situation was very slow.

10. In Sikkim case study of agroforestry model development work is continued at two different sites, viz. at Chhamgaun for temperate region since 1994 and at Debrong for subtropical region since 1995. The cost at temperate site has reduced to <10% and the returns increased from Rs 1025 to 18,300 per annum between 1994 - 96. The benefit is mainly due to growing cash crops (50%) i.e. ginger, peas, pulses and turmeric; foodgrains (12%); fodder (8%) and remaining by growing other items.

11. Trials have been made on the high yielding varieties of turmeric, ginger and peas at agroforestry model sites. Four

varieties of turmeric (RCT 1, PTS 10-Roma, PT 10, PTS 24) were tested. The input:output ratio varied from 1:9 to 1:13 (fresh weight basis). Ginger was sown by two methods, by sowing full rhizome (traditional) and by cutting rhizome into small pieces. The yield of mother-rhizome was more in traditional method, whereas yield of secondary-rhizome was higher in cut method. Peas also showed an input:output ratio of 1:14.

12. Eight species of planting material have been used at agroforestry model development site at Debrong during monsoon in 1996. After 7 months of plantation the seedling survival was 100% for large cardamom (*Amomum subulatum*) and banana (*Musa sp.*), 96% for nebara (*Ficus roxburghii*), 95% for rose oil plant (*Rosa damascena*), 85% for amliso (*Thysanolaena maxima*), 80% for pipli (*Symingtonia populnea*) and 60% for kaijal (*Bischoffia sp.*). The seedling survival was minimum (20%) for labsi (*Spondias axillaris*).

13. Eleven most preferred fodder trees species were selected for estimation of fodder production and nutrient analysis. The fodder production varied from species to species, and an average tree produces 10-15 kg for *Debregeasia velutina*, 15-20 kg for *Morus laevigata*, 30-50 kg for *Grewia oppositifolia*, 60-70 kg for *Ficus hookerii* and *F. roxburghii*, 70-80 kg for *Litsaea polyantha*, to as high as 150-200 kg/tree for *Ficus benjamina* and 200-300 kg/tree for *F. bengalensis*. Nutrients were more in new leaves than the old ones. The crude protein for various fodder species vary from 10-20%.

14. Seeds of some important species are being raised at Pangthang nursery for research work and subsequently for distribution to the locals. Farmers showed preference for 11 timber and fuel wood species, 5 fodder species and 6 wild edible species. Nearly 10,000 seedlings were raised in 1993-94, 14,800 seedlings in 1994-95, 20,250 in 1995-96 and 30,000 in the year 1996-97. Seedlings were distributed to the farmers of the watershed and other areas as part of agroforestry extension module.

(c) Resource use pattern of trans-humant pastoralists

Results and Achievements

For Arunachal case study:

1. The Monpa tribe is settled in 163 villages, out of which 3 villages are pure nomadic in nature and survive through barter exchange and sale of milk and milk products with the fellow Monpa agriculturalists.
2. The monetary gains are fairly high through sale of milk products, and a number of medicinal herbs and few minor forest products.
3. Monpa society has strong influence of Buddhism and monastry in their social and cultural life, and are very cohesive due to monastry and polyandrous nature of their society.
4. These people have a rich knowledge of wild herbs, and have a developed system of ethno-veterinary knowledge.

For Garhwal case study:

1. In general, energy input in the form of organic manure and labour was higher in mixed cropping as compared to monoculture.
2. Monetary output/input pattern for various crops cultivated in monoculture shows that the highest monetary output was obtained for amaranth followed by potato and oat.
3. Per year kid production from a flock of 200 sheep and goats was higher in the Jadhs and minimum in the Merchas.
4. The net profit from 200 sheep was about

Rs. 16253 (Rs. 81.30 per sheep/year) whereas, from 200 goats was about Rs. 20268 (Rs. 103.0 per goat/year).

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

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

Results and Achievements

1. The Van panchayat and its functioning has been studied in the buffer zone villages of Nanda Devi Biosphere Reserve in order to understand its role and effectiveness on the management of the natural resources.

2. An attitude survey was conducted in the villages located in the buffer zone and outside buffer zone reveals that more than 75% and 35% population of buffer zone and outside buffer zone villages are having negative attitude towards establishment of Biosphere Reserve (Fig. 6)

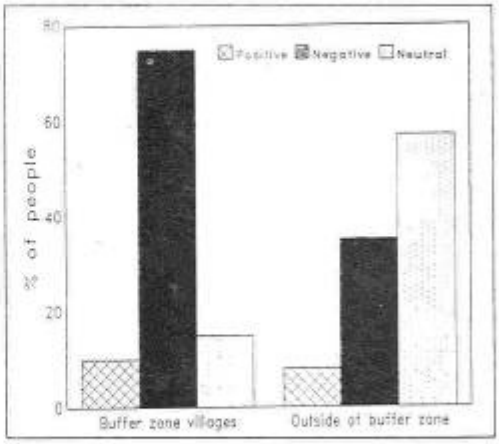

Fig. 6. Attitude towards establishment of reserve

3. Biosphere Reserve and people conflicts were studied in-depth. Ban on expedition/ mountaineering on Nanda Devi and other related peaks after establishment of National Park and Biosphere Reserve has been identified as one of the major conflict which hampered the local economy significantly (Table 6).

4. Two land rehabilitation sites in the buffer zone villages were planted with 5000 seedlings of 10-11 MPTs with the participation of villagers.

Table 6. Annual income by the buffer zone villages of NDBR through expedition to the Nanda Devi and other peaks before establishment of National Park and Biosphere Reserve.

	Average of 10 years	
	Between (1962 - 71)	*Between (1972 - 81)*
Total days spent (per person/yr) towards tour guidance & porters	215	235
Wages earned by porters(Rs/yr)	822375 (@ Rs. 22.50/day)	2157300 (@ Rs. 45/day)
Wages earned by tour (Rs/yr)	404200 (@ Rs. 40 /day)	676800 (@ Rs. 80/day)
Total money earned by the villagers (Rs/yr)	1226575	2834100
Monetary earning (Rs/yr) by a person as porters or guide	5652	11808

3.2.3. 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. The rate of survival of planted species recorded during March, 97 is more than 90 per cent. Severe frost in winters caused damage to many plant species, *Bauhinia retusa* being the most severely affected one. The per cent change in mean height and girth was maximum for *Quercus glauca* and *Grewia oppositifolia* respectively (Table 7).

2. The total live above ground biomass of ground vegetation has increased but there is a decrease in relative proportion of biomass of C_3 species. The per cent biomass of nitrogen fixing species has shown a slight decrease from 27.76 per cent in 1995 to 26.19 per cent in 1996 (September).

3. The total count of fungi, bacteria and actinomycetes from rhizosphere and non rhizosphere soils has shown an increase, probably owing to an improvement in soil fertility status (Table 8).

4. Quantitative and qualitative information on the role of individual species or genera (grasses, herbs & micro organisms) to the primary productivity and resilience pattern of stressed degraded lands proves to be of relevance. The research studies throw light on bio-diversity, ecological dominance and physiological responses of plant communities to environment and climatic perturbations and also on the effect of stabilizing factors on the population and stability of disturbed ecosystems.

Table 7: Height(cm)/Girth(mm)/change(%) of species planted at project site

Species	*Height 1995*	*Height 1996*	*Height change*	*Girth 1995*	*Girth 1996*	*Girth change*
Q. incana	62.36	112.80	80.88	13.17	20.05	52.24
Q. glauca	80.33	181.50	125.90	13.04	21.29	63.26
G. oppositifolia	159.93	300.34	88.51	19.52	36.83	88.68
Ficus macrophylla	69.14	90.31	30.62	18.98	21.04	10.85
Ficus nemoralis	92.00	154.00	67.74	21.73	35.35	62.68
Debregeasia longifolia	100.42	152.00	51.36	20.26	31.98	57.84
Ougeinia delbergiodes	91.89	140.00	52.36	18.72	23.35	24.73
Bauhinia retusa	149.50	256.00	71.24	24.67	29.22	18.44
Albizia lebbek	143.50	181.75	26.65	19.01	21.42	12.67
Dalbergia sissoo	207.36	312.33	50.62	22.63	39.83	76.00
Alnus nepalensis	292.40	344.10	17.68	58.29	80.01	37.26

Table 8: Changes in average number of micro-organisms/gm dry soil (xD) during 1995-1996

Micro-organisms	1995 Rhizosphere	1995 Nonrhizo	1996 Rhizosphere	1996 Nonrhizo
Fungi	220	122	246	139
Bacteria	172	115	204	154
Actinomycetes	68	44	75	51

For fungi D= x1000; For bacteria and actinomycetes D= x100000

3.3. CONSERVATION OF BIOLOGICAL DIVERSITY

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

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

Results and Achievements

West Himalaya — Askot Wildlife Sanctuary

1. Preference and density distribution of fodder and fuel resources within identified forest communities (i.e. riverine, chir-pine, banj-oak, rianj-oak, kharsu oak, fir and birch) was analysed (Table 9).

2. Of the total 70 fodder species, 33 (47.14%) were not recorded in any of the identified forest communities. Notable among such taxa are *Bauhinia variegata, Ficus semicordata, Brassaiopsis aculeata, Brideliamontana, B. retusa, Saurauia napaulensis* and *Sterculia pallens*. This suggests a rich agroforestry tradition within the sanctuary.

3. Among preferred fodder *Ougeinia oojeinensis, Phoebe lanceolata* and *Quercus lanuginosa* are confined in specific communities.

4. Most of the preferred taxa, in their respective communities, exhibited low densities in different size classes suggesting poor availability and high pressure (Table 9).

5. Some other taxa e.g. *Cascaria glomerata, Engelhardia spicata* in riverine and chir-pine, *Phoenix humilis* in riverine, chir-pine and banj-oak, *Quercus floribunda* and *Q. lanuginosa* in rianj-oak, *Quercus leucotrichophora* in banj-oak and rianj-oak, *Measa indica* in riverine and chir-pine, *Woodfordia fruticosa* in riverine, chir-pine and banj-oak communities showed high density of individuals in different size classes. This indicates richness of these taxa in respective communities.

6. Among fuel species, *Bauhinia vahlii* and *B. variegata* are not recorded in forest areas. Most of the species are harvested from sub-tropical and temperate communities (riverine, chir-pine, banj-oak, rianj oak).

7. *Rhododendron arboreum* in oak communities, *Pinus roxburghii* in chir-pine, *Quercus lanuginosa* in rianj-oak, *Quercus leucotrichophora* in banj oak, *Lyonia ovalifolia* in banj-oak and rianj-oak, *Cascaria glomerata* in riverine and chir-pine and *Macaranga pustulata* in riverine communities are relatively abundant.

   However, low density of *Cornus oblonga* and *Myrica esculenta* in banj-oak and rianj-oak, *Persea duthiei* in reverine, banj-oak and rianj-oak communities reflects the poor availability of these species.

8. Of the 44 agroforestry or marginal species, 22 were represented in the forest communities. Among agroforestry species most are harvested as fodder (37).

9. Among agroforestry/marginal species *Woodfordia fruticosa* (RUI 5284.03), *Quercus leucotrichophora* (727.23), *Phoebe lanceolata* (225.57), *Mallotus philippensis* (384.71), *Ougeinia oojeinensis* (122.20) and *Quercus lanuginosa* (83.29) in fuel category and *Phoebe lanceolata* (637.29), *Ougeinia oojeinensis* (467.86), *Castanopsis tribuloides* (460.68), *Callicarpa arborea* (401.50), *Ficus roxburghii* (350.40), *Bauhinia variegata* (228.20) and *Mallotus philippensis* (158.67) in fodder category indicates high anthropogenic pressures in the natural habitats.

Table 9. Fodder/Fuel resource preference and distribution in forest communities

Taxa	*Prefrence*	*Forest communities*															
		A				*B*				*C*				*D*			
Fodder resource		*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*
Phoebe lanceolata	1	9	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Ougeinia oojeinensis	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
C. tribuloides	3	9	10	13	-	-	-	-	-	10	5	30	-	-	-	-	-
Bauhinia variegata	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boehmeria rugulosa	5	9	-	6	4	-	-	-	-	-	-	-	-	-	-	-	-
Mallotus philippensis	6	40	33	40	20	12	36	-	-	-	-	-	-	-	-	-	-
Boehmeria platyphylla	7	-	-	270	-	-	-	470	-	-	-	-	-	-	-	-	-
Ficus semicordata	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bridelia retusa	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Q. leucotrichophora	10	11	-	8	-	20	12	28	-	340	55	90	-	24	48	-	-
Millettia auriculata	11	-	-	-	60	-	-	-	-	-	-	-	-	-	-	-	-
Quercus lanuginosa	12	-	-	-	+	-	-	-	-	-	-	-	-	108	116	212	-
Fuel resource																	
Woodfordia fruticosa	1	-	-	80	-	-	-	-	1210	-	-	-	470	-	-	-	-
Pinus roxburghii	2	6	-	-	-	384	504	-	332	-	-	-	-	-	-	-	-
Macaranga pustalata	3	73	74	91	-	-	8	-	-	5	20	10	-	-	-	-	-
Q. leucotrichophora	4	11	-	8	-	20	12	-	28	-	340	-	55	90	-	24	48
Engelhardia spicata	5	57	80	71	-	32	30	32	-	-	-	-	-	-	-	-	-
Mallotus philippensis	6	40	33	40	-	20	12	36	-	-	-	-	-	-	-	-	-
Casearia glomerata	7	47	60	111		12	62	132	-	-	-	-	-	-	-	-	-
Phoebe lanceolata	8	9	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Eurya acuminata	9	-	-	-	-	-	-	8	-	50	43	70	-	8	-	-	-
Lyonia ovalifolia	10	-	-	-	-	8	16	12	-	225	183	-	225	184	152	152	-

A = Riverine; B = Chir-Pine (Pinus roxburghii); C = Banj-Oak (Quercus leucotrichophora); D = Rianj-Oak (Quercus lanuginosa) Community;Kharsu Oak (Q. semecarpifolia), Fir (Abies pindrow), Birch (Betula utilis) communities are not represented by preferred taxa; 1 = Trees/ha, 2 = Seedlinga/ha, 3 = Saplinga/ha, 4 = Shrubs/ha.

North West Himalaya — KWLS

1. Study along Pulga-Bhandag-Shaylmar transect zone (under extension of KWLS), revealed a total of 69 woody taxa (35 trees and 34 shrubs). Of these 65.2%, 13%, 7.3%, 43.5% and 46.38% taxa have habitat preference respectively in forest, ravines, riverine, shrubberies and semi-modified habitats.

2. Inventories on bioresources, use pattern and traditional knowledge on their management is in progress. Use preference analysis (house-holds basis) revealed that *Benthamidia capitata* (17.9% preference and 23.3% use in upper, and 75% preference and 67% use in lower zone), *Rubus ellipticus* (49% preference and 67% use in upper, and 73% preference and 69% use in lower zone), *Prunus cornuta* (91% preference and 95% use in upper zone), *Viburnum cylindricum* (68% preference and 84% use in upper zone) and *Asplenium polypodoides* (34% preference and 58% use in upper zone) are top ranking preferred taxa in KWLS.

3. *Pinus wallichiana* (93.8%) and *Indigofera* spp. (90%), *Cedrus deodara* (62.5%) are commonly used fuel-wood taxa in KWLS. Along vertical range *Cornus macrophylla* (78%) is frequently used fuel in lower zone, after the former two taxa. *Morus serrata* (92.5%) and *Ulmus wallichiana* (68.8%) are commonly used fodder taxa in KWLS. Across the vertical gradient, *Aesculus*

indica (83.7%), *Quercus floribunda* (67%) and *Indigofera* spp. (67%) for upper zone, and *Q. leucotrichophora* (86%), *U. wallichiana* (83.8%) and *Celtis australis* (86%) in lower zone, are frequently used taxa.

4. Traditional tree (non-crop) diversity in agriculture fields of more than 12 villages (KWLS and its adjacent areas) was analysed. Of the 23 prominent taxa, 12 were recorded from 4 inner villages of KWLS; of which 6 are common in both upper and lower zone.

5. *Morus serrata* (83.7%), *Aesculus indica* (62.8%), *Q. floribunda* (46.5%) for upper zone; and *Ficus palmata* (51%), *Q. leucotrichophora* (29.7%) and *Pyrus pashia* (27%) for lower zone were most frequently used taxa.

6. Semi-modified habitats in upper and lower zone village areas have been quantified for woody taxa; the analysis is in progress.

7. Crop damage by wildlife has been analysed (see : Annual Report, 1995-96). Analysis on crop damage by wildlife revealed that, there was an estimated maximum loss of 462 Kg/h for wheat, 524 Kg/h for barley, 472 Kg/h for maize, and 215 Kg/h for French bean. Notable amongst crop raiders were Monkey (62%), Black Beer (29%), Langur (34%) and Porcupine (9%), causing maximum crop field damage.

8. In continuation of local survey of medicinal plants (see Annual Report, 1995-96), review analysis of export from Parvati Forest Division (Parvati valley, as major part) was made. 43 medicinal plants are commercially exported. Of these *Jurinea dolomiaea*, *Potentilla nepalensis* and *Valeriana jatamansi* (91.7%, each), *Acorus calamus*, *Angelica glauca* and *Picrorhiza kurrooa* (83% each) were amongst most frequently exported taxa during 1984-85 and 1994-95. However, *J. dolomiaea* (3304 Qtl.), *P. nepalensis* (2884 Qtl.), *Salvia moorcroftiana* (1683 Qtl.) and *Rheum australe* (1617 Qtl.) were harvested taxa maximum during this period.

3.3.2. Bioresource Inventory of the Himalaya

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

Results and Achievements

a. Papaveraceae and Fumariaceae

1. Inventory of families Papaveraceae and Fumariaceae was prepared and analysed for diversity of endemics in Indian Himalaya (Fig. 7).

2. Family Papaveraceae (38 spp) revealed diversity in Trans/ North West and Central Himalaya (21 spp; 55.26% each), followed by West (13 spp; 34.21%) and East Himalaya (12 spp : 31.58%). Fumariaceae showed richness in Central Himalaya (44 spp; 57.89%).

3. 23 species (63.89%) in family Papaveraceae and 65 species (85.53%) in Fumariaceae are native to Himalaya. Non native taxa are more in the Papaveraceae (12 spp) than Fumariaceae (5 spp).

Fig. 7. A rare endemic plant from western Himalaya

Table 10. Extent of endemism in Indian Himalayan genera and neighbouring areas

Genera	Total Taxa	Indian Himalaya E (%)	Indian Himalaya NE (%)	Nepal A	Nepal B	Bhutan A	Bhutan B	Neighbouring areas Pakistan A	Pakistan B	Iran A	Iran B	Europe A	Europe B	USSR A	USSR B
Papaveraceae															
Argemone	2	-	-	1	-	1	-	2	-	1	-	1	-	-	-
Cathcartia	1	1(100)	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicranostigma	1	-	1(100)	1	-	1	-	-	-	-	-	-	-	-	-
Hypecoum	4	-	-	-	-	1	-	3	-	5	20	4	25	6	-
Meconopsis	20	6(30)	-	14	28.57	-	13	23.08	3	-	1	-	100	1	-
Papaver	10	1(10)	-	3	-	3	-	10	-	32	18.75	34	23.53	52	26.92
Fumariaceae															
Corydalis	66	17(25.75)	38(57.58)	34	20.59	45	17.78	32	6.25	33	45.45	26	42.31	61	31.15
Dicentra	7	1(14.29)	4(57.14)	3	-	3	-	-	-	-	-	1	-	1	100
Fumaria	5	-	-	2	-	2	-	2	-	8	-	-	-	11	-

Abbreviations used : E = Endemic; NE = Near Endemic; A = Total taxa; B = Endemic %.

4. Along vertical gradient, alpine zone (3001-4500m) is species rich and exhibit diversity of endemics (Papaveraceae 7 endemics, 13 near endemics and Fumariaceae 12 endemics, 34 near endemics).

5. Species richness and endemic diversity in Indian Himalaya was compared with neighbouring areas (Table 10). For some genera percent endemism is high in neighbouring countries (e.g. *Corydalis* - Iran 45.45%, Europe 42.31%, USSR 31.15%; *Papaver* - Iran 18.75% , Europe 23.53% and USSR 26.92%).

6. Both the families revealed richness of endemics in Trans/ North West Himalaya (75% : Papaveraceae; 50%: Fumariaceae). Hence the province merit immediate attention for conservation.

7. Among sensitive taxa *Cathcartia* and *Dicranostigma* are monotypic endemic in the Himalaya. *Cathcartia villosa* Hk.f.& Th. is narrow range endemic (East Himalaya: Arunachal Pradesh) and *Dicranostigma lactucoides* Hk.f. & Th. is narrow range near endemic extends from West Himalaya to Bhutan. The narrow genetic base and restricted geographic range of these taxa merit immediate attention for conservation.

b. Inventory of Medicinal Plants (Himachal Pradesh)

1. Inventory and analysis of 360 medicinal plant species (246 genera, 111 families), including 65 trees, 77 shrubs, 197 herbs, 19 climbers, one mushroom and one fern was made. Inventory includes information on habit, use parts, and potential altitude and availability in nature.

2. 71.7% species are perennial and 28.3% annual. Among families, Leguminosae (27 species), Asteraceae (26 species) and Solanaceae (7 species) are rich in medicinal plants.

3. Considering the richness of medicinal plants, district Kullu represents maximum (55.8%) and Chamba the minimum (6.9%).

4. The maximum species (145) are harvested for root/rhizome parts and minimum (8) for the wood. 122 species are exclusively used in ethnomedicine and 65 are in trade.

5. 25 major trade taxa were exported during 1993-94, and 22 in 1994-95 from different forest circles of the state. As per their export (quantity), the species of *Centella asiatica* (5030 and 921 Qtl, respectively for 1993-94 and 1994-95) was at the top and

Saussurea costus (221 and 321 Qtl, respectively for 1993-94 and 1994-95) at the bottom of the 12 topmost commercial taxa. For their assessed market value, *M. esculenta* and *J. dolomiaea* were amongst top. Commercial taxa have been reviewed for their status and the strategies were given for their possible conservation.

3.3.3. Establishment and maintenance of a functional arboreta in the Himalaya

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

Results and achievements

1. Infrastructural facilities such as development of nursery, pathways and extension of arboretum area for the plantation of seedlings of Himalayan species was carried out. Construction of a 10,000 lit capacity water tank for spring and rain water harvesting was completed during the year.

2. Propagules of over 45 species were collected and sown in the arboretum nursery. Species were monitored for germination and growth performance. Among all the species *Heynea trijuga, Grewia oppositifolia, Celtis tetrandra, Toona ciliata, T. serrata, Phoenix humilis, Albizia procera, Robinia pseudoacasia* showed (> 80%) germination. *Thuja orientalis* (2.8%), *Fraxinus micrantha* (6.3%), *Persea gamblei* (13.4%), *Erythrina suberosa* (17.3%) and *Ehretia laevis* (18%), however, showed low germination.

3. Effect of pregermination treatments was monitored for 4 multipurpose tree species of the Himalaya (Table 11).

4. Over 4000 seedlings were planted in arboretum sites and Institute Campus. To develop and strengthen conservation models in school/college campuses over 500 seedlings of 15 species were used.

5. The survival percentage of the species in the arboretum sites was nearly 46%. Heavy frost and destruction by *Porcupine* and *Rhesus* Monkey cause high mortality of individuals.

6. Effect of frost on some of the established tree species in the arboretum site was monitored. *Prunus cerasoides, Spondias pennata, Fraxinus micrantha, Quercus leucotrichophora, Q. glauca, Q. lanuginosa, Q. semecarpifolia, Q. serrata, Castanopsis tribuloides, Ligustrum nepalense, Aleurites moluccana, Betula alnoides, Dalbergia sissoo* proved frost resistant. Among most affected species Dalbergia sericea, *Bauhinia variegata* and Bischoffia javanica (100%), *Albizia chinensis* (76.23%) and *Grewia oppositifolia* (48.21%) are notable.

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

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

Results and achievements

1. A preparatory meeting was held at GIC Champawat on May 28, 1996 to evolve strategy for making the activity popular and to ensure active participation of school/colleges. Participants included Deputy Director Education, Kumaun, Principals and other Authority of District education.

2. Participants appreciated the objectives of the activity and assured active participation.

3. Continuing with series of training workshops "Peoples' participation in biodiversity conservation", 3rd workshop was held at GIC Lohaghat (November 20-21, 1996).

4. On site training was imparted to participants on biodiversity assessment,

Table 11. Effect of pregermination treatment on mean germination percentage.

Treatment	*Semecarpus*[C] *anacardium*	*Olea*[B] *glandulifera*	*Ehretia*[C] *laevis*	*Pittosporum*[D] *floribundum*
Control	34.4 (±1.54)	10.0 (±1.63)	11.5 (±1.35)	51.8 (±2.07)
Water soaking				
12hrs	34.4 (±1.54)	11.6 (±1.48)	15.0 (±1.37)	55.0 (±1.91)
24hrs	51.1 (±2.00)	20.0 (±1.22)	24.9 (±1.13)	60.3 (±1.12)
36hrs	33.3 (±2.04)	6.6 (±1.91)	10.0 (±1.63)	40.5 (±0.68)
48hrs	15.0 (±1.37)	3.6 (±1.78)	3.8 (±1.42)	26.1 (±1.68)
18hrs	3.2 (±2.74)			15.0 (±1.37)
Boiling water				
2 min.	34.4 (±1.54)			41.1 (±1.49)
5 min.	30.0 (±1.54)			32.2 (±1.55)
10 min.	16.6 (±1.27)			11.6 (±1.48)
15 min.	2.7 (±1.72)			3.8 (±1.41)
Acid scarification (50% H_2So_4)				
2 min	35.0 (±1.23)	30.0 (±1.07)	15.0 (±1.37)	6.6 (±1.91)
5 min.	55.0 (±0.98)	46.6 (±0.96)	20.0 (±1.22)	
10 min.	74.8 (±1.05)	20.0 (±1.12)	24.1 (±1.71)	
20 min.	41.4 (±0.96)	6.6 (±1.91)	32.8 (±1.57)	
30 min.	18.3 (±1.03)		5.5 (±1.14)	
Mech. Scarification	36.7 (±0.98)	20.0 (±1.22)	35.4 (±1.52)	
Mech.+water soaking	45.0 (±0.98)	23.3 (±1.12)	65.0 (±2.19)	
GA_3				
50 ppm	38.3 (±0.97)	17.6 (±1.92)	16.6 (±1.27)	59.8 (±1.54)
100 ppm	45.0 (±0.98)	37.3 (±0.98)	24.0 (±2.20)	86.8 (±2.83)
500 ppm	47.3 (±0.53)	27.6 (±2.22)	45.0 (±0.98)	39.5 (±1.57)
1000 ppm	20.5 (±1.79)	11.6 (±1.48)	32.7 (±1.01)	24.4 (±1.71)
Thiourea				
50 ppm	35.0 (±2.63)	17.6 (±1.48)	9.9 (±1.63)	53.8 (±1.93)
100 ppm	38.0 (±1.69)	9.9 (±1.63)	29.4 (±1.63)	58.9 (±2.03)
500 ppm	38.3 (±1.98)	6.6 (±1.91)	20.0 (±1.22)	63.3 (±0.98)
1000 ppm	30.4 (±2.50)	3.2 (±1.72)	5.5 (±1.20)	37.2 (±1.50)
F ratio (P<0.001)	138.09 DF 24	121.08 DF 20	219.06 DF 20	447.64 DF 21

Value given in parenthesis is standard deviation from mean value.
A LSD for P≤0.05, 0.01 for germination mean 2.62, 3.48.
B LSD for P≤0.05, 0.01 for germination mean 2.92, 3.89.
C LSD for P≤0.05, 0.01 for germination mean 2.28, 3.05.
D LSD for P≤0.05, 0.01 for germination mean 3.29, 4.40.

relationships of biodiversity with land and water resources, value addition and recent techniques of conservation. Nursery techniques, monitoring of growth performance of seedlings and seed collection and storage were other aspects of training (Fig. 8).

5. Participants' reactions were obtained through standardized questionnaire (Table 12).

6. Nursery of indigenous valuable taxa is

Fig. 8. On-site training activity

being developed at the Campus land of G.I.C. Lohaghat, with active participation of students/ teachers.

7. Survival of the species was monitored in the college Campus (60%) and Ashram land (100%) at Narayan Nagar.

Table 12. Responses of the participants during workshop.

	Teachers n = 18	*Students n = 43*
Objectives		
Agreed	94	100
Achieved	78	75
Interaction/Training		
Good	61	93
Satisfactory	28	5
Needs improvement	11	2
Future Participation		
Voluntary	100	63
Land/resource arrangement	39	3
Technical inputs	39	16
No reply	—	18
Mode of future trainings		
As such	56	37
More frequent	22	12
Training needs modification	22	7
No reply	—	44

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

Background

Timberline represents a transition between high temperate and low alpine zone across the Himalaya. In the west Himalaya it is a cradle of high temperate and low alpine sensitive elements of tremendous biological value. The area is also subjected to anthropogenic disturbances of various types and magnitudes, reflected at different organizational levels. In view of the rich biological diversity it supports, it is important to assess the threats to the ecotone. The data available on realised and potential value of biodiversity elements and the nature and extent of pressure on the ecotone is not adequate. Keeping in view the salient attributes of the zone and gaps in our knowledge, the project envisages to identify conservation sites on the basis of biodiversity elements, socioeconomic concerns and conservation feasibility.

Objectives

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

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

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

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

Results and Achievements

1. Collection of data on floristics from relevant secondary sources, such as florulas, research papers, doctoral thesis, reports, Forest Working Plans etc. for the study area (i.e., Kumaun, Garhwal and Himachal) is completed. Presently, data analysis and the interactions/dependence at several levels is being worked out.

2. Map of the study area (west Himalaya) which stretches from east of Satluj in the west to Kumaun in the east is being prepared presently for prioritizing conservation sites.

3. A two day Consultation Meeting on Prioritization was organized at GBPIHED, Kosi on April 12-13, 1997 to discuss and develop rationale for prioritization through informal interaction among biodiversity experts.

3.3.6. Biodiversity Studies using Remote Sensing in the Indian Himalaya

Background

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

Objectives

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

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

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

Results and Achievements

1. Preparation of base maps and literature survey have been done

2. As per the project objectives, IRS-1C and LANDSAT (TM) satellite data are being procured from NRSA, Hyderabad.

3. Intensive ground truthing has been conducted in Gori Ganga Valley, a representative site of Askot wildlife sanctuary.

4. Data collected from the field are being analysed.

5. Attempts are being made to integrate the ground truth data with remote sensing data.

3.3.7. Wild Edible Plants of Food Value, Their Nutrient Status and Regeneration in Sikkim Himalaya

Background

Sikkim is a hill state and has very rich plant diversity of over 6000 plants. The state has sub-tropical to temperate and alpine type of climatic conditions in an elevation range from 300-8500 m above sea level. Low lands are utilised for double crop production but most of the high lands have monocropping system. In the Sikkim Himalaya a large number of wild plant species are used as food, medicine, beverages, fish-poisoning, dyes, oil, timber, firewood, fodder and various other purposes. Besides growing the traditional crops, natives consume many wild plants and also use other plants for various purposes. Some of these wild plants also come to the market. These plants have got little attention despite their various uses. There is a need to do further survey to see more species of potential use, their growth as well as their nutritional status. Due to habitat destruction some species are under threat of becoming extinct. At the same time some other species have the scope of domestication, though it needs an in-depth study to avoid adverse effects, if any, by introducing a new species. The aim of this study is to give detailed information of various wild edible plants, their distribution, marketing and regeneration status in the Sikkim Himalaya. An attempt has also been made to provide information on various other plants and products which have significant use value in the day to day life in the Sikkim state.

Objectives

1. To make an inventory investigation of wild edible plant species, their distribution and *in situ* regeneration and biotic pressure on them in Sikkim Himalaya.

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

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

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

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

6. Mass multiplication of elites of some selected wild edible species and their domestication in agroforestry system.

Results and Achievements

Out of a total of 175 wild edible plants about 85 were trees, 30 herbs, 29 shrubs, 13 woody climbers, 8 climbers, 5 woody grasses, 3 epiphyte-parasites and 2 tree-herb/fern species. *Agaricus* species, locally known as chayo, has at least 4 varieties/types which are yet to be identified, occur particularly during rainy season at all elevations in Sikkim and are relished by the inhabitants. Similarly *Angiopteris evecta* a fern, occurs from 500 m to 2200 m. The rhizome of this species is ground into flour and eaten. *Kadsura roxburghiana* is a large woody climber of low, mid and upper hill forest and its seeds are eaten all along the elevation.

People collect wild edible plants from natural habitat and some popular species are sold directly in the market. Fruits 'frequently used' are *Spondias axillaris, Baccaurea sapida, Bassia butyracea, Machilus edulis, Calamus flagellum, Emblica officinalis, Castanopsis tribuloides, Elaeagnus latifolia, Eriolobus indica, Juglans regia, Rhus semialata, Tamarindus indica*, etc. and all of them remain available in the local markets at the time of their fruiting season. Species of bamboo like *Dendrocalamus hamiltonii, Arundinaria* sp., *Cephalostachyum capitatum* are relished by locals as vegetables and sold in large quantities in markets. Other common vegetables which are collected from wild and available in the market at different time each year are tender leaves of *Diplazium esculentum, Girardinia palmata, Urtica* sp., *Chenopodium album, Nasturtium officinale*, root/tuber of *Dioscorea bulbifera* and fruiting body of *Agaricus* sp. Leaves of *Diplazium, Nasturtium officinale, Urtica dioica* and bamboo shoots are popular vegetable collected from wild habitats. All these species are equally consumed by rural as well as urban people, however, people in villages directly collect them from forest areas while urban people purchase them from local market.

Leaves of *Camellia kissi* are used as a substitute for tea. Fruits of *Spondias axillaris, Rhus semialata, Zanthoxylum budrunga, Eriolobus indica, Heracleum wallichii, Emblica officinalis, Tamarindus indica and Mangifera sylvetica*, new buds of *Ficus benjamina* and new shoots of *Bambusa nutans* are very popular for pickles and being used by all the tribes in the Sikkim state. A few wild plants which are preferred for *chutney* and also have medicinal value and are collected from low and mid hills and sold in the market, viz., *Bergenia ciliata, Terminalia belerica, Terminalia chebula, Evodia fraxinifolia, Swertia chirata, Viscum articulatum, Heracleum wallichii, Rhus semialata*, etc.

At low and mid hills most of the plants are consumed during dry season. At upper hills maximum species are eaten during rains which can be attributed to better growing conditions, and just 3 species are taken during dry season. At higher elevation, winter season (Nov-Feb) is lean period when most of the plants cease their growth.

Natural regeneration of most of the wild edible species and other plants is threatened particularly for those species which are collected in large scale. Regeneration of tree species is most threatened as people collect even the last fruit from the wild habitats. A study on the Mamlay watershed in south Sikkim has revealed that the *Spondias axillaris* has just 13 seedlings/ha. *Litsaea*

citrata (6 seedlings/ha), *Elaeocarpus sikkimensis* (6 seedlings/ha), *Myrica* sp. (6 seedlings/ha), *Machilus edulis* (3 seedlings/ha), *Prunus cerasoides* (3 seedlings/ha) had very poor regeneration. Natural regeneration was relatively good for *Castanopsis tribuloides* (111 seedlings/ha), *Cinnamomum tamala* (66 seedlings/ha) and *C. impressinervium* (38 seedlings/ha), probably due to widespread distribution of these species.

Seeds of some selected wild edible species are raised in the nursery, and *Machilus edulis* showed 100% germination after 2 months of seed sowing. *Elaeagnus latifolia* had 60% germination after one month of seed sowing, while seeds of *Bassia* had a germination of 82%. Germination period was relatively longer for seeds of *Elaeocarpus sikkimensis* (12-15 months), probably due to hard seed coat, and 80% seeds were germinated.

Observations are being taken at two important local markets (Hats) at Namchi and Gangtok to know the availability, market price and consumption pattern of wild edible species (Table 13). Weekly survey revealed the simultaneous availability of an individual species in the two markets, however, market prices varied at both the markets. Generally Gangtok market had higher prices of each species which is due to higher labour cost as well as involvement by middlemen. Most of the items are present at higher quantity in Gangtok for each species which reflects bigger market at Gangtok. Wild plants are collected by locals from the forest areas and either directly sold by them or handed over to some

Table 13. Some important wild plants available in the weekly market at Namchi and Gangtok in Sikkim

Plant species	Local name	Time of availabilit	Namchi		Gangtok	
			No. of retailers	Market price (Rs)	No. of retailers	Market price (Rs)
Agaricus sp.	Chayo	Jun-Sep	6	10-20*	8	15-25*
Bassia butyracea	Chiuri	May-	6	3-5*	5	5-8*
Castanopsis tribuloides	Katus	Nov-Dec	7	40*	4	40-60*
Cinnamomum sp.	Sinkauli	whole year	10	30*	11	40*
Dendrocalamus hamiltonii	Tamba	Jun-Oct	4	12*	6	15*
Dioscorea sp.	Bantarul	Jan-Mar	5	5*	6	10*
Diplazium sp.	Ningro	Mar-Aug	10	10-15*	13	15-20*
Elaeocarpus sikkimensis	Bhadrase	Apr-Jun	3	10-20*	3	15-20*
Elaeagnus latifolia	Malido	Feb-Mar	-	-	6	10*
Emblica officinalis	Amala	Oct-Jan	3	4*		-
Ficus benjamina	Kabra	Feb-Mar	5	8-10*	2	15-20*
Heracleum wallichii	Chimfing	Jul-Aug	4	10+	3	80*
Juglans regia	Okhar	Sep-Nov	8	20#	14	50#
Machilus edulis	Pumsi	Jan-Feb	8	15*	12	20-25*
Rhus succedanea	Timur	Aug-Sep	3	2-3+	5	3-5++
Rumex nepalensis	Halhale	whole year	4	10*	6	2++
Spondias axillaris	Labsi	Oct-Dec	7	4*	10	5*
Swertia chirata	Chirauto	May-Oct	4	15-20*	3	20-30*
Tamarindus indica	Titri	Feb-May	8	5*	10	8*
Terminalia belerica	Barra	whole year	3	20*	2	-
T. chebula	Harra	Feb-Mar	5	20#	5	25-30#
Urtica dioica	Sisnoo	Feb-Mar	7	5++	6	3++
Viscum album	Harchur	whole year	6	5-10*	4	15*

*per kg, # per 100 units, + per 50 g, ++ per 100 g

commission agents.

Interview with shop owners revealed that though most of the species are still coming to the market, however, in recent years the quantity has decreased drastically. Also, species like *Dioscorea* sp., *Elaeocarpus lanceaefolius*, *Juglans regia*, *Machilus edulis*, *Rhus semialata* used to come to the market in large quantities 10-15 years ago. The prices of each species has gone very high. For example market price for the fruits of *Elaeagnus latifolia* was recorded Rs. 10 per kg, 5 times more, in 1996 than in 1981. Similarly prices of bamboo shoots has risen by fourfolds, tender leaves/shoot of *Ficus* (kabra) by 3-5 times, *Diplazium* by 4-6 times, *Zanthoxylum* by about 8 times, *Urtica* by 4-6 times, nuts of Junglans by 2 times, *Machilus edulis* by 4 times and twigs of *Juniperus* sp. by 5 times in the year 1994-95 in comparison to 1981.

3.3.8. Sikkim Biodiversity and Ecotourism (1996-1999)

Background

The rich natural and cultural heritage of Sikkim makes this small Himalayan state in north-eastern India an attractive destination for international and domestic tourists. With over 90,000 domestic and 6,000 international tourists in 1995, tourism is rapidly becoming an important economic activity for Sikkimese people. Ecotourism, with its focus on environmentally sound practices and generating widespread economic incentives to conserve, offers an opportunity for Sikkim to improve mountain livelihoods and protect its unique heritage. The Sikkim Biodiversity and Ecotourism Project is a collaborative initiative designed to conserve the biological diversity of key destinations. At the heart of the Project are participatory approaches that link enterprise operation with conservation action, while merging traditional cultural practices (Fig. 9). Working with communities, the private sector and government, the project builds upon their skills, interests and knowledge, to: (i) increase

Fig. 9. Interaction of the project staff with the community

community and private sector conservation; (ii) increase economic returns from ecotourism services and enterprises; and (iii) contribute to policies that meet ecotourism and conservation goals. The Project is a joint effort of G.B.Pant Institute of Himalayan Environment and Development and The Mountain Institute. Project collaborators include the Travel Agents Association of Sikkim (TAAS), The Green Circle and Khangchendzonga Conservation Committee (Sikkimese NGOs) and local communities at the sites. Khangchendzonga National Park and communities in surrounding areas in West Sikkim are the focus of the project. Within the park is Sikkim's major trekking route, the Yuksam-Dzongri-Goechha La Trail—an exhilarating climb through dense forests and past impressive mountain views (Fig. 10). The forests and alpine meadows are some of the most biologically diverse in India, and contain over 36 species of Rhododendrons, 400 species of Orchids and many other

Fig. 10. Trail between Tsokha and Dzongri

flowering plants. The Park and surrounding areas also contain a large proportion of the 81 mammals, 300 plus birds, and about 400 butterflies recorded in Sikkim alone. The spiritual and physical focus of the area is Khangchendzonga, the world's third highest mountain peak (8,548 m.), and revered as the protective deity of Sikkim. At the trail head is Sikkim's first capital, Yuksam. From Yuksam, visitors can take short walks to several archeological ruins and to Dubde, Sikkim's oldest monastery. A number of different groups, including Lepchas, Bhutias and Nepalis, as well as Tibetan refugees, live in this culturally and historically rich area. Most pursue traditional agricultural livelihoods, while some have added tourism in recent years. Other project sites include Khechopalri Lake, one of Sikkim's most sacred and popular lakes and Pelling, a settlement near Pemayangtse Monastery.

Objectives

Increasing community and private sector biodiversity conservation initiatives. Activities include: (a) community ecotourism plans covering site-enhancement, trail and site maintenance, natural resource management and monitoring, and conservation education; (b) supporting fuelwood reduction measures by trek operators and local lodges; and (c) supporting local NGOs working in ecotourism and conservation.

Increasing economic returns from community-based and TAAS ecotourism. Activities include: (a) training in ecotourism services,e.g., for guides, lodge-owners, cooks, porters; (b) supporting new community ecotourism enterprises—vegetable growing, indigenous foods, fuelwood-saving equipment hire for treks, short guided treks; (c) developing marketing strategies for community-based ecotourism and TAAS ecotourism activities; and (d) conducting market research and developing new ecotourism products, e.g., off season activities, eco-lodge designs.

Improving and contributing to policy-making on conservation and ecotourism. Activities include: (a) scientific and participatory monitoring of project activities and impacts; (b) applied research on conservation and ecotourism; (c) sharing of research and monitoring findings among policy-makers, communities and the private sector; and (d) promoting public-private sector dialogue through workshops, exchanges and policy review.

Results and Achievements

Current and future activities build upon a participatory planning phase involving local communities, the private sector and government in 1995, and the following significant achievements in the year of reporting:

A Code of Conduct for Ecotourism developed at a workshop has enabled TAAS to obtain increased supplies of fuelwood alternatives, and provides the basis of a marketing strategy.

1. Community members in Yuksam prepared ecotourism plans and carried out village and trail clean-ups, tree-planting, fuelwood substitution and formed a local conservation organization to monitor natural resource use and manage cultural sites.

2. Over 200 people have participated in training courses for six key ecotourism professions (porters, lodge operators, trek cooks, guides, travel agents, pack animal operators) and two new enterprises (vegetable growing and naturalist guide). Project participants and local researchers have prepared and are now implementing a comprehensive project monitoring and research plan. Plant and animal diversity are monitored all along the trail and also by establishing permanent plots. The effect of grazing on plant diversity at high altitude grasslands along the trail is monitored. Pressure of fuelwood and fodder extraction on biodiversity has been estimated.

Ecosystem processes are being evaluated by comparing pristine, degraded and semi-degraded conditions especially on hydrological parameters at Tshoka. Effects of sediments on Khechopalri lake health as a result of community activities in the surrounding catchment area is being monitored. Expenditure profile of foreign and domestic tourists at the project sites are collected. The revenue earned by the different sections of tourism related enterprises and their contribution towards biodiversity conservation are recorded.

Workshops and meetings have increased the level of public and private sector interaction on tourism and conservation issues. Two working sessions (a) for developing biological and socio-economic monitoring plan, and (b) for participatory monitoring plan have been conducted for the project.

3.3.9. Community based rapid assessment of biodiversity conservation prospects in North East India.

Please see section on quick appraisal studies

3.4. ECOLOGICAL ECONOMICS AND ENVIRONMENTAL IMPACT ANALYSIS

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

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

Transportation is an important need for development of a region, because it plays a vital role for the economic and infrastructural development. In the case of transportation in the hill area, it is a fact that roads are major means for transportation and communication. This fact was analyzed along the temporal development of road network in a remote location of high ranges of district Almora, i.e., Kapkot Block. In general, most of the infrastructure was concentrated along the road or within two kilometers approach and a decreasing trend was observed with increasing distance from the road.

The second aspect of road development is social transformation. It provides exposure to new techniques, methods and development of new ideas to modify the traditional practices in existing situations, for example, (i) cash crop cultivation instead of traditional food grain (ii) changes in type and pattern of settlement, shape and size of window, door and dwelling, building material, etc. These changes were observed along the roadside villages.

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

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

Results and Achievements

1. Urban solid wastes at point sources indicated that value of readily biodegradable wastes (RBW ~63%) and biodegradable waste (BW ~18%) fractions were highest during monsoon season. Non biodegradable waste (NBW) fractions were measured ~34% in winter, ~26% in summer and ~20% in monsoon seasons. Similarly, RBW at disposal site were derived 52% in summer, ~51% in monsoon and ~46% in winter seasons. BW fractions were measured 25% in monsoon, ~18% in both winter and summer. NBW values were in between RBW and BW (Fig. 11). The average moisture from point sources were in between 51-53%, average bulk density were 266-317 Kg/m^3 whereas at disposable site these moisture and bulk density were 45-56% and 291-452 Kg/m^3 respectively.

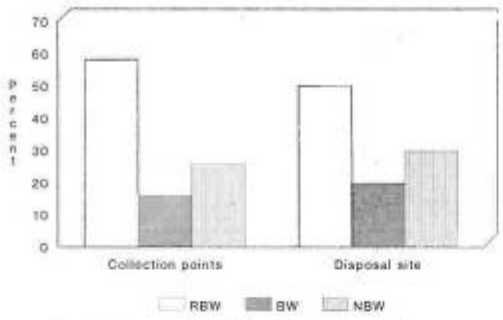

Fig. 11. Comparative solid waste characterisation

2. A comparative waste characterization results of star and non star categories of hotels showed that RBW was above 55% in Manali resort and 63.2% in Zarim hotels, while BW was 31% in star category and 13.6% in nonstar category. NBW category waste was higher in nonstar category rather than star category hotel. Much of the food under Kitchen waste (~54%) was left and turned into waste in star category hotel. However, within room waste, paper was high (~26%) in nonstar category.

3. Hospital waste characterization showed that highly infectious waste was same (0.2%) in both the hospitals, i.e, Mission and Civil. But infectious waste category came around 27% and 11% in Mission and Civil hospitals respectively. The remaining waste was found as noninfectious.

4. The results of chemical parameters of solid wastes showed pH value: 6.6-7.5, conductivity: 0.910-2.260 ms/cm, carbon/nitrogen ratio: 18 55, potassium: 0.30.8%, phosphorous: 0.5 0.9% and calorific value: 633-2190 K. Cal/Kg. 0`6 High organic matter (~32%) and moisture contents showed potential for aerobic composting or bio-gas production. The average compostable waste was noted to be ~54% and recyclable waste ~24% from management point of view. The remaining waste may be landfilled including hospital waste with proper treatment through disinfection, grinding of infectious waste and recycling and incineration of non-infectious category.

3.4.3. Environmental Assessment in and around Valley of Flowers

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

Results and Achievements

1. In the stretch from Govindghat to Ghangharia, sampling was carried out in 21 shops which denoted that readily biodegradable wastes (RBW) were found to be 16%, biodegradable waste (BW) 2% and non biodegradable (NBW) 82% amongst which soft drink (take away) bottles were maximum. In the same way, waste characterisation was carried out in 12 shops from Ghangharia to Hemkund Sahib where RBW were found to be 7%, BW 5% and NBW 88% (Fig. 12).

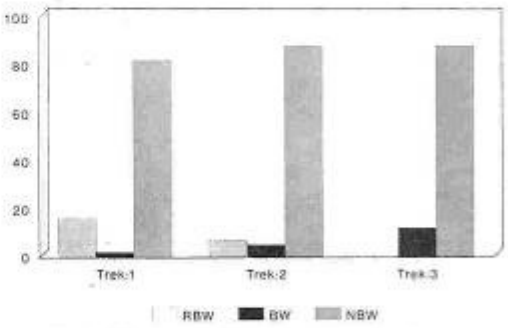

Fig. 12. Trek-wise solid waste characterisation

2. On the trek in between Ghangharia to Valley of Flowers, solid waste characterisation showed that plastic prone waste was the maximum, i.e., 31%. Metal prone was found to be ~25% followed by leather and rubber waste (~23%). The remaining fractions belonged

to cloth prone wastes (~3%), i.e., glass, paper, etc.

3. Average moisture level in garbage from Govindghat to Hemkund was ~54%. Chemical characteristics of solid waste from Govindghat to Ghangharia and Ghangharia to Hemkund Sahib indicated a pH range of 7.8-8.3, conductivity ranged from 0.435-1.268 ms/cm and Carbon/ nitrogen ratio was found 25 to 49, whereas potassium as K_2O range of 0.2-0.5%, phosphorous as P_2O_5 ranged from 0.6 to 0.7% and calorific value ranged from 249 to 1054 K. Cal/Kg.

4. In essence, recycling becomes one of the measures for solid waste management options in the study region along with active participation and mutual understanding amongst villagers, shopkeepers, visitors, Gurudwara Prabandhak committee (Govindghat) and District Administration.

3.4.4. Ambient Air Quality Monitoring in Kullu Valley

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

Results and Achievements

1. The concentration of SPM ranged in between 14 and 153 ug/m^3 within the selected monitoring stations. This was based on weekly/bimonthly observations carried out at Mohal, Manali and Kothi. Monthly average SPM values were within 39 and 93 (ug/m^3) which were under specified limit of 100 (ug/m^3) upto 24 hrs for sensitive areas. The SPM concentrations at Manali were found in excess of 24 hrs standard during summer season. The highest average SPM concentration was detected as 115 (ug/m^3) in May and the lowest was as 41 (ug/m^3) in the month of July. Average SPM concentrations at Kothi was obtained to be very close to pristine levels (Fig. 13).

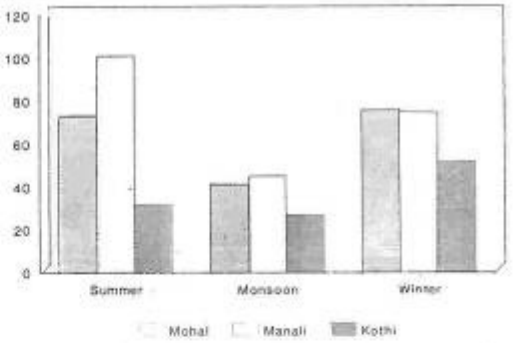

Fig. 13. Seasonal variations of suspended particulate

2. Amongst trace gases concentrations, sulphur dioxide and oxides of nitrogen were within 12-29 ug/m^3 and 16-28 ug/m^3 at Mohal (Kullu), 12-40 ug/m^3 and 12-34 ug/m^3 respectively in Manali whereas the concentration of sulphur dioxide and oxides of nitrogen was in excess of specified 24 hrs standard for sensitive areas (15-30 ug/m^3) during summer season in Manali. As far as ammonia concentration was concerned, it was obtained 7-10 ug/m^3 at Mohal, and 2-4 ug/m^3 at Manali. Ozone gases were found in between 20-28 ug/m^3 during summer season at Mohal (Kullu).

3.4.5. 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 of the Institute. Please see previous Annual Reports for details.

Results and Achievements

The ecology, economy, culture and developmental problems & prospects for two tribal communities, i.e., the Jaunsaries & the Bhotias, were studied covering 10 villages each and 3847 and 3266 population respectively. In this issue, major economic findings are discussed.

Agriculture appeared to be major occupation for both the communities engaging 70.6% and 39.3% of main workers among the Jaunsaries & the Bhotias respectively. Service sector engaged second largest workforce, i.e., 13.6% and 22.7% of main workers among the Jaunsaries & the Bhotias respectively. About 13% of the main workers among the Bhotia was engaged in wool related activities in comparison to 0.1% among the Jaunsaries. For the Jaunsaries, the highest percentage of income was from agriculture (39.6%) followed by service (29.4%), while for the Bhotias the highest percentage of income was from service (37.2%) followed by business & trade (31.9%). The highest percentage of expenditure for both the communities was on food, i.e., 33.7% for the Jaunsaries & 43.3% for the Bhotias, followed by expenses on social sector, clothing & education.

Per capita availability of livestock (cattle units) for Bhotia was 3.11 against 2.4 for Jaunsari. Goat and sheep were predominant in the livestock holdings of the Jaunsaries & the Bhotias respectively (Table 14). About 70% of the Jaunsari & 89% of the Bhotia households were marginal farmers, owning less than 1 ha. of land. The per capita land holding for Jaunsari was 0.26 ha against 0.15 ha for Bhotia in 1995-96. In 1951-52, the per capita land holding for Jaunsari was 0.42 ha and that for the Bhotia was 0.23 ha in 1963-64 (Table 15). Percentage of service holders to literates among the Jaunsari was 6.8 against 12.0 among the Bhotias.

Table 14: Per capita availability of livestock

Livestock	*Per capita availability (Unit)*	
	Jaunsari	*Bhotia*
Jupu	0.00	0.03
Ox	0.32	0.22
Cow	0.42	0.47
Buffalo	0.08	0.02
Horse	0.02	0.02
Mule	0.02	0.02
Sheep	0.40	1.62
Goat	0.84	0.64
Total	2.14	3.11

Table 15. Per capita change in cultivated land availability (in ha)

Study villages	*Per capita availability in*		*Change*
Jaunsari	*1952-53*	*1995-96*	
Chapnu	0.19	0.15	(-)0.04
G. Sakraul	1.54	0.35	(-)1.19
Mashak	0.43	0.56	(-)0.13
Phanar	0.24	0.17	(+)0.07
Dasau	0.15	0.08	(-)0.07
Khatuwa	1.25	0.74	(-)0.51
K.C. Gatha	0.62	0.16	(-)0.46
Thana	0.24	0.23	(-)0.01
Matiyawa	0.25	0.12	(-)0.13
Deo	0.25	0.16	(-)0.09
Total	0.42	0.26	(-)0.16
Bhotia	*1961-62*	*1995-96*	*Change*
Chharchhum	0.17	0.06	(-)0.11
Milam	0.28	0.36	(+)0.08
Paton	0.14	0.07	(-)0.07
Darkot	0.06	0.04	(-)0.02
Tomik	0.29	0.21	(-)0.08
T. Bhainskot	0.07	0.06	(-)0.01
Seepu	0.24	0.26	(-)0.02
Baun	0.38	0.25	(-)0.13
Kuti	0.14	-	-
Sirkha	0.52	0.35	(-)0.17
Total	0.23	0.15	(-)0.08

3.4.6. The socio-economic and developmental problems and prospects of Raji (Van Rawat) tribe of Central Himalaya.

Background

The Rajis or (Van Rawats) are socially, educationally and economically, the most under-developed tribal community of Central Himalaya. They were recognized as a scheduled tribe in 1967 and as a primitive tribe in 1975 by Government of India. The community is numerically small and are reported from 10 villages in total, i.e., 9 villages in Pithoragarh district and 1 village in Udham Singh Nagar district of state of Uttar Pradesh. Other than being primitive and forest dwellers, the tribe is a nomadic community. Probably, its nomadism has been

the factor that prohibited a complete and true enumeration of its total population, as various studies carried out by various authors and agencies have reported difference in population for the tribe for a single period. Hardly little is known about the demographic behaviour, socio-economic and developmental issues of this tribe. Also, knowledge in quantified terms about the changes that must have occurred under developmental and technological interventions is totally lacking. With this background, a study has been undertaken to have some explanations and answers to the above issues.

Objectives

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

Results and Achievements

A complete census of the population of the tribe has been carried out through primary survey. The total population of the tribe was 531 in the first quarter of 1997 distributed in 10 settlements (villages) in 4 tehsils of Pithoragarh district and in 1 village in 1 tehsil of Udham Singh Nagar district of Uttar Pradesh (Table 16).The tribe has a sex ratio of 818 which varies in different age groups. Low sex ratios have been observed in the early age groups, i.e., 716 for the populace below the age of 7 and 707 for populace in the age group 8 to 14. This low sex ratio in the early age groups is, probably, because of high female infant and female child mortality. Percentage distribution of populace in different age groups indicates an increasing growth rate as 23.91 per cent of the populace are in the age group of below 7 and 18.64 per cent of the populace are in the age group of 7-14. More than 65 per cent of the populace are below the age of 30. From 1971 to 1981, the decadal growth rate for the tribe was 33.15 while the growth rate from 1991 to 1997 was 7.49.

Table 16: Some Major Geo-demographic Features of Raji Tribe

District	Tehsil	Settlement	Population			Sex Ratio
			Total	Male	Female	
Pithoragarh	Dharchula	Kimkhola	125	70	55	768
		Ganagoan	60	34	26	765
		Chiftaltara	20	11	9	818
	Didihat	Madanpuri	36	18	18	1000
		Katyula	20	12	8	667
		Kutachaurani	55	27	28	1037
		Kauli	19	11	8	727
		Kanalichina-Ratura	46	26	20	769
		Kantoli (Jamtori)	69	39	30	769
	Champawat	Krirdwari	63	35	28	800
Udham Singh Nagar	Khatima	Chakarpur	18	9	9	1000
			531	292	239	818

Source: Primary Survey, 1997

The crude literacy rate was 26.74. The effective literacy rate (excluding the populace below the age of 7) was 35.06, it being 50.68 for males and 16.66 for females.

About 52.35 per cent of the populace constituted the main workforce. Out of it, 44.6 per cent were agriculturists, 37.40 per cent were wage labourers, 16.90 per cent were engaged in forest produces and the rest 1.10 per cent were in service. As found out, 3 persons among the tribe were in government service.

The total families were 116, predominantly nuclear (78.45%). About 23.35 per cent of the houses were mud, 74.17 were semi-pucca and only 2.5 per cent were pucca in construction. About 30.83 per cent of these houses were single roomed. Nearly 12.10 per cent of the families had no land and 58.62 per cent had less than 0.5 acre of land. Per family and per capita livestock holdings were 2.65 and 0.87 respectively. Per capita income and per capita expenditure during 1995-96 were Rs. 1352 and Rs. 1450 respectively. Almost all the families were below poverty line as the average income per family estimated to be was Rs. 6188. About 50.46 per cent of the total income of the tribe was from wage labour, while that from agriculture, forest produces and others were 12.55, 27.78 and 9.21 per cents respectively. During the year 1995-96, maximum expenditure was on food (73.76%) followed by clothing (10.77%) while least expenditure was on health and medicine (0.72%) followed by education (1.24%).

Mean ages at first marriage for male and female were 21.8 and 17.28 respectively. About 5.4 per cent of the females were married below the age of 13 while 38.80 per cent were married at the age of 13 to 16 and 36.93 per cent were married at the age of 17 to 20. The survey also revealed that 8.5 per cent of the females were below the age of 16 at first pregnancy while about 60 per cent of the females were between the age 16-21 at their first pregnancy. Average number of pregnancies for an ever married female (EMF) was 4.29 and the number of surviving children for an EMF was 2.25.

About half of the populace of the tribe has changed to settled agriculturists from nomadism, which was a positive indicator of development interventions.

3.4.7. Environmental Assessment of recent landslides in Kalimpong sub-division of West Bengal in Darjeeling Himalaya

Please see section on quick appraisal studies

3.5. ENVIRONMENTAL PHYSIOLOGY AND BIOTECHNOLOGY

3.5.1. Microbial Inoculants for Improved Plant Performance in the Himalaya

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

Objectives

1. Microflora of higher altitudes.
2. Isolation and selection of plant growth promoting rhizobacteria.
3. Studies on rhizoflora associated with conifers.
4. Microbial interactions in tea rhizosphere.
5. Maintenance of microbial cultures of the Himalayan region.

Results and Achievements

1. Microbial analyses of soil samples collected from 1200 m to 2000 m amsl of Mamlay watershed, Sikkim were carried out.

Three groups of microorganism, i.e., bacteria, actinomycetes and fungi were taken into consideration. In general, microbial population decreased with increasing altitudes. *Bacillus*, a group of endospore forming bacteria, did not show much difference in their populations along various altitudes. *Pseudomonas* and other pigmented bacterial populations increased with the increasing altitude, probably indicating their adaptability to higher altitudes. A large number of microbial species have been isolated, are being maintained, and studied for various properties, e.g., antimicrobial activity, phosphate solubilizing and N-fixing ability. These soils seem to have a great potential for screening efficient strains of microorganisms having antimicrobial and phosphate solubilizing properties, especially those adapted to the higher altitudes. For example, a fungal isolate, *Paecilomyces varioti*, showed a higher degree of phosphate solubilizing activity at 10°C than 24°C. Similarly amongst bacteria a number of *Pseudomonas* strains were found to be well adapted to higher altitude soils and exhibited antifungal, phosphate solubilizing and plant growth promoting properties. Some of the strains of *Pseudomonas* were able to grow at 4°C and also found to have N-fixing ability, albiet lower than the well known N-fixing bacteria.

2. *Pseudomonas* and *Bacillus* have been identified as best suited plant growth rhizobacteria for higher elevations. This is mainly due to the adaptability of these bacteria to the lower temperatures. The well adapted rhizobacteria have been studied for various important properties, viz., root colonization, N-fixation, phosphate solubilization and biocontrol properties. Efforts are also being made on developing the efficient strains as inoculants.

3. The rhizosphere studies on three coniferous plant species *Pinus*, *Cedrus* and *Taxus* are in progress. Rhizosphere effect and plant - microbe interactions are two major aspects taken into consideration. The rhizosphere associated with *Pinus* and *Cedrus* have been proven beneficial for seed germination and subsequent plant growth. Contrary to this *Taxus* associated rhizoflora has been found to have antigermination factors. This resulted in very poor seed germination and subsequent plant growth. The germination significantly improved by manipulating the rhizoflora.

4. Tissue culture raised tea plants, when transferred from lab to field, result in great mortality. Efforts have been made towards overcoming this problem by using microbial cultures. Bacteria isolated from tea rhizosphere and also from other soils were screened and tested for inoculation of tissue culture raised tea plants. Significant improvement in survival (upto 100%) has been recorded in one of the treatments.

5. All the bacterial, fungal and actinomycetes isolates are being maintained. A number of *Bacillus, Pseudomonas, Xanthomonas, Penicillium, Aspergillus, Trichoderma, Paecilomyces* and many other isolates have been identified upto the species level.

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

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

Results and Achievements

1. The standardized vegetative (clonal) propagation of *Taxus baccata* subsp. *wallichiana* with 1st year's young shoots is being used for multiplying plants for experimental purposes based on the better rooting capacity obtained in the monsoon season.

2. The growth and survival of cutting raised plants in its natural habitat in Jageshwar have been monitored. Growth (144% increase over initial height) and survival (46%) following 2 years after transfer indicated a satisfactory performance. This implies that the species could well be conserved and plants could be grown for biomass in its natural habitat (Table 17).

Table 17: Growth and survival of cutting raised plants (rooted during monsoon and after growing in a polythene tunnel for 10 months) following transfer to the field in Jageshwar (1840 m amsl).

Months after transfer[a]	*% Survival*	*%Increase in height*[b]
2	83.3	0
4	71.6	0
6	68.6	0
8	67.6	66.3
10	62.8	69.5
12	62.8	69.5
16	61.8	69.5
20	54.9	140.8
24	46.0	143.9

[a] Rooting was assessed in early Nov 1993 and plants transferred in early Sept 1994 [b] Over mean height (9.5±0.9 cm) at the time of transfer to field.

3. *Agrobacterium rhizogenes,* a soil inhabiting bacterium has the capability to induce root formation in stem cuttings of some plant species. Therefore, stem cuttings of tea, poplar and Grewia have been treated with a pure culture of *A. rhizogenes* in an attempt to examine its rooting ability and to find out an alternative and potential rooting agent. Although differences were not observed in tea, enhanced rooting was achieved in poplar cuttings following treatment with the bacteria when compared to control. Cuttings of *Grewia* did not survive at all.

4. Attempts are in progress to standardize *in vitro* protocol for multiplication of *Taxus baccata;* callus cultures have been initiated from stem segments and excised embryos and cultures are being grown on B5 medium.

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

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

Results and Achievements

1. Short-term effect of elevated CO_2 (700 ppm) at varying temperatures (15-40°C) and light intensity (0-2000 u mol/m²/s) on some alpine and temperate (*Alnus nepalensis*) plants were studied.

2. Maximum photosynthetic activity in *A. nepalensis* was observed at 30°C and at ambient CO_2. A decrease of 43% in net photosynthesis was observed with increase in temperature (Fig. 14a).

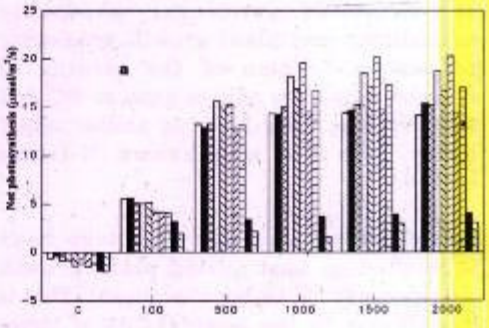

Fig. 14a. Net photosyanthesis

3. An overall increase of 23% in net photosynthesis was observed at elevated CO_2 and at all temperatures studied.

4. Both stomatal conductance and transpiration rate decreased at elevated CO_2. Maximum decrease was observed at the higher temperature (Fig. 14b).

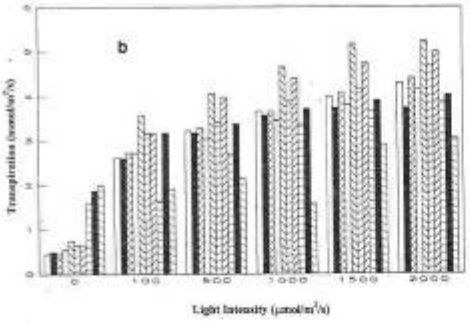

Fig. 14b. Transpiration rate

3.5.4. Evaluation, propagation and utilization of selected multipurpose trees for the waste and marginal lands of Central Himalayan hills

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

Results and Achievements

1. Studies conducted on availability, acceptability and utilization potential of the plant resource of the selected multipurpose species.

2. High degree of variability (morphological and biochemical) was evident among the populations of the selected species. Studies on SDS-PAGE further supplemented the identification and selection of elite population(s) for multiplication.

3. Biochemical factors responsible for deterioration in seed viability of *D. butyracea* during storage were identified. Rapid decline in seed viability due to moisture loss was observed which was accompanied by reduction in soluble protein and carbohydrate content.

4. Procedures for seed germination have been standardized for the selected species. Gibberellic acid treatment was found to be the best to achieve optimum germination in *Bauhinia* whereas acid treatment and water soaking proved best in case of *Sapium* and *Diploknema*, respectively.

5. Protocols for rooting ability of branch cuttings with respect to season and exogenous auxin requirement have been developed for both *Bauhinia* and *Diploknema* species. Branch cuttings showed foliar sproutings but failed to root in case of *Sapium*. Root suckers on the other hand showed positive response.

6. An efficient micropropagation protocol from cotyledonary node explants of seedling and nodal explants of mature climbers of *B. vahlii* has been developed.

7. Development of protocols for micropropagation and callus regeneration for *Sapium sebiferum*.

8. Highly efficient and reproducible protocol developed for *Diploknema butyracea* both through seedling and mature explant.

9. Genetic uniformity among micro-propagated and callus regenerated plants of *S. sebiferum* was tested. Consequence of high degree of variability was observed in callus regenerated over micropropagated plants.

3.5.5. Conservation and Multiplication of Himalayan Threatened Plant Species

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

Results and Achievements

1. Nineteen population of *Podophyllum hexandrum*, two of *Picrorhiza kurrooa*, two of *Nardostachys grandiflora* and four of *Aconitum balfourii* have been identified.

2. Soil collected from all the micro sites have been analyzed for moisture, colour, pH, carbon, phosphorus and nitrogen contents (Table 18).

Table 18. Diversity and distribution of the genus *Podophyllum*

Taxa	*Distribution*	*Source*
Podophyllum aurantiocaule Hand.-Mazz.	India (Arunachal Pradesh)	FPNB
P. Favaleriei Leveille	China (Kweichau)	IKS (Vol. 5)
P. chengii Chien	China (Chekianj)	IKS (Vol. 10)
P. delavayi Franch.	Yunnan	IKS (Vol. 1)
P. duffirae Gensk, & E.H. Wils.	China	IKS (Vol. 4)
P. diphyllum Linn.	-	IL
P. esquirolii Leveille	China (Kweichau)	IKS (Vol. 5)
P. hexandrum Royle Syn P. emodi	Himalaya (Afganistan	IKS (Vol. 10)
P. himalayense Le Maout & Decne	to China)	IKS (Vol. 6)
P. hispidum Hao	Himalaya	IKS (Vol. 9)
P. japonicum T. Ito, ex Maxim.	China (Kwangsi)	IKS (Vol. 1)
P. mairei Gagnep.	Japan	IKS (Vol. 10)
P. omjoense Gagnep.	China (Yunnan)	IKS (Vol. 10)
P. montanum Rafin.	China(Kweichau)	IL
P. onzoi Hayata	-	IKS (Vol. 5)
P. peltatum Linn.	Formosa	IK (Vol. 2)
P. pleianthum Hance	USA, Formosa	IK (Vol. 2)
P. sikkimense R. Chatterjee & Mukerjee	China	IKS (Vol. 12)
P. tonkinense Gagnep.	India (Sikkim) &	FPNB
P. triangulum Hand.-Mazz.	Bhutan	IKS (Vol. 10)
P. veitchii Hemsl. E.H. & Wils.	Indo-China (Tokin)	IKS (Vol. 7),
P. versipelle Hance	China(Hunan)	FPNB
	China	IKS (VOl. 4)
	China, India (AP)	IK (Vol. 2), FPNB

FPNB = Flowering plants of Nepal and Bhutan
IKS = Index Kewensis Supplementum
IK = Index Kewensis
IL = Index Londinensis

3. Morphological variations in the number, shape and size of leaves, seed weight and colour as well as biochemical variations among and within population has also been recorded in these species.

4. Isoelectric focussing of esterase in populations of *P. hexandrum* and *A. balfourii* has given much better resolution with varying intensity.

5. Technique for large scale propagation using callus cultures and micropropagation have also been developed for *A. atrox*. Callus cultures from leaves have been obtained for *P. hexandrum* and attempts are made for the micropropagation of this plant.

3.5.6. Biomass of Woody Debris and other Detrital Pools in Different Forest Types of Binsar Wildlife Sanctuary

Background

Input of woody debris as a result of catastrophic events, viz., fire, wind, epidemics, etc. creates canopy gaps within the forest ecosystems. In these canopy gaps, resource availability is greatly altered and a change in immediate environment occurs which influences functioning of an ecosystem. Thus, the studies on forest gaps help to understand the mechanism of ecosystem functioning. Ground vegetation has been considered important in energetic, trophic interactions, nutrient flow and tree regeneration. A study was, therefore, carried out to understand

functioning of ground vegetation in a mixed broadleaf forest (hereafter referred to as open canopy forest in which crown cover was reduced to about 4% due to fire event of 1992, and was compared with mixed broadleaf forest (hereafter referred to as closed canopy forest) having > 80% crown cover at 2500 m amsl.

Objectives

1. To analyse and compare N, P, K, Ca and Na concentration in live shoots (sedges, grasses and herbs), dead shoots and roots.

2. To estimate and compare storage, uptake and release of different nutrients.

3. To determine the relationship between annual nutrient uptake and dry matter flow.

Results and Achievements

1. For most of the studied parameters, nutrient concentration was significantly higher under closed canopy forest compared to open canopy forest.

2. The data indicated a substantial withdrawal of nutrients following senescence of live shoots.

3. Storage of different nutrients was 5-16 times higher under open canopy forest in comparison to closed canopy forest.

4. The total uptake of different nutrients was 7-9 times greater under open canopy forest compared to closed canopy forest.

5. The amount of different nutrients released annually as a result of decomposition was lower (0.13 to 3.58 kg/ha) under closed canopy forest as compared to the open canopy forest (1.10 to 22.30 kg/ha).

6. Both the forest sites had similar amount of nutrients absorbed and released per unit of dry matter accumulated and disappeared, respectively.

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 Reports for background and objectives.

Results and Achievements

1. High frequency and reproducible somatic embryogenesis achieved in *Quercus* and *Podophyllum* sp. (Fig. 15 & 16).

Fig. 15. Somatic embryo formation in *Quercus* spp.

Fig. 16. Multiple shoot formation in *Podophyllum hexandrum*

2. *In vitro* conditions optimized for obtaining uniform growth of microshoots and maximizing adventitious roots in tea.

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

4. Direct initiation of adventitious shoots obtained from embryos of *Cedrus deodara*.

5. Shoot multiplication, rooting and somatic embryogenesis obtained in *Dendrocalamus hamiltonii* (maggar bamboo).

6. Four fungal strains associated with the rhizosphere of *C. deodara* were identified to exhibit strong phosphate solubilizing activity and was found to depend on temperature.

7. Bacterial inoculation of tissue culture raised tea plants resulted in high rate of survival upon transfer to field.

8. During winter months, photosynthetic rate of shade grown tea plants is higher than that of plants kept in open.

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

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

Results and Achievements

1. Based on evaluation and assessment of existing landuse practices, related problems, and with due consideration of the existing physical conditions of the watershed, an eco-friendly, model has been developed.

2. For conservation of water, a simple and cheap water harvesting technology through the development of a "Polypond" (pond lined at the base and along the sides with polythene sheet) has been introduced with active participation of village people.

3. Eco-friendly biofencing adopted and demonstrations have been set up by using *Agave* sp. and *Vitex negundo*.

4. Based on the preference of villagers to combat scarcity of green fodder, a number of appropriate plants (grasses, viz., bamboo, broom and napier; trees like Bhimal, Mulberry, Oaks, *Bauhinia*, etc.) have been planted along the rivers/ streams, irrigation channels and along terrace bunds (Table 19 a & b).

5. To create awareness among the villagers and to propagate these ideas and models, training on nursery development, natural resource management and protection, was provided to the villagers (Fig. 17).

6. For monitoring, obtaining feed back, encouraging replication, awareness, etc., a number of researchers, NGOs, students from India and abroad have visited the watershed.

7. *Crotalaria tetragona* has been introduced in the form of hedge across the hill slopes on highly degraded slopes for site improvement and soil erosion control.

Fig. 17. Protected cultivation of off-season vegetables.

Table 19 a. Other useful introduced plant species

Botanical name	English name	Botanical name	English name
Horticultural Species		**Vegetables**	
Actinidia chinensis	Kiwi	*Abelmoschus esculentus*	Lady finger
Carica papaya	Papaya	*Capsicum spp.*	Capsicum
Citrus aurentifolia	Sour lime	*Lycopersicon esculentum*	Tomato
C. medica	Lemo	*Raphanus sativus*	Radish
C. reticulata	Orange	*Sechium edule*	Uskhus
C. sinensis	Sweet orange	*Solanum melongena*	Brinjal
Emblica officinalis	Amla	*Vicia faba*	Bean
Eriobotrya japonica	Loquat		
Juglans regia	Walnut	**Cash Crops**	
Litchi chinensis	Litchi	*Amomum subulatum*	Large cardmom
Magnifera indica	Mango	*Rosa damascena*	Bullgarian rose
Prunus amygdalus	Almond		
P. armeniaca	Apricot	**Fodder Grasses**	
P. persica	Peach	*Pennisetum spp.*	Napier
Psidium guajava	Guava	*Thysanolaena maxima*	Broom grass
Pyras communis	Pear		
P. malus	Apple		

Table 19 b. Multipurpose tree species used in Haigad model

Plant species	Uses
Alnus nepalensis	- Timber, fuel, soil fertility maintenance
Bauhinia vahlii	- Fodder, leaves are used as binding material of famous sweet "singauri" and for making "pattal" (plates), soil fertility maintenance.
B. variegata	- Fuel, food (floral buds used as vegetable), fodder, bark yields dye, medicine, and gum
Butea frondosa	- Fodder
Cassia fistula	- Timber, fuel, ornamental
Cedrus deodara	- Timber for furniture, medicine
Dendrocalamus strictus	- Paper pulp, wicker workds, soil binder
D. hamiltonii	- Fodder, paper pulp, wicker works, soil binder
Diploknema butyracea	- Fodder, timber, vegetable oil from seeds
Ficus palmata	- Fodder, fruit, medicine
F. roxburghii	- Fodder, fruit, fuel
Grewia oppositifolia	- Fodder, fiber, fuel, timber
Melia azedarach	- Fuel wood, box planks, paper pulp, Fodder, medicine
Morus alba	- Fruits edible, timber, sport good, fodder, leaves for silk-worm feeding
Ougenia oojeinensis	- Fodder, fuel wood, wood for making utensils
Quercus glauca	- Fodder, fuel wood, timber for agricultural implements, soil conservation
Q. leucotrichophora	- Fodder, fuel wood, timber for agricultural implements, tannin, soil conservation
Sapindus mukorossi	- Fruits used as a substitute for soap

3.5.9. Seedling Development and Subsequent Growth in Relation to Cotyledonary Senescence in two Alpine Rosettes

Background

Two herbaceous dicots, namely *Podophyllum hexandrum* Royle (Podophyllaceae) and *Aconitum heterophyllum* Wall (Ranunculaceae), which grow in the Himalayan alpines and sub-alpines, are of tremendous medicinal and export value, and are presently endangered. Although these plants perennate through underground parts (containing active principles of medicinal value), the period of active growth

is confined only to a few summer months. Regeneration is both by vegetative means as well as via seeds. On many occasions little or no viable seeds are produced, and their germination is not uniform; seeds may take several months to a few years for germination/ seedling establishment. Moreover, following seed germination, the plumule remains quiescent until the onset of senescence of cotyledons, which occurs towards the end of 1st year of growth. It is only during the 2nd growing season that the true leaves emerge. It appears that the cotyledons regulate the development of apical meristem and the new leaves which would emerge adjacent to it. As flowering and seed setting start in the 4th year, it results in a prolonged growing cycle. In view of the medicinal importance and commercial relevance of these plants, it would be appropriate to estimate the endogenous plant growth substances (known to regulate various aspects of growth and development, including senescence) in seeds, cotyledons and to experimentally influence seed germination and stimulate seedling growth.

Objectives

1. To understand the hormonal (endogenous) basis of cotyledonary control of development of the apical meristem. Isolation and quantification of plant growth substances most likely to be involved in this phenomenon.
2. To initiate growth of the plumule in the 1st year itself by chemical means in order to hasten the growing cycle.
3. Comparisons to be made with another species of *Aconitum*, namely *A. balfourii* where inhibitory influence of the cotyledon is not present.
4. To influence seed germination by chemical means.

Results and Achievements

1. Enhancement of seed germination has been found with certain plant growth substances.
2. Cotyledons are being analysed for endogenous hormone content.
3. Various chemicals have been applied in order to enhance growth of the plumule in the 1st year itself (results are awaited).

3.5.10. Biochemical Aspects of Ammonium Assimilation in Mountain Plants

Background

Today major concern in the area of plant biochemistry, biotechnology and crop improvement is to understand the mechanisms that control the expression and developmental pattern of enzyme proteins involved in nitrogen metabolism and how they regulate the distribution of carbon and nitrogen in different plant parts? It is because nitrogen metabolism is also linked to carbon metabolism through citric acid cycle. A clear understanding of these two major pathways is necessary for the future plant biotechnology and crop improvement programme. This can be achieved only if we understand the sub cellular and developmental synthesis/activity of enzymes involved, and the environmental factors on their synthesis/ activity. This would be of specific value in the area where the soil fertility is very poor. The long term goal of this project is to develop a strong biotechnology programme for improving ammonium assimilation and nitrogen distribution in economically important plants.

Objectives

1. To understand the biochemical and molecular mechanisms involved in the regulation of gene expression and enzyme synthesis associated with ammonium assimilation in plants.
2. To study the effects of various environmental stress conditions on the activity/ synthesis of GS, GOGAT and GDH at protein and mRNA level.

Results and Achievements

1. Growth pattern, nutrient accumulation and some enzymes of nitrogen metabolism were studied in *Glycine max* and *Selinum vaginatum*.

2. Shoot length decreased with increasing altitude increases while shoot and root dry weights were highest at middle altitude in both the species.

3. Higher soluble protein at lowest altitude and varying level of free ammonia in tissues during plant development are common for both the species. A rapid decrease in glutamine synthetase activity was observed in both the species as altitude increases. Glutamate synthase did not show any constant trend while glutamate dehydrogenase activity increased as altitude increases.

4. *G. max* shoot organic carbon increased as altitude increases whereas an opposite trend was observed in *S. vaginatum*.

3.6. INSTITUTIONAL NETWORKING AND HUMAN INVESTMENT

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

According to the recommendations of the Project Evaluation Committees (PECs), the following sixteen projects (ten to Universities, two to NGOs and four to Govt. Institutions/ Autonomous Organisations) were sanctioned and funded during the year.

1. Assessment of toxic metals and nutrients in lake of Nainital: Biomonitoring and remediation studies with phytoplankton and macrophytes. (Dr. R.D. Tripathi, Department of Aquatic Botany, Environmental Sciences Division, National Botanical Research Institute, Lucknow, U.P.).

2. Collection and evaluation of non-conventional food plants of Assam and Nagaland. (Dr. A.K. Handique, Department of Biotechnology, Gauhati University, Guwahati, Assam).

3. Afforestation based eco-conservation in Gangotri-Gaumukh area. (Dr. (Ms.) Harshwanti Bisht, Department of Economics, Govt. P.G. College, Uttarkashi, U.P.).

4. Integrated watershed management of Subansiri river basin, Arunachal Pradesh. (Dr. R.S. Yadav, Department of Geography, Arunachal University, Doimukh, Itanagar, Arunachal Pradesh).

5. Studies on ecology of Kala Bans (*Eupatarium adenophorum* Sprengel). (Dr. M.P.S. Arya, Hill Campus -Ranichauri, G.B. Pant University of Agriculture and Technology, Pantnagar, U.P.).

6. Recovery of degraded ecosystem by mixes of woody species of varying symbiotic associations. (Dr. S.P. Singh, Botany Department, Kumaun University, Nainital, U.P.).

7. Conservation and propagation of three endemic endangered and rare plant species of Saharanpur-Siwaliks, Doon valley and lower Mussoorie forests. (Dr. Y.P.S. Pundir, Department of Botany, DBS (PG) College, Dehradun, U.P.).

8. Studies of genetic diversity and improvement of Seabuckthorn (*Hippophae* L.), a multi-purpose plant of cold desert Himalaya. (Dr. Virendra Singh, Department of Agroforestry and Environment, Himanchal Pradesh Krishi Vishwavidhyalaya, Palampur, H.P.).

9. Exploration of Amphibion fauna of Arunachal Pradesh with emphasis on the conservation measures, reproductive behaviour and ethnozoological information.

(Dr.(Mrs.) Sabitry Chowdhury, Department of Zoology, Cotton College, Guwahati, Assam).

10. Comparative environmental investigation in Dewalgarh and Bachhangad catchments, Garhwal Himalaya, U.P. (Dr. G.S. Rawat, Department of Geology, HNB Garhwal University, Srinagar, Garhwal, U.P.).

11. Building a model plan for biodiversity conservation and socio-economic development of the people in the buffer zone of Parks based on sustainable eco-tourism. (Mr. Mahendra Singh Kunwar, Himalayan Action Research Centre (HARC), Dehradun, U.P.).

12. Biodiversity of *Dendrobium* (Orchidaceae) in North-Eastern India: Studies on their conservation for sustainable use. (Dr. Yogendra Kumar, Department of Botany, North Eastern Hill University , Shillong, Meghalaya).

13. Standardization of propagation and afforestation techniques of shrubs of Western Himalaya. (Dr. P.S. Chauhan, Department of Silviculture and Agroforestry, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P.).

14. Vano main agni ke prabhawon ke prati janjagrukata evam vaigyanik sodh tatha sanrakshan-sambandhit vibhinna ghatakon ke madhya samanjasya sthapita karana. (Mr. Bhupendra Singh Bhandari, Society for Entirety and Efficacious Development, Srinagar, Garhwal, U.P.).

15. Commercial viability and strategy for success of eco-friendly agro-based and forest-based industries in U.P. hills. (Dr. K.S. Negi, Department of Commerce, HNB Garhwal University, Srinagar, Garhwal, U.P.).

16. Aspects of ascariasis and hookworm infections in tropical and montaneous high rain fall areas of Meghalaya: An investigation into transmission dynamics and anthelmintic efficacy of a putatively curative plants. (Dr. (Mrs.) Veena Tandon, Department of Zoology, North Eastern Hill University, Shillong, Meghalaya).

Financial commitments of twenty-six on-going projects were also fulfilled during the year. Seven projects were completed and recommendation of these projects were sent to the concerned user departments of State/ Central Government for follow-up action/ replication. For wide dissemination of research findings the executive summaries of these completed projects were sent for publication in the ENVIS Bulletin of the Institute. Monitoring of thirty-eight on-going projects was done through the evaluation of Annual Progress Report by subject experts whereas six field oriented on going projects were got monitored through Expert Committees by spot evaluation. Follow-up actions on the suggestions of experts/expert committees were also initiated during the year. In all, follow-up action on ninety-five projects files was initiated during the year. Of these, ten project files were completed in all respects and closed. During the year fifty-four projects were ongoing in ten States of Indian Himalaya. According to the suggestion and approval of the Project Evaluation Committee (PEC) the project profile of the programme (i.e. IERP) was modified during the year and printed for the use of prospective PIs. For the finalisation of pending fresh/ revised project proposals during the year seventh meeting of the PEC under said programme was organised at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) on August 21-22, 1996. Seven members including the Chairman, nominated by Ministry of Environment & Forests, Govt. of India, attended the meeting. Follow-up action on the recommendations of the PEC was also initiated/completed during the year.

3.6.2. Environment Awareness Programmes

For wide dissemination of natural resource conservation and management message, a two day workshop was organized by the Institute at Govt. Inter College, Lohaghat, Pithoragarh from November 20 to 21, 1996. About fifty-six students and teachers representing seventeen schools/colleges of Pithoragarh district actively participated in the workshop. Recent techniques of biodiversity assessment and conservation were discussed in details during the workshop.

World Environment Day was organised by the Institute all across the Himalaya. Plantation programme at Katarmal Campus and a group discussion among the staff were organised at the Headquarters, Kosi, Almora. Himachal Unit of the Institute organized a public forum discussion GREEN MANALI-CLEAN MANALI at Manali by involving local people, NGOs, forest department officials and representatives of schools and scientific organizations of the area. The discussions during this occasion were focused on on-going garbage problem in Manali town, land and forest degradation, declining air and water quality, etc. The scientists of the Unit also highlighted Institute's efforts in garbage management and air monitoring work initiated at Manali and adjacent areas of the Himachal Unit. Garhwal Unit celebrated World Environment Day in Dugar Gad Catchment of Pauri Garhwal by involving local inhabitants, Mahila Mangal Dal women and children. To begin with, each participant brought a container of water from a nearby stream and watered the plantation raised by the Institute. Issues on local environmental problems were also discussed during the occasion. North-East Unit of the Institute celebrated World Environment Day at Dimapur, Nagaland that was attended generally by the local people whereas Sikkim Unit of the Institute organised it at Gangtok by involving local teachers and officials of various departments.

World Biodiversity Day was also celebrated by the Institute all across the Himalaya. At Headquarters local school/college level students and teachers, Institute scientists and project staff participated in the meeting. Issues relating to Himalayan Biodiversity Conservation: Issues and options were discussed during the occasion. Some school/college students were also declared winners based on their deliberations during the occasion. Garhwal Unit celebrated it at a remote and high altitude village, Reni, in Nanda Devi Biosphere Reserve (NDBR). Participants, including women and children, were the inhabitants of buffer zone of the Reserve. Activities initiated by the Institute on the aspects of biodiversity conservation particularly in NDBR were discussed during the meeting. Himachal Unit celebrated World Biodiversity Day by involving students and teachers of Day Star School, Manali. Himalayan biodiversity and its importance were the main aspects of the discussion. A competition on essay, poems and drawing for school and college level students was organised by Sikkim Unit of the Institute at Gangtok jointly with WWF-India, Sikkim Field Office. After deliberations winner students were awarded prizes. North-East Unit also celebrated it at Dimapur by involving local inhabitants, students and teachers.

3.6.3. On-site Training Programme

The Fifth On-site Training Programme to villagers/farmers/rural women for three days on nursery development, tree plantation techniques and natural resource conservation and management was organised by the Institute from February 2 to 4, 1997 at Chhamgaon village, South Sikkim, Sikkim. Forty five trainees from four remote villages of South Sikkim (i.e. Chhamgaon, Jaubari, Dhanbu Dara and Mamaly) attended the on-site training programme. The programme was inaugurated by Mr. Bishnu Lal Shetriya, the oldest person of Mamlay village, and presided over by the Scientist Incharge of Sikkim Unit on 2nd February 1997. The Scientist of INHI

Core and Sikkim Unit imparted the training to the trainees. The trainees welcomed this activity and positive response from the trainees indicated an urgent need to create environmental awareness through on-site training programmes among villagers/ farmers/ rural women working particularly in the other remote villages of the Indian Himalaya.

Fig. 18. On-site training programme at Chhamgaon village

3.6.4. Dissemination of information through networking

The Institute is actively involved in the dissemination of knowledge through in house publications, such as Hima-Paryavaran, Annual Report and ENVIS Bulletin were distributed during the year to 215 NGOs, 108 Academic/ Scientific/ Government Departments and 380 subject experts working on various aspects of Himalayan Environment and Development.

Since the inception of the Institute a number of NGOs, academic, scientific, defence, medical and village level institutions are seeking technical and scientific inputs from the Institute. Therefore, inputs on various aspects of Himalayan environment and development were provided by the Scientists of the Institute to fifteen Academic/ Scientific/ Govt. Department, ninety-five villagers/ farmers/ rural women, forty-three ex-service army personnel, fifty-five in-service persons and sixty-five representatives of various NGOs during the year. Valuable scientific and technical inputs especially in the field of medicinal plants were also provided during the year to the medical students and teachers of Tibetan Medical and Astrological Institute of HH the Dalai Lama, Dharamshala, Himachal Pradesh. This activity will be continued and strengthened further.

3.6.5. Strengthening of Central Nursery at the Headquarters

The availability of appropriate plant material is an important prereqisite to the success of many eco-development programmes. Furthermore, *ex-situ* conservation is considered a viable option for complimenting *in-situ* activities. Maintaining the important Himalayan germ plasm through developing and strengthening nursery is an effective approach for *ex-situ* activity. For ensuring uninterrupted distribution of plant material to the rural inhabitants for the use in agroforestry and rehabilitation of degraded lands and also to the R&D organisations for scientific screening/ evaluation, the central nursery at the Headquarters of the Institute was maintained and developed further during the year. Thirty-six thousand and fifty (36,050) seedlings/saplings of forty-five promising mountain trees were raised in the nursery during the year. Of these, eight thousand (8,000) seedlings of various trees were distributed to the villagers/farmers/rural women of central Himalaya whereas four thousand two hundred and eighty (4,280) seedlings/ saplings of different trees were distributed to various R&D institutions for research purpose during the year. The nursery also remained income generating during the year.

3.6.6. 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. Project funding was pursued through UNESCO and other agencies.

2. Coordinator continued to work on Resource quality of inputs in various systems.

3. Vice chairman/his nominee has presented the progress of work at Governing Council meeting and ensured support to SARNET from Core funds.

4. Networking with individual scientists and database compilation continued.

3.6.7. Environmental Information System on Himalayan Ecology

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

Result and Achievements

1. ENVIS bulletin 4(1) was published and 4(2) is ready to be published.

2. 125 quaries were handled during the year to provide services.

3. Data bases were expanded with view to provide services for experts and publications on Himalayan Ecology.

4. Attempts were made to prepare an interactive database for landuse in U.P. Hills.

3.6.8. Mountain Environment and Natural Resources Information System Programme

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

Result and Achievements

1. Review of progress was done and the ongoing programmes are scheduled for compilation during the year.

2. The work of NGO, Dhauladhar Public Education Society of Kangra, was supported for agricultural support area redevelopment.

QUICK APPRAISAL STUDIES

Community based rapid assessment of biodiversity conservation prospects in North East India

North East India represents the trasition zone between the Indian, Indo - Malayan, Indo - Chinese biogeographic region as well as a meeting place of Himalayan mountains with that of Peninsular India and therefore act as a biogeographic gateway. About 8000 species of flowering plants are expected to grow here. This region is considered a sanctuary of ancient angiosperms, as a number of primitive flowering plants are found here. As such, this area is considered as a cradle of flowering plants.

The unique and rich floral diversity along the altitude gradient from flood plains of the great Brahamaputra to snow capped peaks in North East Region of India supports a diverse terrestrial and avian faunna. These faunnal elements have evolved, over a millennia, in intricate association with the communities distributed along the mountain and hill slopes. North East region of Indian forests form important habitats of a number of mammalian species and breeding grounds of a diverse avi-fauna. The animals comprising a total of 11 order, 21 families, 86 genera, 148 species and 186 sub-species (BHCP 1993) has been reported from this region. Altogether about 50% of the mamalian species are endemic to this region (SAARC, 1992). Out of 16 species of primates found in India, 11 sps. have been reported from this region. The state of Arunachal Pradesh alone have reported 9 sps. of primates (Jerdon, 1874; Pocock, 1939; Prater, 1948; Roonwal and Mohnot 1977). Out

of 71 species of birds, globally threatened and reported 53 species in India are found in North East region (Bhattacharjee, 1996). Most of the endemic bird and animal species of the region are rare and on the verge of extinction. It is also note worthy to mention that of the 36 feline species found the world over, India alone has 15 spp. and within India North East region have a representation of 9 species, such as clouded leopard, marble cat and golden cat are endemic to this region.

Like in most mountaineous regions, the natural forest is an indispensible component in the traditional agro - ecosystems of the mountain environment in the North Eastern region in India (Changkija 1996). The people engage in collecting, grazing, hunting and selected logging activities in the forests to supplement their needs and to earn cash income to supplement their farm production. Plant collected in the forests include edible fruits, seeds, flowers, leaves, tubers, mushrooms, bamboo shoots and stems; in addition, as many a hundred medicinal plants, fibre and weaving materials, and dying materials are gathered from the natural forests. Hunting provides a means of procuring a source of animal protein for mountain people as well as of earning cash income by selling furs and certain parts of the animals which are used for medicinal purposes. Villagers in the area do not log trees throughout the entire forest area does it but selectively in specific areas. In this respect, there are a diverse variety of non-timber products which are valuable for home consumption and for sale in local markets. The important aspects of these activities is that they do not result in forest degradation because collection is controlled, certain part of the plants only are collected, and the quantity harvested is not excessive because local needs are limited. The tribals of north eastern uplands of India primarily practicing Swidden cultivation subsists mainly on cultivated cereals and a few selected vegetable crops. They however are also directly dependent on the natural forest for all other subsidary food requirements, medicine, building materials, fuels etc. Even today, the degree of dependency and the relationship that ensues is close one specially in the rural areas. As Ramakrishnan (1992) rightly commented, their livelihood persuits with the surrounding forest and forest related activities reveals an amazing understanding of their environment. This understanding coupled with their subsistance requirement gave rise to development of survival strategies based on the local resources. Over the years, this has given rise to a unique cultural mechanism of resource management practices that allow the harvesting of resources without endangering their natural assetts and their very survival (Fig. 19 & 20).

Another important aspect is the existence of sacred forests are usually strategically located and collectively owned by the community. In such sacred forests were performed all the important religious rituals and ceremonies. Such forests were believed to be the abode of the spirits. It was taboo to cut trees, hunt games or even collection of herbs and children were strictly restricted from entering such forest for fear that the rage of the spirits will befall them if the forest is disturbed in any way.

However, the process of change has brought a change in their philosophy. Thus although the beliefs exist, it is not seriously considered nor do the people adhere to the practices prescribed.

Fig. 19. Community reserve forest

Fig. 20. Minor forest products sold in the market

On the other hand, as local population pressure increases and marketing linkages with the outside are introduced, loss of idigenous control over collection of valuable forest products. This is evidenced by the fact that in those villages located near the township the natural forest areas are practically gone to make way for the expanding towns.

The traditional utilization of diverse biological resources in the region reflects a diverse resources use patern, but also the way of maintaining biodiversity in mountain ecosystems by the mountain people (Fig 19 & 20). Here the natural resources management systems are localised systems which form a basis for decision making for rural people, since the majority of the farming systems and all production systems in the region operate through indigenous knowledge systems.

As in the case of the Nagas, every tribal community of the region have their customary laws and traditional rights to land and its resources. For an effective implementation of communnity based conservation of biodiversity in the region, it is pertinent to have proper unnderstanding of the operation of such laws and rights and the institutions that maintains and regulate them. Formulation of community based conservation strategies should aim at reviving the age-old tribal knowledge and the involvement of the traditional system of management. In this context, it is of importance to state that the village council, which is a traditional institution of village administration is recognised and is protected by the law as per the provisions of Article 371A of the Indian constitution. It consists of representatives of all the different clan units of the village who are well versed in the history and customary laws and rights of its community. The decisions and the authority of the council within its territory is undisputed and binding for all practical matters and issues.

The Nagar follow an indigenous system of land holding wherein, land is divided into three categories:- (a) Individual holding, (b) clan holding, and (c) village holding. In each of these three categories of holding, land is classified into two types: (i) Forest lands and (ii) Jhum lands or cultivable lannds. The areas under jhum lands are used for cultivation purposes on a rotation basis. The areas under forest lands are usually kept preserved for minimal foraging and extraction of materials for house building and firewood etc. It is further pointed out that the social organisation of tribal societies emphasizes on enhancement of the spirit of community welfare. Such in-built community spirits combined with their intuitive ecological understanding could be positively explored for conservative purposes.

While urbanisation and commercialisation is a symbol of modernisation, the forces of which can not be stopped; the prospect of establishing community based conservation system by harnessing the traditional system of village administration and land use pattern offers ample scope and needs further investigation.

For evolving suitable conservation strategies for various species at risk it would be essential to catalogue these to begin with. Detailed biological conservation studies should follow the initial process of identification of species and their habitat and threats to their continued survival. The

members of the community may then be educated on the importance of conservation. The Govt agencies of NGO's efforts at conservation should aim at motivating and involving the people at the grass root level. Strategies of conservation should be formulated on the basis of the understanding of the local situation. Since forests and it's resources management system is a participatory system, direct communal involvement should be invited and encouraged. As far as possible the conservation programmes should aim at utilising and strengthening the local enforcing bodies like the village councils. This will ensure the commitment of the community towards the conservation efforts.

Environmental Assessment of recent landslides in Kalimpong Sub-division of West Bengal in the Darjeeling Himalaya

Background

A landslide event of large magnitude consisting of numerous landslides in Kalimpong Sub-division of Darjeeling Himalaya took place on 12th July 1996. This caused tremendous loss of lives and property on a single calamitous night. Good farm lands with standing crops and human settlements were perished apart from so many lives. These landslides occurred following torrential rains of high intensity lasting over 5 days preceeding these hazardous evtents. The affected areas are near Burbut Devithan in Nimbung village (claiming nearly 7 lives) and near community center of Gestok village (claiming nearly 19 lives). An assessment of two big landslide sites of Burbut devithan was undertaken to understand the causes and implications.

Observations

1. Land use at both the sites were observed as agriculture, livestock rearing and settlements within the main body of slides. Open forest exists near the crown and main scarp portions. These sites have an elevation range of 900 meters to 1200 meters. The toe portions almost reach upto to Turung khola (stream) which finally drains into Tista river. Slope was observed in the range of 45o to 55o in a direction of N120o. The width of surface of rupture and the displaced mass was found to be 20 to 120 meters; slope length along the main body including zones of depletion, accumulation and displaced material upto the toe is 120 to 350 meters.

2. Geologically, these areas show occurrence of mica schist and garnetiferous mica schist as predominant lithology. The affected sites showed the presence of highly weathered mica schist as bed rocks. Thus, the cause of these slides seem to be heavy water saturation of these weathered rocks and soils during the high intensity rainfall leading to finite shear failure in the form of rotational slides. The sliding movements perceptibly took place on the circular or near circular surface of failure.

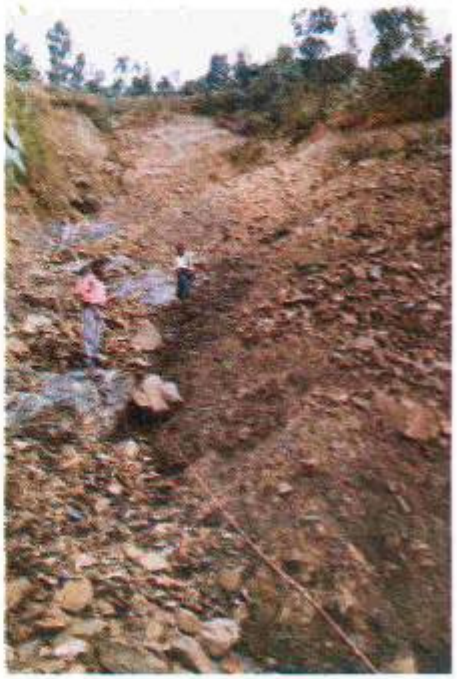

Fig. 21. Field documentation of landslide

Fig. 22. Affected agricultural field

3. Therefore, the inferred causes are inhospitable geological conditions as the presence of highly weathered rocks coupled with anthropogenic activities as farming and the high intensity rainfall. The calamitous proportions of these environmental events require in-depth researches on assessment of risks, monitoring and control measures in such Himalayan terrain (Fig. 21, 22 & 23).

Fig. 23. A village house cluster in the dangerous vicinity of the site

4. MISCELLANEOUS ITEMS

4.1. Addition to Library

Eight hundred and forty-seven (847) books were added in the library during the year. The total number of books available in the Library is 6769. A total of 115 international and national periodicals are being subscribed in the library including 15 periodicals subscribed by the ENVIS Centre on Himalayan Ecology at the Institute. Databases of library have been updated. Yearwise volumes of published research papers, popular articles, and books (1989-96) have been updated. Articles Alert Services are being provided by the library. A number of very useful books have been received from the Environmental Information System (ENVIS) Centre. Some books were also received from International Centre for Integrated Mountain Development (ICIMOD), Kathmandu. Library is also receiving complimentary copy of international journal "Mountain Research and Development" from ICIMOD.

4.2. Visitors

Dr Edwin Bernbaum, Senior Fellow, The Mountain Institute, Franklin, West Virginia, USA visited Garhwal Unit of the Institute on 14th September, 1996 and the Head Quarters of the Institute on September 24- 25, 1996. At both places he delivered a talk on "Sacred Mountains of the World". He also visited Hanumanchatti and participated in the Third Ritual Distribution of Tree Seedlings and Plantation Ceremony organised under Badrivan Restoration Programme (BRP) of the Institute on 19th September, 1996. He subsequently made the assessment of the above mentioned programme (BRP).

4.3. Membership of Professional Societies

- Indian Plant Tissue Culture Association (**L.M.S. Palni**)
- Member, Steering Committee on

Rathangchu Hydel Project, Sikkim (1996-continuing) (**E. Sharma**)

* Chairman Multidisciplinary High Level Committee on Rathangchu Hydel Project, Sikkim (since 1997) (**E. Sharma**)

* Member, Governing and Executive Councils, State Science and Technology Council, Sikkim (1996-continuing) (**E. Sharma**)

* Indian Society for Plantation Crops (**S.K. Nandi**)

* Ecological Society of America (since 1997) (**R. C. Sundriyal**)

* World Federation of Culture Collection, Netherlands (**Anita Pandey**)

* Member for the State Level Biodiversity Committee, Shimla (State Council for Science, Technology and Environment) (**H.K. Badola**)

* Members of Advisory Committee for Improved Forest Management Practices, Indo UK HP Forestry Project, Department of Forest Farming and Conservation, Govt. of Himachal Pradesh (**H.K. Badola and S.C.R. Vishvakarma**).

* Association of Microbiologists of India. (**Anita Pandey**).

4.4. AWARDS

* Vishisht Vaigyanik Puraskar for 1995 awarded by the Ministry of Environment and Forests, Government of India, Paryavaran Bhawan, New Delhi in recognition of work in the area of Ecology, Eco-regeneration and Conservation of Natural Resources. (**E. Sharma**)

* Internship Award on Mountain Agrobiodiversity and Crops Research Management was conferred to **Dr. R.K. Maikhuri** by International Center for Integrated Mountain Development, Kathmandu, Nepal which has been availed at ICIMOD in terms of 5 weeks training programme from January 9 to February 17, 1996.

4.5. Publications of the Faculty

4.5.1. Scientific Papers

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4.5.2. Popular Articles by Faculty

Airi, S. & Jyoti Upreti (1996). Himalay Ki Uchch Shikhariy Aushadhi Padap Prajatiya-Sanrakshan and Uses. In: Dhar et al. (ed) Himalay Ki Jav Vividhata Sanrakshan Mei Janta Ki Bhagidari : GBPIHED, Katarmal, Almora, 37-67.

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Badola, H.K. & Y.K. Bhatt (1996). Pastures in Kanawar Wildlife Sanctuary : Conservation Potential. Hima-Paryavaran *7(2)-8(1):* 19-20.

Bag, N., S.K. Nandi & L.M.S. Palni (1995/96). Mass scale propagation of tea. Hima Paryavaran *7 & 8:* 14-16.

Bisht, B.S., B.P. Kothyari, S.K. Bhuchar and L.M.S. Palni (1996). The Pivotal role of women in Central Himalaya: A case study from village Arah. ENVIS, Vol 4(1), 3-11.

Dhar, U., S.S. Samant & R.S. Rawal (1996). Himalay Ki Jav Vividhata Sanrakshan Mei Janata Ki Bhagidari : III (ed.). GBPIHED, Kosi-Katarmal, Almora. 77 pp.

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Kumar, K. and G.S. Satyal (1996). Jav Vividhata Sanrsyan Hetu Mrada Tatuon kaa Adhiyan, Dhar, U., S.S. Samant and R.S. Rawal (eds.) Himalayan kee Jav Vividhata, Sanrsyan mai Janata kee Bhageedari, Gyonadaya Prakashan, Nanital. pp. 46-50.

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Negi, G.C.S., V. Joshi & K. Kumar (1996). Drinking water issues in the hills- Diagnosis of the problem and some remedial measures. In: Proceedings of a Seminar on Water Management in the Himalayan Regions of India. Society for Himalayan Environmental Rehabilitation and Peoples' Action, Lucknow. pp.153-63.

Rai, S.C., & R.C. Sundriyal (1996) Pipon System: a traditional conservation practice in north Sikkim. Hima-Paryavaran 7(2) & 8 (1) : 16-17

Rawal, R.S. (1996). Javik Samuday, 1. Sanrachnatmak vividhata. In: Dhar et al (ed) Himalay Ki Jav Vividhata Sanrakshan Mei Janta Ki Bhagidari : BPIHED, Kosi-Katarmal, Almora. 40-45.

Samant, S.S. (1996) Champawat Tahsil Ki Jav Vividhata : Ek Avlokan. In: Dhar et al. (ed.) Himalay Ki Jav Vividhata Sanrakshan Mei Janta Ki Bhagidari, GBPIHED, Kosi-Katarmal, Almora, 14-33.

Sharma, S., A.K. Mishra and S.K. Nandi (1995/96). Iodine evam manav swasth. Hima-Paryavaran *7 & 8* : 23-24.

Sharma, R., Sundriyal, R.C. & E. Sharma (1996) Himalayan alder: Potential and prospects for sustainability. SSS Newsletter 9(2): 8-11.

Upreti Jyoti, A.Tewari, E.A. Siril, I.D. Bhatt and D.S. Mehta (1996). Bahu Upyogi Prajatiyo Mei Pravardhan Vidhiyo ka Adhyyan In: Dhar et al. (ed) Jav Vividhata Sanrakshan Mei Janta Ki Bhagidari, GBPIHED, Kosi-Katarmal, Almora, 68-75.

4.6. PARTICIPATION IN SYMPOSIA/ CONFERENCES

Seminar on Cash Crops and Vegetable Cultivation for Rural Development organized by Society for Himalayan Agriculture and Rural Development, Augustmuni (Chamoli). 22 May, 1996. **(R.K. Maikhuri).**

Seminar on Water Management in the Himalayan Regions of India organized by Society for Himalayan Environmental Rehabilitation and Peoples' Action, Nainital. 22-23 August, 1996 **(G.C.S. Negi).**

Seminar on Rabbit Rearing and Regional Development organized by Society for Environment, Education and Development (SEED) at Chopta (Chamoli). 25-26 September, 1996. **(R.K. Maikhuri).**

Internship Fellowship Programme on Mountain Agrobiodiversity and Crops Research Management organized by the Mountain Farming System Division of International Center for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal. January 9-17 February, 1997. **(R.K. Maikhuri).**

Seminar on Environmental Problems and Solution in Hill Area of Uttar Pradesh organized by the Environment Directorate, Uttar Pradesh at Srinagar-Garhwal. 27 March, 1997. **(R.K. Maikhuri & A.S. Rawat).**

Jal Samagam: Paiyjal Par Kendrit Karyshala organized by Peoples' Association for Hill Area Research and U.P. Academy of Administration, Nainital. 29-30 March, 1997. **(G.C.S. Negi).**

Paharon Mein Swachh Satat Paiyjal Apurti Hetu Prabandhan organised by Sri Bhubneshwari Mahila Ashram, Tehri Garhwal. 3-4 April, 1996. **(G.C.S. Negi).**

Project Monitoring Working session, Organised by Biodiversity Conservation Network, USA, at Martam village, East Sikkim, during 1 - 5 May, 1996. **(R.C. Sundriyal, S.C. Rai & E. Sharma)**

Expert Meeting on Agriculture Biodiversity Management at India International Centre, New Delhi, organised by ICINOD diring 17 - 18 July 1996 **(E. Sharma, K.S. Rao, R.K. Maikhuri)**

Expert Meeting on Rangeland and Pastoral Management at ICIMOD during 4 - 6 November 1996 **(R.C. Sundriyal & N.A. Farooquee)**

International symposium on Open IGBP/ BAHC-LUCC joint Inter - core Projects Symposium on Interactions Between the Hydrological Cycle and Land-use/cover, held at Kyoto, Japan during November 4 - 7, 1996 **(S.C. Rai)**

APO World Conference on Green Productivity at Manila, Philippines during 2 -4 December 1996 **(R.C. Sundriyal)**

Landslide Hazard Zonation organised by Central Building Research Institute, Roorkee, and Department of Science and Technology, Government of India and Sikkim State Science and Technology Council, held at Gangtok during March 3 - 4, 1997 **(A.P. Krishna)**

Participatory Monitoring Working Session organised at Martam Village for Langtang Ecotourism Project (Nepal), Makalu-Barun Conservation Area Project (Nepal) and Sikkim Biodiversity and Ecotourism Project (Sikkim) during March 7 - 9, 1997 **(S.C. Rai, R.C. Sundriyal & E. Sharma)**

Participated in seminar on "Solid Waste Management : A Developing Countries Perspective" organized by National Council of Development Communication, New Delhi, September 28, 1996 **(A.P. Jain and A.S. Shannigrahi).**

Seminar on Planning and Development of Kullu Valley, organized by Department of Country and Town Planning, Govt. of Himachal Pradesh, Shimla, October 12 13, 1996, Kullu, **(J.C. Kuniyal and S.C.R. Vishvakarma)**

4.7. TRAINING COURSES/ WORKSHOPS

Rural Environment Management Training Course sponsored by British Council Division, British Deputy High Commission, Calcutta and Coordinated by Centre for Arid Zone Studies, Univerisity of Wales, Bangor, U.K. and Xavier, Institute of Management, Bhubneshwar from 27, January to 4, April, 1997 **(S.S. Samant).**

Regional Kharif Crop workshop organized by G.B. Pant University of Agriculture and Technology Hill Campus, Ranichauri (Tehri Garhwal). 15 May, 1996. **(R.K. Maikhuri).**

Indian Building Congress on Built Environment and Natural Hazard organized by Indian Building Congress, Vigyan Bhawan, New Delhi. 7-8 February, 1997. **(V. Joshi).**

Workshop on Futuristic Model Habitat organized by Wadia Institute of Himalayan Geology, Pauri-Garhwal. 7-9 March, 1997. **(V. Joshi).**

Indo-U.S. Workshop on Palaeoseismicity (with Reference to Seismic Hazard Assessment in the Himalaya) organized by Wadia Institute of Himalayan Geology, Dehra Dun. 26-28 March, 1997 **(V. Joshi).**

Regional Workshop on Nursery Development, Training and Technique of Afforestation Programme organised by Biomass Research Centre, HAPPRC, HNB Garhwal University, Srinagar (Garhwal). 27-28 March, 1997. **(R.K. Maikhuri).**

National Seminar on Backward Communities: Identity, Development & Transformation, M.B. Govt. P.G. College, Haldwani. November 15, 1996 **(P.K. Samal)**

International Workshop on Global Advances in Tea Science. Organised by National Institute of Science, Technology and Development, New Delhi, 10-12 October, 1996. **(Anita Pandey & L.M.S. Palni).**

International Workshop on Prospects of Medicinal Plants, Dr Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan, H.P. 4-9 November' 1996. **(M. Nadeem).**

Symposium on Plant Physiology for National Development, Bose Institute, Calcutta. 17-19 December, 1996. **(S.K. Nandi).**

Twelfth Plantation Crops Symposium, Kottayam, Kerala. 27-29 November, 1996. **(Poonam Vyas).**

National Seminar on Conservation, Banaras

Hindu University, Varanasi. 5-7 December, 1996. **(S. Sharma).**

National Symposium of Plant Tissue Culture Association Meeting, Osmania University, Hyderabad. 29-31 January, 1997 **(L.M.S. Palni)**

Study Visit to Biocontrol of Plant Diseases Laboratory through sponsorship of USDA, International Cooperation & Development, Research & Scientific Exchange Division, Beltsville, Maryland, USA11 July - 9 August, 1996. **(Anita Pandey).**

Delivered lecture on "Domestication Strategy for Himalayan Medicinal Plants of Economic Value" in National Workshop on "Harvesting Herbs - 2000, HAPPRC. HNB Garhwal University, Srinagar, October 1996 **(U. Dhar).**

Invited to deliver Keynote Address on "Conservation and Endangered species and ecosystems - Ecological and Biological Approaches, Banaras Hindu University, Varanasi, December 1996 **(U. Dhar).**

Delivered lecture on " Role of Taxopomists and Para-Taxanomists in Enriching Data base on Biodiversity, in National Workshop on 'Capacity Building in Taxonomy in India". Jaipur, February 1997 **(U. Dhar).**

Biodiversity Conservation Prioritisation Project, Project Design Workshop, organized by WWF, New Delhi, India from 18-19 April, 1996 **(S.S. Samant).**

Field Workshop for School children, as first phase of International Day of Biodiversity, Manali, 12 December, 1996 **(H.K. Badola).**

NGO Workshop, Astitva Ke Liye Sangarsh, organized by Sadprayas, Kullu, 11-14 January, 1997 **(H.K. Badola).**

Proposed Mid term Review Workshop of FREEP-Great Himalayan National Park, Mohali - Kullu, 2 March, 1997 **(H.K. Badola).**

Delivered lecture on " Introducing Biodiversity on International Day for Biodiversity, to students of Trinity School, Mohal Kullu **(H.K. Badola).**

Brain Storming Session on Himalayan Biodiversity Conservation organized by GBPIHED (CBD), Kosi-Katarmal, India on September 2, 1996 **(U. Dhar, H.K. Badola, S.S. Samant, R.S. Rawal, Sabodh Airi, Jyoti Upreti, Anurag Tewari, E.A. Siril, I.D. Bhatt).**

National Seminar on Tribal Development Options organized by GBPIHED, Kosi-Katarmal, almora from 22-24 May, 1996 **(S.S. Samant).**

Delivered lecture on resource use pattern of natives of West Himalaya to Candian Students during Summer Programme from 17-28, June, 1996 **(S.S. Samant).**

International Symposium on Sustainable Utilization of Biodiversity, organized by Sai Institute of Environmental and Reliable Distributors, at Indira gandhi National Forest Academy, Dehradun, India, from 8-10 March, 1997 **(R.S. Rawal).**

Participated in Project Assessment Workshop on Great Himalayan National Park, Shamshi Kullu (H.P.). 2 February, 1996 **(H.K. Badola, J.C. Kuniyal & S.C.R. Vishvakarma).**

Brain storming session on Himalayan Biodiversity, GBPIHED, Kosi Almora. 2 September, 1996 **(H.K. Badola)**

3rd Training Workshop, Jav Vividhita Sanrakshan me Janta Ki Bhagidari, Organized by CBD, GBPIHED (Kosi Almora), Lohaghat. 20 21 November, 1996 **(H.K. Badola).**

Field Workshop for school children, as first phase of International Day for Biodiversity, Manali. 12 December, 1996 **(H.K. Badola)**

Participated and delivered a lecture on,

Tourism and Environment' in Seminar on Paryatan Vikas ka ek marg (in Hindi) organised by Sadprayas, Kullu (H.P.), 11 13 January, 1997 **(H.K. Badola, J.C. Kuniyal & S.C.R. Vishvakarma)**

Participated in a Multi country field visit to On the job training sites in Sichuan, China. 1 4 September, 1996 **(J.C. Kuniyal)**

Gender issues in energy and environment management. TERI, New Delhi, August 17, 1996. **(B.S. Bisht and S.K. Bhuchar).**

Participated in 22nd WEDC Conference : Reaching the Unreached Challenges for the 21st Century organized by Water, Engineering and Development Centre, Loughborough University, Leicestershire, England in collaboration with IPHE, India at New Delhi, 9 13 September, 1996 **(A. P. Jain, J.C. Kuniyal & A.S. Shannigrahi)**

Participated in seminar on "Solid Waste Management : A Developing Countries Perspective" organized by National Council of Development Communication, New Delhi, September 28, 1996 **(A.P. Jain and A.S. Shannigrahi).**

Seminar on Planning and Development of Kullu Valley, organized by Department of Country and Town Planning, Govt. of Himachal Pradesh, Shimla, October 12 13, 1996, Kullu, **(J.C. Kuniyal and S.C.R. Vishvakarma).**

Management Development Programme on Women and Environment towards Sustainable Development, Organised by Indian Institute of Forest Management, Bhopal, May 13 - 17, 1996 **(N.A. Farooquee)**

Regional Pilot Training on Landslide Hazard Management and Control in the Hindu Kush Himalaya, organised by ICIMOD at Kathmandu during 13 May to 7 June 1996 **(A.P. Krishna)**

4.8. MEETINGS

Annual Review Meeting on Biodiversity Conservation within the context of Traditional Knowledge and Ecosystem Rehabiltation (MacArthur Foundation - UNESCO Project) organized by French Institute of Pondichery at Pondichery. 5-6 October, 1996. **(R.K. Maikhuri & Sunil Nautiyal).**

Meeting on Joint Forest Management in U.P. Hills organized by U.P. Forest Department at U.P. Academy of Administration, Naini Tal. 15-16 November, 1996. **(G.C.S. Negi).**

Himalayan Ecosystem Studies organized by Space Application center, Ahmedabad. 18 January, 1997. **(V. Joshi).**

A public forum discussion (meeting) on Green Manali Clean Manali, Phase II for World Environment Day celebration, Manali. 5 June, 1996 **(H.K. Badola & A.P. Jain)**

Meeting on Improved Forest Management Practices (IMPs) at Department of Forest, Govt. of Himachal, Shamshi. 30 08 1996 & 23 11 1996. **(S.C.R. Vishvakarma).**

International Day for Biological Diversity organised by G. B. Pant Institute of Himalayan Environment & Development, Himachal Unit, Shamshi Kullu, Venue: Trinity School, Mohal Kullu, 29 December, 1996 **(H.K. Badola, A.P. Jain, J.C. Kuniyal & A.S. Shannigrahi)**

State Level Biodiversity Committee Meeting, organized by the State Council for Science, Technology and Environment, Shimla. January 6, 1997 **(H.K. Badola)**

State Forest Research Advisory Committee Meeting organized by Principal Chief Conservator, Uttar Pradesh, Lucknow on January 7, 1997 **(S.S. Samant).**

A public forum discussion (meeting) on Green Manali Clean Manali, Phase II for World

Environment Day celebration, Manali. 5 June, 1996 (**H.K. Badola & A.P. Jain**).

International Day for Biological Diversity organised by G. B. Pant Institute of Himalayan Environment & Development, Himachal Unit, Shamshi Kullu, Venue: Trinity School, Mohal Kullu, 29 December, 1996 (**H.K. Badola, A.P. Jain, J.C. Kuniyal & A.S. Shannigrahi**).

Meetings were held at Biodiversity Conservation Network, United States' Agency for International Development and World Bank at Washington DC, The Mountain Institute, Franklin, University of West Virginia, Morgan Town; Colorado State University, Fort Collins; Oregon State University, Corvallis and at Indiana University, Bloomington, during November 29 - 17 December 1996 (**E. Sharma**).

5. STATEMENT OF ACCOUNTS

I.C. Sanghal & Co.
Chartered Accountants
17, Rajpur Road, Dehradun-248001
Phone (0135) 654607, 653402 Fax: (0135) 723831

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

A.K. Jain
B.Com., F.C.A.

To
Director
G.B. Pant Institute of Himalayan Environment & Development
Kosi-Katarmal, Almora 263 643

Dear Sir,

We have examined the Balance Sheet of G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT as on 31.3.97 and the Income & Expenditure A/c 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 accounts 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 not visited by us, subject to the comments given below.

In our opinion and to the best of our information, and according to the information and explanations 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 31.3.97;

ii) in the case of Income & Expenditure A/c of the Income of its accounting year ending on 31.3.97.

For I.C. Sanghal & Co.,
CHARTERED ACCOUNTANTS.,

Sd/-
A.K. JAIN
(Partner)

Seal
17-Rajpur Road, Dehradun.
Dated: 29.8.97

I.C. Sanghal & Co.
Chartered Accountants
17, Rajpur Road, Dehradun-248001
Phone (0135) 654607, 653402 Fax: (0135) 723831

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

NOTES FORMING PART OF THE REPORT ON THE STATEMENT OF ACCOUNTS OF G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT, KOSI, ALMORA - 263 643. FOR THE YEAR ENDING 31-3-97 AND ANNEXED TO THE BALANCE SHEET OF EVEN DATE.

1. Books of Accounts have been maintained in cash basis subject to para 4 below.

2. Depreciation has not been provided on fixed assets in the accounts and value has been shown at cost.

3. All purchase of consumables, laboratory expenses, chemicals, glasswares, stores, and stationery etc. have been charged to Income and Expenditure Account at the time of purchase.

4. Interest on Fixed Deposits has been provided on accruals basis.

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

6. Provident Fund liabilities and investments of the institute has been incorporated in the statement of accounts.

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

8. Outstanding enteries pending adjustments in the Bank Reconciliation Statement needs to be rectified.

9. Deposit for Construction of Rs. 12,39,19,000 with C.C.U. (M.E. & F.) New Delhi, needs to be adjusted as a part of the building have been completed.

10. Annexure 'A' to 'M' and '1' to '34' are integral part of the Statement of Accounts prepared for the year.

For I.C. Sanghal & Co.,
CHARTERED ACCOUNTANTS.,

Sd/-
A.K. JAIN
(Partner)

Seal
17-Rajpur Road, Dehradun.
Dated: 29.8.97

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

BALANCE SHEET AS ON 31st MARCH 1997

PARTICULARS	ANN	AMOUNT	AMOUNT
SOURCE OF FUNDS:			
General Fund:			
Last Balance:		1469499.14	
Additions for the year:		972791.00	2442290.14
Endowment Fund:			
Last Balance:		1963222.81	
Add: Interest Earned		210481.00	2173703.81
Fixed Assets Fund:			
Last Balance:	58797802.31		
Additions for the Year:	11886937.00	70684739.31	
Less: Sale during the Year:		257077.00	70427662.31
Construction Fund:			
Last Balance:		108906377.00	
Addition for the year:		15012623.00	123919000.00
Provident Fund:			
Last Balance:	1941774.40		
Additions for the year:	769763.00	2711537.40	
Less: Payment during the year:		61740.00	2649797.40
Project Funds: 1			
Research & Development Fund:		2960183.34	
Construction Fund:		56319.00	
NEC Shillong Fund:		(6981.00)	
IERP Project Fund:		5.51	
ENVIS Project Fund:		(113692.00)	
DST\SKB\Project Fund:		922.00	
DST\RSR\Project Fund:		1032.00	
DST (RKM) Project Fund:		5869.00	
CSIR\HCR/GCSN\Project Fund:		4761.00	
BIOTECH (I) Project Fund:		(14953.00)	
BIOTECH (II) Project Fund:		(413897.00)	
BIOTECH (III) Project Fund:		3437738.00	
IEG Project Fund:		30795.00	
UNDP (Haigad) Project Fund:		(54849.00)	
Balance Carried Forward:		5893252.85	201612453.66

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

BALANCE SHEET AS ON 31st MARCH, 1997

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward:		5893252.85	201612453.66
Project Funds (Brought Forward)			
CSIR (RCS) Project Fund:		437.00	
DST (SKN) Project Fund:		78908.00	
ICIMOD Project Fund:		43151.05	
TSBF Project Fund:		(25695.00)	
INDO CANADIAN Project Fund:		(300366.00)	
ICIMOD SALT Project Fund:		(62990.79)	
ICIMOD ISSMA Project Fund:		253975.00	
GIS TRAINING Programme Fund:		116965.00	
MACARTHER UNESCO Proj.Fund:		(48514.00)	
ECO TOURISM Project Fund:		207406.00	
AGRICULTURE BIO DIV.Fund:		140000.00	
LAND USE Project Fund:		32324.00	
WWF (UD) Project Fund:		65609.00	
ICIMOD (CBD) Project Fund:		510266.00	
ICIMOD (PARDYP) Project Fund:		722081.00	
ICIMOD (FIBRE) Project Fund:		104045.00	7730854.11
Other Liabilities:			
Group Saving Link Insurance:		200.15	
CPF Payable		93.00	
Salary Payable		5466.70	
ST Payable		671.00	
Medical Claim Payable		230.00	
Security Payable		8000.00	
Advance (K.S.RAO)		1990.00	
ADVANCE (SALT) NE UNIT		49906.00	66556.85
TOTAL RS..			209409864.62
APPLICATION OF FUNDS:			
Fixed Assets:	33	70427662.31	
Deposits with:			
CCU for Construction:		123919000.00	
SP.LAO for Land:		80000.00	123999000.00
Security Deposits:		32721.00	
Closing Balances:	34	14950481.31	
TOTAL RS..		209409864.62	

As per our separate report of even date.

Sd/-
(Finance Officer)

(Seal)

Sd/-
(D.D.Officer)

Sd/-
(Director)

Sd/-
A.K.JAIN
(Partner)
I.C. SANGHAL & Co.
CHARTERED ACCOUNTANTS
17-Rajpur Road, Dehra Dun
29 AUG 1997

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

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH, 1997

PARTICULARS	ANN	AMOUNT	AMOUNT
INCOME (Grant in aid):			
Designated Project Grant For:			
RESEARCH & DEVELOPMENT			
AND OTHER EXPENSES:		25400000.00	
CONSTRUCTION WORK:		12000000.00	
IERP Project:		3904138.02	
ENVIS Project:		225000.00	
DST(SKB) Project:		200000.00	
CSIR (HCR/GCSN) Project:		54100.00	
BIOTECH (I) Project:		175000.00	
BIOTECH (II) Project:		237700.00	
BIOTECH (III) Project:		315000.00	
UNDP (HAIGAD) Project:		51000.00	
CSIR (RCS) Project:		52243.00	
ICIMOD Project:		176802.00	
TSBF Project:		213807.00	
ICIMOD (SALT) Project:		212243.00	
MACARTHER UNESCO Project:		298030.00	
ECO TOURISM Project:		856207.00	
ICIMOD (FIBRE) Project:		105631.00	
ICIMOD (CBD) Project:		547516.00	
ICIMOD (PRDYP) Project:		819706.00	
LAND USE Project:		100000.00	
WWF (UD) Project:		100000.00	
CSIR (RS)		19665.00	
AGRI.BIO DIV.Project:		140000.00	
INDO CANADIAN SUMMER PROGRAMME		150000.00	46353788.02
Less: Tfd.to Designated Funds For:			
RESEARCH & DEVELOPMENT			
AND OTHER EXPENSES:		25400000.00	
CONSTRUCTION WORK:		12000000.00	
IERP Project:		3904138.02	
ENVIS Project:		225000.00	
DST(SKB) Project:		200000.00	
CSIR (HCR/GCSN) Project:		54100.00	
BIOTECH (I) Project:		175000.00	
BIOTECH (II) Project:		237700.00	
BIOTECH (III) Project:		315000.00	
UNDP (HAIGAD)Project:		51000.00	
CSIR (RCS) Project:		52243.00	
ICIMOD Project:		176802.00	
TSBF Project:		213807.00	
ICIMOD (SALT) Project:		212243.00	
MACARTHER UNESCO Project:		298030.00	
ECO TOURISM Project:		856207.00	
ICIMOD (FIBRE) Project:		105631.00	
ICIMOD (CBD) Project:		547516.00	
ICIMOD (PARDYP) Project:		819706.00	
LAND USE Project:		100000.00	
WWF (UD) Project:		100000.00	
CSIR (RS)		19665.00	
AGRI.BIO DIV.Project:		140000.00	
INDO CANADIAN SUMMER PROGRAMME		150000.00	46353788.02

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

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING ON 31st MARCH 1997

PARTICULARS	ANN	AMOUNT	AMOUNT
Interest From Banks:		547502.00	
Other Income:			
Sale of Scrap:		1320.00	
Sale of Vehicle:		325648.00	
Licence Fee:		20309.00	
Water Testing Fee:		18750.00	
Nursery:		1580.00	
Miscellaneous:		182672.00	
Sale of Tender:		300.00	550579.00
Designated Grant Utilised For:			
RESEARCH & DEVELOPMENT AND OTHER EXPENSES:		24949763.45	
CONSTRUCTION WORK:		14912623.00	
IERP Project:		3904136.00	
ENVIS Project:		509462.00	
DST (SKB) Project:		199475.00	
NWDPRA Project:		129935.00	
Balance Carried Forward:		44605394.45	1098081.00

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

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING ON 31st MARCH 1997

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward:			1098081.00
Desig. Grant Utilised Contd:			
Funds (Brought Forward):		44605394.45	
CSIR (HCR/GCSN) Project:		53504.00	
BIOTECH (I) Project:		281566.00	
BIOTECH (II) Project:		578647.00	
BIOTECH (III) Project:		734389.00	
UNICEF Project:		9624.00	
IEG Project:		43365.00	
UNDP (HAIGAD) Project:		84327.00	
CSIR (RCS) Project:		162744.00	
DST (SKN) Project:		438096.00	
ICIMOD Project:		265840.00	
TSBF Project:		282734.00	
INDO CANADIAN Project:		404451.00	
ICIMOD (SALT) Project:		387168.79	
ICIMOD (ISSMA) Project:		192294.00	
MACARTHER UNESCO Project:		366485.00	
ECO TOURISM Project:		754461.00	
CSIR (RS) Project:		19665.00	
WWF (UD) Project:		34391.00	
LAND USE Project		67676.00	
ICIMOD (PARDYP) Project:		97625.00	
ICIMOD (CBD) Project:		37250.00	
ICIMOD (FIBRE) Project:		1586.00	
NORAD Project:		47059.21	
INDO CANADIAN SUMMER PROGRAMME		150000.00	50100342.45
TOTAL INCOME (A):			51198423.45
EXPENDITURE:			
Project Expenditure:			
RESEARCH & DEVELOPMENT AND OTHER EXPENSES:	2	14019695.45	
IERP:	4	3904136.00	
ENVIS:	5	378318.00	
DST (SKB) Project:	6	199475.00	
NWDPRA Project:	7	65077.00	
CSIR (HCR/GCSN) Project:	8	53504.00	
BIOTECH (I) Project:	9	281566.00	
BIOTECH (II) Project:	10	534920.00	
BIOTECH (III) Project:	11	475989.00	
UNICEF Project:	12	9624.00	
IEG Project:	13	24500.00	
UNDP (HAIGAD) Project:	14	84327.00	
CSIR (RCS) Project:	15	113976.00	
DST (SKN) Project:	16	114924.00	
CSIR (RS) Project:	17	19665.00	
WWF (UD) Project:	18	34391.00	
LAND USE Project:	19	67676.00	
ICIMOD Project:	20	265840.00	
TSBF Project:	21	282734.00	
Balance Carried Forward		20930337.45	

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

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING ON 31st MARCH 1997

PARTICULARS	ANN	AMOUNT	AMOUNT
Project Expenditure Contd:			
Expenditure (Brought Forward):		20930337.45	
INDO CANADIAN Project:	22	404451.00	
ICIMOD SALT Project	23	387168.79	
ICIMOD ISSMA Project:	24	192294.00	
MACARTHER UNESCO Project:	25	366485.00	
ECO TOURISM Project	26	686526.00	
ICIMOD (PARDYP) Project	27	97625.00	
ICIMOD (CBD) Project	28	37250.00	
ICIMOD (FIBRE) Project	29	1586.00	
NORAD Project:	30	47059.21	
INDO CANADIAN SUMMER PROGRAMME	31	156000.00	23300782.45
Tfd. to CCU for Capital Expenditure			14912623.00
Capital Expenditure:			
RESEARCH & DEVELOPMENT:			
Libary:	3631652.00		
Scientific Equipments:	5120861.00		
Office Equipments:	536377.00		
Furniture:	1006141.00		
Vehicle:	574075.00		
Fire Fighting Equipments	60962.00	10930068.00	
Scientific Equipments:			
ENVIS Project:	131144.00		
NWDPRA Project:	64858.00		
BIOTECH (II) Project:	43727.00		
BIOTECH (III) Project:	258400.00		
CSIR (RCS) Project:	48768.00		
DST\SKN\Project:	323172.00		
IEG Project:	18865.00		
ECO TOURISM Project:	67935.00	956869.00	11886937.00
Loss on sale of Assets			125290.00
TOTAL EXPENDITURE RS.(B)			50225632.45
SURPLUS (A B)			
EXCESS OF INCOME OVER EXPENDITURE (TFD.TO GENERAL FUND A/C)			972791.00
TOTAL RS.			51198423.45

Sd/-
(Finance Officer)

Sd/-
(D.D.Officer)

Sd/-
(Director)

(Seal)

As per our separate report of even date.

Sd/-
A.K.JAIN
(Partner)
I.C. SANGHAL & Co.
CHARTERED ACCOUNTANTS
17-Rajpur Road, Dehra Dun
29 AUG 1997

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

RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31st MARCH 1997

PARTICULARS	ANN	AMOUNT	AMOUNT
RECEIPT			
Opening Balance	32	13111597.68	
Grant in aid For:			
Research & Development			
and Other Expenses:		25400000.00	
Construction Work:		12000000.00	
IERP:		3904138.02	
ENVIS:		225000.00	
DST(SKB):		200000.00	
CSIR(HCR/GCSN):		54100.00	
BIOTECH (I):		175000.00	
BIOTECH (II):		237700.00	
BIOTECH (III):		315000.00	
UNDP (HAIGAD):		51000.00	
CSIR (RCS) :		52243.00	
LAND USE :		100000.00	
WWF (UD):		100000.00	
CSIR (RS)		19665.00	
AGRI.BIO DIV.:		140000.00	42973846.02
Refund from NORAD		739189.00	
Interest From Bank:			
Institute		547502.00	
Endowment Fund		210481.00	757983.00
Security Received		7000.00	
Other Income:			
Sale of Scrap:		1320.00	
Sale of Vehicle:		200358.00	
Licence Fee:		20309.00	
Water Testing Fee:		18750.00	
Nursery:		1580.00	
Miscellaneous:		182672.00	
Sale of Tender:		300.00	425289.00
TOTAL RECEIPT RS..			58014904.70

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

RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31st MARCH 1997

PARTICULARS	ANN	AMOUNT	AMOUNT
PAYMENT:			
Project Payment For:			
Research & Development and Other Expenses:	2	14250698.05	
Construction Work:	3	14912623.00	
IERP:	4	3904136.00	
ENVIS:	5	378318.00	
DST (SKB) Project:	6	199475.00	
NWDPRA Project:	7	65077.00	
CSIR (HCR/GCSN) Project:	8	53504.00	
BIOTECH (I) Project:	9	281566.00	
BIOTECH (II) Project:	10	534920.00	
BIOTECH (III) Project:	11	475989.00	
UNICEF Project:	12	9624.00	
IEG Project:	13	24500.00	
UNDP (Haigad) Project:	14	84327.00	
CSIR (RCS) Project:	15	113976.00	
DST (SKN) Project:	16	114924.00	
CSIR (RS) Project:	17	19665.00	
WWF (UD) Project:	18	34391.00	
LAND USE Project:	19	67676.00	35525389.05
Capital Expenditure:			
RESEARCH & DEVELOPMENT:			
Libary:	3631652.00		
Scientific Equipments:	5120861.00		
Office Equipments:	536377.00		
Furniture:	1006141.00		
Vehicle:	574075.00		
Fire Fighting Equipments	60962.00	10930068.00	
Scientific Equipments:			
ENVIS Project:	131144.00		
NWDPRA Project:	64858.00		
BIOTECH (II) Project:	43727.00		
BIOTECH (III) Project:	258400.00		
CSIR (RCS) Project:	48768.00		
DST\SKN)Project:	323172.00		
IEG Project:	18865.00	888934.00	11819002.00
F.C.Inter Account:			2500.00
Balance Carried Forward:			47346891.05

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

RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING ON MARCH 31,1997

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward:			47346891.05
Closing Balance:			
Cash & Bank Balance:			
Cash in Hand (IC A/C)			
Almora:		5938.55	
Srinagar:		368.49	
Sikkim:		931.80	
Kullu:		1697.17	
Dimapur:		6461.45	15397.46
Cash at Bank (IC A/C)			
CBI Kosi A/c No.CD 14:		1110057.65	
SBI Almora A/C No.22752:		6549939.27	
SBI Almora A/C No.23884:		12270.81	
SBI Tadong A/C No.CA/4/65		509.22	
SBI Kullu A/C No.50201/7:		20637.81	
SBI Srinagar A/C No.3/615:		7397.72	
SBI Dimapur A/C No.C & 1/6/22:		134.16	7700946.64
Advances:			
House Building Advance:		83024.00	
Motor Cycle/Car Advance		132000.00	
Festival Advance:		6900.00	
Units of Institute:			
Garhwal:		82569.00	
Sikkim:		27422.00	
North East:		67810.00	399725.00
Fixed Deposit:			
With SBI Endowment Fund:		2023700.00	
Intt.Accrued on above		137733.00	2161433.00
Due Staff/Others (IC A/C)			
Director IARI		26.50	
G.C.S.Negi(CSIR)		2000.00	
A.S.Parihar:		389.00	
P.L.Gautam (WMP)		20000.00	
B.P.Kothyari		6000.00	
J.M.S.Rawat		4382.00	
S.P.Maikhuri (TTA)		7400.00	
LI COR inc.U.S.A.		1905.00	
R.K.Nanda & Sons:		28517.00	
Pertech Computers:		2000.00	
Employment News:		14150.00	
Balance Carried Forward:		86769.50	57624393.15

G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT, KOSI (ALMORA)
RECEIPT & PAYMENT ACCOUNT FOR THE YEAR ENDING 31st MARCH 1997

PARTICULARS	ANN	AMOUNT	AMOUNT
Balance Brought Forward:		86769.50	57624393.15
ECIL New Delhi (Biotech I):		204.00	
Sigma Aldrich Chemicals:		10590.00	
G.B.P.A.University (Biotech III):		10000.00	
Siltap Chemicals Ltd.(Biotech III):		16320.00	
Director FRI, Dehradun(ENVIS):		12800.00	
Employment News (DST SKN):		900.00	
Jain Scientific Instrument,Ambala		540.00	
CPF Account:		129.00	
N.R.S.A Hydrabad:		77600.00	
Shivalik Agro Products:		677.00	
Klenzaids Con.Controls Pvt.Ltd.:		57175.00	
M.P.C.B.:		16382.00	
Group Sav.Link Ins:		425.05	
CCU ME&F (Sub Station)		100000.00	390511.55
TOTAL PAYMENT RS...			58014904.70

As per our separate report of even date.

Sd/-
(Finance Officer)

Sd/-
(D.D.Officer)

Sd/-
(Director)

(Seal)

Sd/-
A.K.JAIN
(Partner)
I.C. SANGHAL & Co.
CHARTERED ACCOUNTANTS
17-Rajpur Road, Dehra Dun
29 AUG 1997

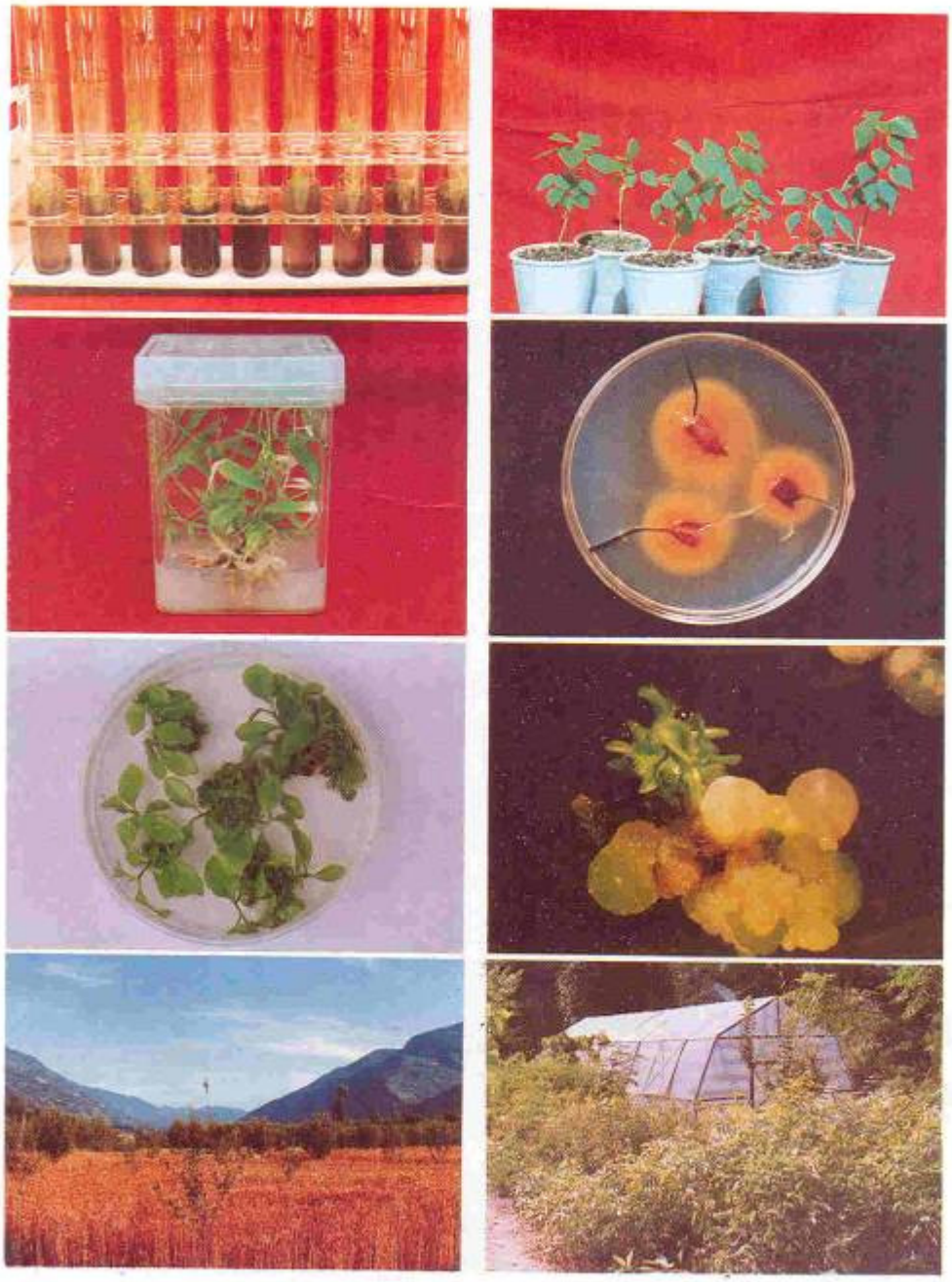
ABBREVIATIONS USED

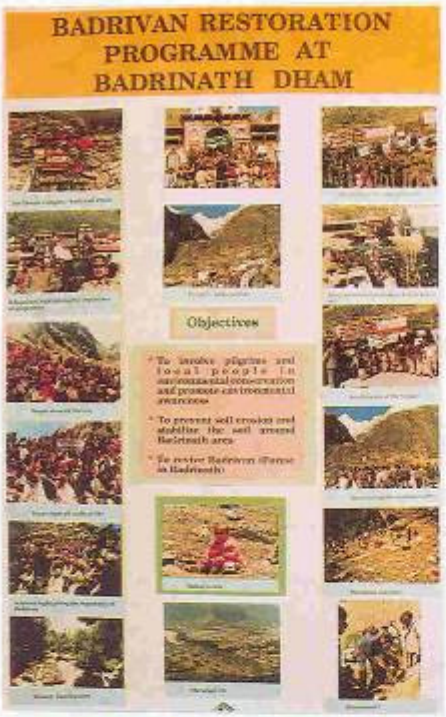
NORAD	:	Norwegian Agency for Development Corporation.
ICIMOD	:	International Center for Integrated Mountain Development.
TSBF	:	Tropical Soil Biology Fertility
IERP	:	Integrated Eco Research Program
ENVIS	:	Environmental Information System
DST	:	Department of Science & Technology
CSIR	:	Council of Scientific & Industrial Research
BIOTECH	:	Department of Bio-technology
NEC	:	North Eastern Council
NWDPRA	:	National Watershed Development Project for Rainfed Areas.
UNDP	:	United Nations Development Programme.
UNESCO	:	United Nations Educational Scientific and Cultural Organisation.
UNICEF	:	United Nations Children Fund.
IEG	:	Institute of Economic Growth
WWF	:	World Wide Fund for Nature.
SALT	:	Sloping Agriculture Land Technology.
ISSMA	:	Institutional Strengthening for Sustainable Mountain Agriculture.





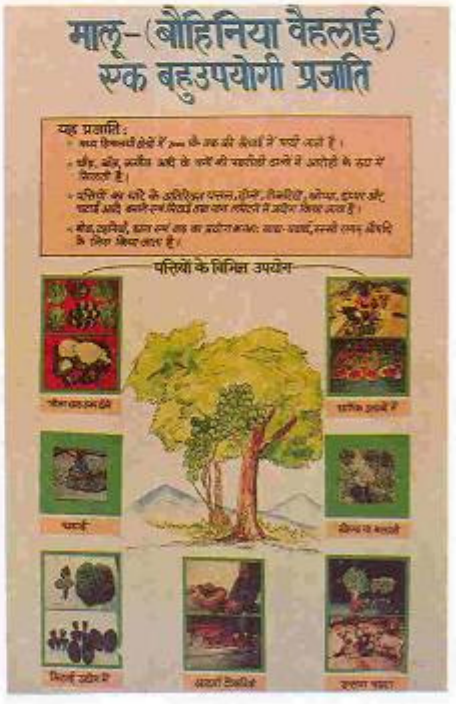


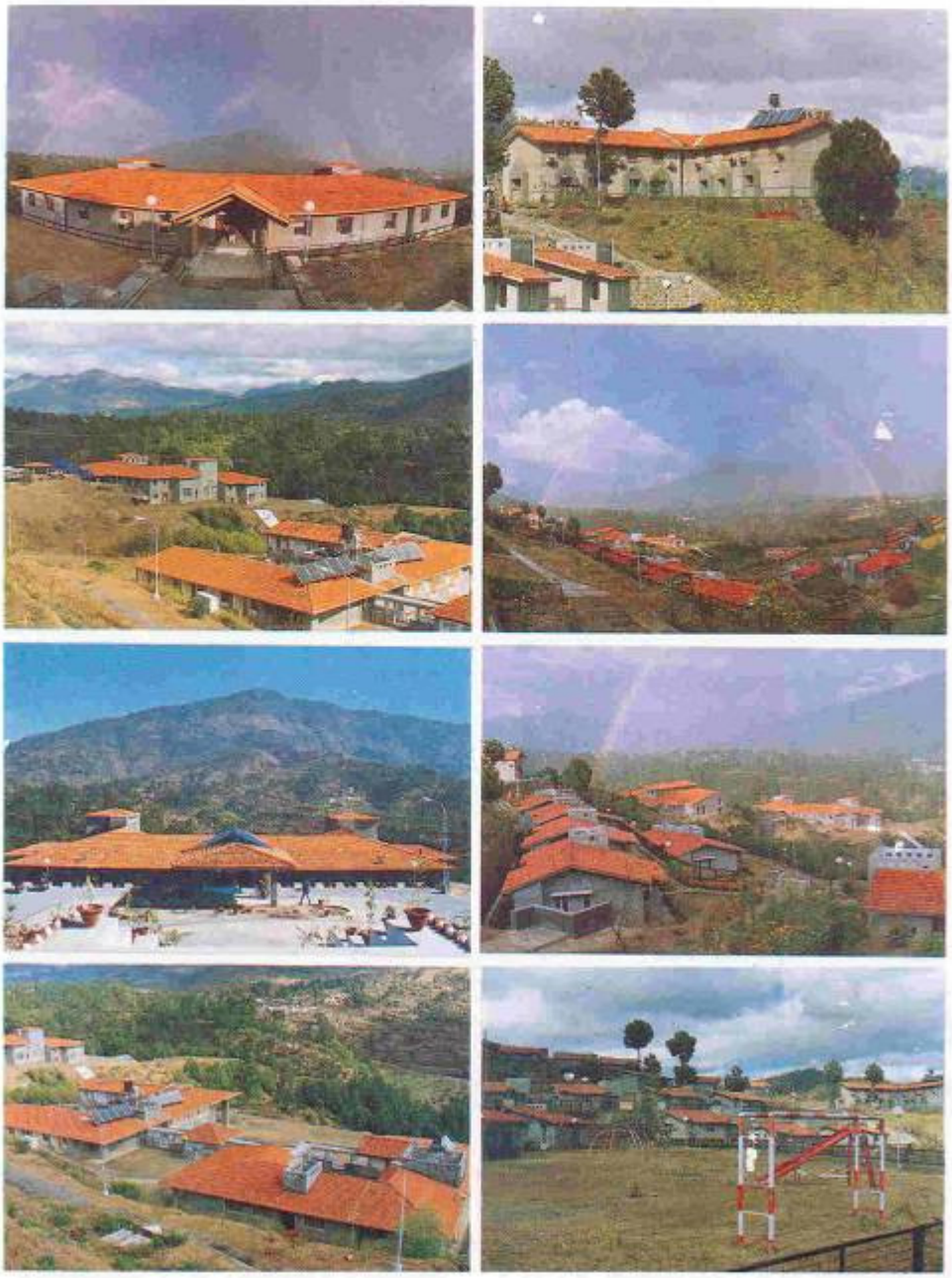




BADRIVAN RESTORATION PROGRAMME AT BADRINATH DHAM
Objectives
To involve pilgrims and local people in environmental conservation and promote environmental awareness
To prevent soil erosion and stabilise the soil around Badrinath area
To revive Badrivan (Forest in Badrinath)


PROJECT ON HIMALAYAN THREATENED PLANT SPECIES
TARGET SPECIES
OBJECTIVES
ACHIEVEMENTS
SURVEY AND IDENTIFICATION
SOIL ANALYSIS
COLLECTION OF GERMPLASM
NURSERY DEVELOPMENT
IN-VITRO TECHNIQUES
ELECTROPHORETIC STUDIES


TISSUE CULTURE STUDIES IN SOME WOODY SPECIES


मालू-(बौहिनिया वैहलाई)
एक बहुउपयोगी प्रजाति
पत्तियों के विभिन्न उपयोग



INSTITUTIONAL PUBLICATIONS

1991

* Agricualture Economy of Himalayan Region, Vol I Kumaon.

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 band 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.

1996

* Land Utilization in the Central Himalaya : Problems and Management Options.
* Tribal Development : Options
* Water Management in Himalaya Ecosystem : A Study of Natural Springs of Almora.

REGULAR PUBLICATIONS

Hima-Paryavaran (Newsletter-Biannual)

ENVIS Bulletin (biannual)

Annual Report