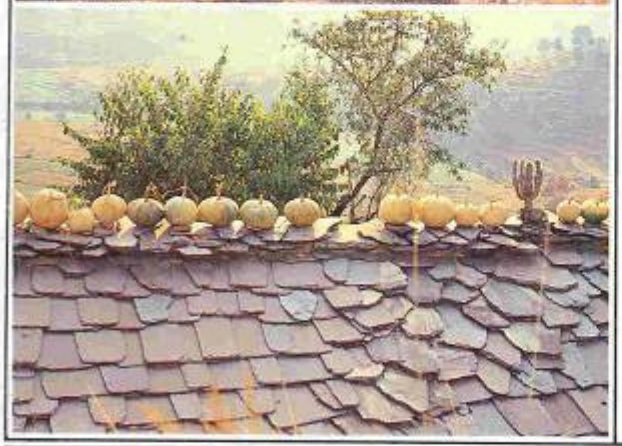
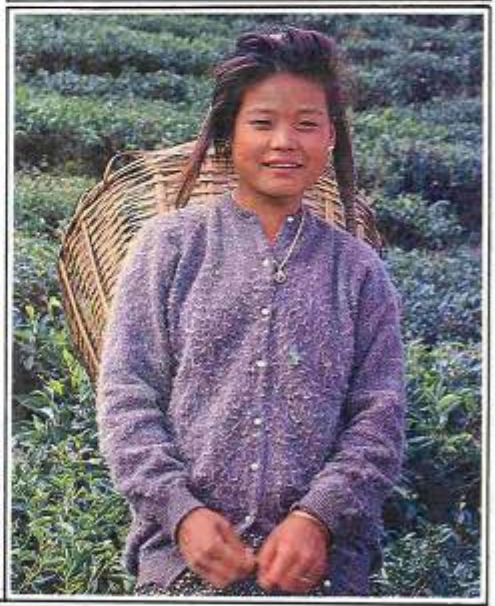


ANNUAL REPORT

1994-95



G.B. Pant Institute of Himalayan Environment and Development

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

Kosi, Almora-263643

INDIA

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ANNUAL REPORT

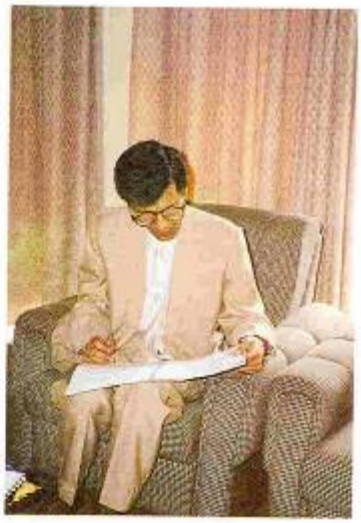
1994-95

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 1994-95 : AN OVERVIEW

The Institute continued to develop and carefully nurture a policy of description, prescription and demonstration. Following this basic philosophy the Institute has, during this year, added a few more Status Documents for various locations to its list of major publications given on the inside back cover. The demonstration sites are selected carefully with emphasis on local needs, attitude of the inhabitants, traditional knowledge base and their value as "models", rather than on easy accessibility and nearness to roadheads. At all times, a conscious effort is placed on supplementing local customs and indigenous practices, rather than outright replacement, in order to ensure peoples participation and acceptance for sustained development. To achieve "on site" development, Institute staff spends considerable time at these remote locations; we have realized only too well that development in the mountains can not be achieved through "remote control" approach.



The Institute is not deterred by its remote location, on the contrary it helps the Institute in defining its goals and in shaping various activities. However, Institute's growth depends on available manpower, funding and infrastructure. Some advances were made in this direction during the year. At present, the Institute has 29 scientific, 34 support and 36 project staff associated with various core programmes, spread across its various units. In addition to core funds from the Ministry of Environment & Forests, Govt. of India, present funding for the Institute has come from various national (DBT, CSIR, DST, UGC, INSA, NEC, Sikkim Govt.) and international (ICIMOD, UNESCO, NORAD, TSBF, UNICEF, UNDP/FAO/UNIDO, MacArthur Foundation & Indo-Canadian Foundation) agencies. This is an indication of the growing recognition of capabilities of the Institute and its staff. The residential complex and the Institute guest house are nearing completion at the Head Quarters and the construction of administrative block, laboratories and library, etc., is in progress; these are expected to be ready in 1996. The land for the Sikkim (Panthang) and Himanchal (Kullu) units has been acquired and the construction will start in the coming year. For the Garhwal (Srinagar) unit, U.P. Govt. has transferred a part of a building complex and the unit has started functioning from there. The Nagaland unit has been shifted to Dimapur.

The details of various ongoing projects are listed under appropriate Core Programmes in the text. Major R & D achievements are outlined separately, as are the milestone events for the year 1994-95. In conclusion, this document is a summary presentation of Institute's endeavour in coming a step closer to its mandate. The considered views and remarks on the achievements & activities of the Institute will be most welcome.

As my tenure of 5 years will be over in August 1995, I close this year's overview with a personal note. I record my pleasure at being privileged to lead this Institute since 1990. I am confident in its ability to continue to play an important role at the National and International level on mountain agenda.

A.N. PUROHIT
Director

MAJOR ACHIEVEMENTS

Development of agroforestry models using integrated watersheod management approaches in Mamlay watershed of Sikkim.

Designing, development and demonstration of adaptive mini-microhydel and cable way for transport of essential goods in a village located in Pranmati watershed in Distt. Chamoli.

Improvement of soil fertility status through development and demonstration of weed composting technology and use of nitrogen fixing trees.

Identification and promotion of value addition to wild edibles as a source for offfarm income generation.

Introduction of high value cash crops (e.g., hops, saffron, large cardamom, Bulgarian rose, etc.,) at various locations in Central & Eastern Himalaya.

Devlopment and Demonstration of : (a) Sloping Watershed Environmental Engineering Technology (SWEED); a packaoge for regeneration of degraded lands in hills, (b) Polypit technology for optimal-accelerated-grown of tree seedlings.

Establishment of a functional arboretum at Kosi and Panthang.

Development of Bioresource inventory of Himalaya with particular reference to endemics.

Development of vegetative propogation technology package for common Yew-A Himalayan asset under threat. Significant improvement in seed germination from less than 8% to above 75%.

Initiation of Badrivan restoration program at Badrinath. The basic philosophy of this program was highly appreciated in International NGO consultation meeting on the moutain agenda held in Lima, Peru from February 22-27, 1995.

Detailed documentation of status of Natural Water Spring of Almora town with reference to domestic swage disposal and recommendations for remedial measures.

Development of tissue culture laboratories at Kosi, Srinagar and Gangtok.

1. INTRODUCTION

The reporting year 1994-95 is the sixth financial year of research and developmental initiatives being carried out by the Institute, including its units, at various locations in the Indian Himalaya. These activities include programmes supported through core funds of the Institute and projects financed by external agencies, both national and international. All programmes are formulated with a strong focus on regional issues, and endeavour to seek practical and workable solutions to specific problems *pro bono publico* with peoples participation at all levels. The Science Advisory Committee of the Institute provides approval, general guidance and help for all programmes *ab initio*. At the present time, R & D activities of the Institute can be broadly classified into six designated Core Programmes. Some projects were successfully concluded during the year, summaries of these are placed at appropriate places in the text; in due course detailed documents will be published and made available to the public. The progress made during the year 1994-95 on various ongoing and newly initiated projects, and a brief account of academic and other activities, along with the statement of accounts, is presented in this report. We would be most grateful for critical comments, suggestions for improvement and for indication of our shortcomings by anyone interested in the well-being of Himalaya and its people.

2. MILESTONE EVENTS

* The Sikkim unit of the Institute hosted INSA seminar and council meeting on May 4-5, 1994 at Gangtok. A seminar on "Plant Wealth of India" was organised on this occasion as a part of the Diamond Jubilee Year celebrations of INSA.

* H.E. Shri Motilal Vohra, Governor of U.P. visited the Institute on May 9, 1994 to review the progress of R & D activities. He appreciated the initiatives taken by the Institute and assured closer cooperation between the State Government and the Institute. An Institute publication entitled "Hydropower management for sustainable rural development in remote unelectrified zones of Himalaya" was also released on this occasion.

* A seminar cum meeting on "Perception of Peoples' Representatives on Environment and Development" was organized in Joshimath, Chamoli on June 5, 1994. A total of eighty participants, including elected representatives and NGOs, attended the meeting. The seminar recommended setting up of demonstration farms for cultivation of high altitude herbs and restoration of surroundings.

* A workshop on medicinal plants and orchids was organized by the Sikkim Unit of the Institute, jointly with the Govt. of Sikkim and Sikkim Science Society on October 21-22, 1994 at Gangtok. The workshop was inaugrated by H.E. Shri P. Shivashanker, Governor of Sikkim, who also released an Institue publication entitled "Medicinal Plants of the Sikkim Himalaya: Status, Uses and Potential".

* The Institute celebrated its Fourth Annual Day Function at Guwahati on October 25, 1994 which was attended and graced, among others, by H.E. Shri Lok Nath Mishra, Governor of Assam, Honb. Shri Hiteswar Saikia, Chief Minister, Assam and Prof. U.R. Rao, Member, Space Commission, India. The highlight of the function was the IVth G.B. Pant Memorial Lecture entitled "Space for Sustainable Development with special emphasis on Himlayan Region" delivered by Prof. Rao. He outlined the role of space science in promoting education, particularly in the rural areas, in understanding complex and diverse issues like forest management, land/soil conservation, environmental pollution, and disaster management, etc. Two publications of the Institute, namely "Kaifal- A promising under exploited tree crop of the Himalaya", and "Environment Friendly Hill Development - an approach for District Chamoli", were also released on this occasion.

* Following a meeting with the Director General, ICIMOD and Secretary, ME&F, Govt. of India in April, 1994, ICIMOD Board of Governors and Support Group Meeting was organised in New Delhi in November, 1994.

* The Institute's experiences and attitudes were greatly appreciated in the "Regional Conference on Sustainable Development of the Fragile Mountain Areas of Asia" held on December 13-15, 1994 at Kathmandu, Nepal, and an "International NGO Consultation Meeting on Mountain Agenda" held on February 22-27, 1995 at Lima, Peru.

* Institute has initiated a training programme on Tree Plantation & Nursery Techniques for Environment and Nature Conservation. In this regard the first nine days training was given to army personnel from nearby areas from January 20-28th, 1995.

* A two day workshop on "Peoples participation in biodiversity conservation" was organized on March 21-22, 1995 at Gangolihat. Over two hundred and fifty participants attended the workshop.

* A workshop with emphasis on cash crops for the development of Himalaya was organized on March 27-29, 1995 at Kosi. Three experts, namely Drs Singh, Zutshi and Kitchlu from Regional Research Laboratory, Jammu-Tawi also attended and gave general advice on the cultivation of Hops and Saffron.

* A workshop regarding a binational project on "An empirical study of development of tribal communities from eco-cultural perspectives: a study in the Central Himalayan region of India" was held at Kosi on March 30-31, 1995.

* A technology package entitled "Sloping Watershed Environmental Engineering Technology" (SWEET) was released by the Institute during the year after conducting trials at several locations. It is presently being tested in 7 states of Indian Himalaya, namely J&K, H.P., Assam, Arunachal Pradesh, Mizoram, and in hills of U.P. & West Bengal by independent agencies through IERP.

* The Institute signed a Memorandum of Understanding with Shastri Indo-Canadian Institute, Calgary and the University of Western Ontario, Canada for a CIDA-SICI Partnership Programme. "Designing, developing and testing sustainable natural resource management models through peoples participation in critical villages in Nanda Devi Biosphere Reserve for achieving the objectives of conservation and biological resources in the Himalaya" was the theme of a MOU signed with UNESCO. Another MOU was signed with the Northeast Council for projet formulation in the field of Biodiversity Conservation.

3. RESEARCH AND DEVELOPMENT PROGRAMMES

As a general rule research and development programmes of the Institute are based on a multi-disciplinary and holistic approach with particular emphasis on interlinking of natural and social sciences to achieve sustainable development of the Indian Himalaya. In this process special attention is placed on the preservation of fragile mountain ecosystems, indigenous knowledge and customs. A consicuous effort is made to ensure participation of the local population for long term acceptance and success of various programmes. The R & D activities of the institute are centred around six core programmes, viz., Land and Water Resource management, Sustainable Development of Rural Ecosystems, Conservation of Biological Diversity, Ecological Economics and Environmental Impact Analysis, Environmental Physiology & Biotechnology, and Institutional Networking and Human Investment. The progress made in various projects during the year has been placed under appropriate core programmes in the text. The project implementaion sites are carefully selected, keeping in view the heterogeneous heritage of the

Himalaya along with the specific needs and aspirations of the local inhabitants. All activities are need based, target oriented and time bound; efforts are made to provide practicable solutions rather than theoretical prescriptions. Whenever required, field activities are supported by laboratory experimentation. 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 1994-95, alongwith a brief, conceptual background, specific objectives and major achievements are summarized for individual projects.

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 current year as a follow-up action with a view to develope a model at the farm level for demonstration. Based on the results of first phase of study as well as farmer's priorities, agroforestry models have been proposed at two different villages (one each in the subtropical and temperate zones) of the watershed. Various interventions in the form of technology packages, such as intensification of traditional crops, strenthening of fodder component, weed composting, use of symbiotic N_2-fixers and root associated diazotrophs for crop improvement, germination and growth of rare and potential wild edible species, introductory trials of some high value cash crops and resource management will be made. Apart from the above studies relating to two basic resources (soil and water) will be carried out further at the watershed level for better utilization and management. The natural resources of the watershed will be mapped in greater detail using satellite digital data, and a complete resource inventory will be made, and attempts will be made to quantify pressures on these resources.

Results and Achievements

1. A small farm family was taken as a unit with the aim of increasing the agriculture-cash crop production; a common priority of all farmers. About 8 acres of land was selected at Chhamgaun and work was initiated in 5 acres of abandoned land to protect soil erosion and increase productivity of the land. Both mechanical and biological interventions were used to stabilize soil by making small terraces using small stone walls and planting the terrace margins with *Thysanolcana maxima*, a grass which is used for fodder and for making brooms. Species of *Arundodonax*, a fodder species, which can be easily multiplied was also planted on steep sloppy lands. Napier grass and fodder trees (*Ficus* spp.) were also planted along terrace margins. To increase/maintain fertility of the soil, weed composting through vermiculture has been introduced. *Eupatorium* and other field weeds and unpalatable grasses/species are being used to make compost. Mixed forestry is being developed at higher elevations using *Michelia excelsa, M. lanuginosa, Alnus nepalensis, Symingtonia populnea, Machilus* sp., *Ficus roxburghii* and *F. hookerii*, etc. Apple trees have also been planted on trial basis.

2. Some high value crops were also introduced in Sikkim, which included saffron (*Crocus sativus*) and rose oil plant (*Rosa damascena*). Saffron has been planted at 3 different temperate and alpine sites viz. Jaubari (1800 m, south Sikkim), Pangthang (1900 m, east Sikkim) and Kyongnosla (3000 m, east Sikkim). About 80% germination of corms has been recorded this year, however, flowering has not occurred so far. *Rosa damascena* has been tried at 3 elevations; 1000 m (Kamrang, south Sikkim), 1700

m (Chhamgaun, south Sikkim) and 1900 m (Pangthang, east Sikkim). About 40% of the stem cuttings developed roots, and after transplantation 60% cuttings have survived.

3. Influence of N_2-fixing associates on dry matter production and biogeochemistry were intensively studied in large cardamom and mandarin agroforestry systems in the watershed. The temperate cardamom agroforestry system under the influence of N_2-fixing *Alnus* was more productive and showed faster nutrient cycling. The sub-tropical mandarin-based agroforestry is highly nutrient exhaustive and N_2-fixing *Albizia stipulata* enhances the rates of nutrient cycling; the role of *Albizia* would therefore seem indispensable in efficient managment of the mandarin agroforestry.

4. Detailed hydrological studies of the Mamlay watershed under different land-uses have been made. The overland flow of rainwater was 1853×10^6 liters from the agriculture area (1220 ha); highest of all the land-uses. Soil loss on total area basis was highest (582×10^3 t/year) from agriculture land-use followed by 4.6×10^3 t/year from temperate natural forest, 4.3×10^3 t/year from fallow land, 3.7×10^3 t/year from subtropical forest and lowest (2.8×10^3 t/year) from mandarin agroforestry systems. A total of 600×10^3 t/year soil was lost from above six land-uses of the watershed along with 3.0×10^3 kg nitrogen/year, 15.4×10^3 kg organic carbon/year and 0.9×10^3 kg total phosphorus/year.

5. Partitioning of incident precipitation into various path ways in different land-uses of the watershed was also made. Among the different land-uses stand throughfall (% of the incident precipitation) was highest (80%) in the temperate natural forest and lowest (33%) in *Cryptomeria* plantation forest. Floor leachates were 44% under temperate natural forest, 42% in plantation forest, 41% in cardamom agroforestry systems, 48.7% in mandarin agroforestry systems and 23% in subtropical natural forest.

6. Temperate natural forest (TNF) and sub-tropical natural forest (STNF) revealed a high diversity of plants using species area curve at three different locations in each forest type which vary from 44 to 66 and 39 to 66 species in 0.02 ha area in STNF and TNF, respectively. In TNF highest number of species was recorded in open areas (66) followed by close canopy forest (61), however, a low number of species(39) were recorded in planted sites. In case of STNF, low hill forest dominated with sal (*Shorea robusta*) showed highest species richness with 66 species, followed by mid hill forest (63). The temperate forest has shown a high diversity ($H=3.71$ to 4.65) and can be considered as one of the most diversified forests in the Himalaya.

7. An inventory of the soil resources of watershed for land-use planning purposes has been prepared using SPOT PLA scene and other collateral information. The soil-physiographic criteria have been adopted in view of the strong correlation of soil pattern and genesis with physiography. This has given rise to four soil physiographic units in this watershed; the soil associations of each unit have been worked out with nomenclature, properties and land-use practice being supported.

8. The land-use change detection studies have been carried out using IRS LISS II data for 1988 and 1992, in conjunction with additional SPOT MLA scenes of 1990 for better delineation of the land cover types. The forest cover shows progressively decreasing trend over the years 1988 (76.14%) - 1990 (69.94%) - 1992 (67.34%). Agricultural lands show a positive socio-economic impact, with progressively increasing trend over the years 1988 (15.43%)-1990 (20.28%)-1992 (23.69%); once again the environmental impact is negative as this land cover increase is mainly at the cost of forest cover. Built-up land/settlements do not show much change and as per SPOT data of 1990, 2.99 per cent area comes under this category.

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

Background

Based on the land use mapping of a watershed in Sikkim, the project aims to identify available resources and physical constraints. The main problem of upland farming systems is erosion; this will be 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 especially in monsoon. Different crop combinations and cropping pattern conserve soil, water and nutrients, and will be 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 agroforestry species will be, therefore, selected for future promotion.

Objectives

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, and identification of ecologically and economically useful agroforestry trees for the region.

Results and Achievements

1. Khanikhola (Melli Dara - Paiyong) watershed was selected and the area coverage under different land-use systems has been estimated using IRS IB LISS II imageries. Identification of cropping patterns and two major types of agroforestry systems (horticulture based and fodder based) has been completed. Physical and chemical analyses of soil and water have been carried out.

2. Survey of exsting crop legumes and tree legumes for N_2-fixation and nitrogen accretion studies has been done. Identification of raised bund species growing in the watershed has also been carried out.

3.1.3. Appropriate Technologies for Soil Conserving Farming Systems

Background

Inaccessibility and marginality in the mountains have promoted agricultural practices which are aimed at achieving food security at a local scale. While there are several positive aspects of traditional agriculture, such as high level of crop diversity, utilization of locally available organic resources for sustained yields, cooperation and social integration, there are some negative aspects also, e.g., increased levels of soil erosion, hydrological imbalance and forest degradation. This regional programme involving coordination of eight countries by ICIMOD seeks to evolve, test and demonstrate the environmentally sound upland agricultural systems considering the local environmental and socio-economic conditions.

Objectives

1. To develop prototype, cost effective sloping agricultural land technology (SALT) models in different agroecological zones and farming systems, which will enhance the productivity of agricultural land while conserving soil and its fertility.

2. To spread awareness about SALT through training, workshops, exchange of experiences and networking of national institutions/agencies in implementing the SALT programme; and to

introduce several other appropriate technologies such as polythene film technology and urea molasses block technology with the SALT system .

Results and Achievements

1. Two sites, one in village Changki, District Mokokchung, Nagaland, an area where shifting agriculture is the predominant agricultural system, and the other in Kumaon where upland terraced farming by settled farmers dominates the agricultural land use, were selected for the purpose of the project.

2. Socio-economic analysis of the target areas was undertaken to identify potential options for improvement in conservation efficiency of traditional agriculture. Work plan was finalized involving discussion with local farmers and the village institutions.

3. Land treatment using interventions like introduction of nitrogen fixing species as hedgerows, fast growing fuelwood and fodder species, will be completed before the onset of rainy season in the following year.

3.1.4. Integrated Watershed Management : Case studies in Garhwal Himalaya

This is an ongoing project. Please see Annual Report 1993-94 for background and objectives.

Results and Achievements

1. Drinking water sources of the catchment consist of 21 public taps, 9 naulas and 16 springs. Out of these only 3 functional taps, 5 springs and all naulas are utilized; the dependence upon these varies with season and from one household cluster to another. During summer, household water consumption is drastically reduced to about one-third of the normal consumption.

2. Rocks of the catchment are in the NW-SE direction. They consist of dark green to grey thinly bedded phyllite, alternating with hard grey phyllitic quartzite and thin bands of white to dull pale coloured quartzite. The thickness of quartzite bands varies from 50-75 m. At places, thin bands (1 to 2 ft.) of dark grey slates are observed in the phyllitic quartzite.

3. Distribution of catchment land into different slopes (14.3% land > 60°, 19.1% between 50-60°, 3.1% between 40-50°, 12% between 30-40°, 17.5% between 20-30°, 14.1% between 10-20°, and the remaining 19.8% land < 10° slope) indicates that about 51% land in the catchment is safe for terrace cultivation with regard to soil conservation; currently only 14% land is being cultivated.

4. Covering an area of 286 ha, **Srikot Gad** catchment (Fig 1) has three villages with a population of 501 belonging to 103 families. People own a total of 57.3 ha land, 1046 animal units, 136 hens, 1376 individuals of fodder/firewood trees, 363 fruit trees and 291 oak and pine trees.

Fig. 1. Location & Catchment area of Silt & Run off Post Srikot Gad

5. A comparative account of landuse of Dugar Gad and Srikot Gad catchments indicates similarities with regard to cultivated land, but large differences occur for other landuses (Table 1). Significant

differences in rainfall, run-off and sediment output were noticed for the two catchments. The greater water retention and low sediment output in Srikot Gad may be attributed to less degraded land and higher area under forested land.

Table 1. Landuse (expressed as percentage to the total geographical area), annual rainfall, run-off and sediment output from two representative catchments of Garhwal Himalaya.

Parameters	Dugar Gad (306 ha)	Srikot Gad (286 ha)
Landuse		
Cultivated land	37.60	38.00
Degraded land	53.30	12.00
Forested land	9.30	50.00
Hydrology		
Rainfall (m^3/ha)	18237.00	22300.00
Run-off (m^3/ha)	6658.60 (36.50)	535.50 (2.40)
Sediment output (Kg/ha)	10752.80	1679.70

6. Within the Dugar Gad catchment, 1.5 ha wasteland has been given by the inhabitants to establish a Land and Water Resource Management (LWRM) demonstration; the site has been fenced and a low-cost tank built. Water for this tank is derived from a near-extinct spring existing within the site. A nursery has also been developed at the site.

7. Vegetative measures to revive a near-extinct spring within the LWRM demonstration site include planting of *Alnus nepalensis, Prunus cerasoides* and *Quercus leucotrichophora* and prohibition of grazing in the upper catchment area of the spring. Daily monitoring has indicated 4017 l/d average discharge during winter (ranging from 2644 l/d in January to 6969 l/d in November).

8. With regard to resource-use pattern, villages of Dugar Gad catchment vary significantly. A total of 43.6 t foodgrain produced in the cropfields meets only one-third demand of the people, the remaining is met through market purchase. Annually 243 t fuelwood, 29300 litre kerosene oil, 37 t dung cake and 4.4×10^{10} kcal electricity (66% households are electrified) is used. Livestock dietary demand is met through 227 t handcut ground fodder and 87.2 t crop residue (available within the catchment), 12 t fodder purchased from outside and a substantial part through grazing in the catchment.

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

This is an ongoing project. Please see Annual Report 1993-94 for background of the project. The scope of this project has been extended to cover the Central Himalaya.

Objectives

1. Evaluation of existing irrigation and rural water supply systems of Central Himalaya for possible enhancement in their efficiency.

2. Study of drinking water supply levels in representative villages of the area including hydrological aspects of the existing water sources.

3. Development of location specific models for demonstration of low cost water harvesting, irrigation scheduling including the consumptive use estimation for tradionally grown crops.

Results and Achievements

1. In five development blocks of Pauri Garhwal, the Irrigation Department has employed five types of irrigation, covering a total of 4731 ha culturable command area (CCA).

2. Based on the data collected for Almora tehsil it was observed that CCA was 2229 ha in five blocks. A total of 1856 ha land is irrigated through canal irrigation. Other types of irrigation systems in use are: tank (239 ha), lift/pump (120 ha) and sprinklers (14 ha).

3. Out of these five blocks, Lamgarha block is having the highest irrigated land (30.6% of total CCA). The lowest irrigated land is in Hawalbagh block which is only 9.3% of CCA.

3.1.6. Development of Agroforestry Model in Garhwal Himalaya

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

Results and Achievements

1. The survival percentage for all species after 42 months in the agroforestry site remained same as it was after six months of plantation. However, in restoration site, majority of species have more than 52% survival. The maximum survival was recorded for species like *Prunus cerasoides, Sapindus mukorossi,* and *Dalbergia sissoo*.

2. The average growth of main axis and diameter at collar height in agroforestry site after 42 months of plantation was highest for *Alnus nepalensis*, followed by *Ficus glomerata*, and *Dalbergia sissoo* and least for *Pyrus pashia* and *Ficus auriculata*. However, on the restoration site species such as *Alnus nepalensis* and *Albizia stipulata* showed best performance.

3. Locally available mulch materials were applied in the restoration site to assess its direct impact on seedling survival, establishment and growth performence after 18 months of plantation. Majority of seedlings showed better survival and growth when treated with partially decomposed mulch of *Eupatorium* spp., *Colebrookia* spp. and *Artemisia* spp. Litterfall and decomposition studies have also been initiated recently on the agroforestry and restoration sites.

4. Following 42 months of transplantation in the agroforestry site, a total of six species have been assessed for biomass. The average biomass on dry weight basis was maximum for *Alnus nepalensis* (17.23 kg) followed by *Ficus glomerata* (11.85 kg), *Dalbergia sissoo* (11.73 kg), *Celtis australis* (9.93 kg), *Sapium sebiferum* (6.30 kg), and *Boehmeria rugulosa* (6.24 kg).

5. Cardamom was introduced in the restoration site in open condition (without shade) and in combination with *Alnus* trees. Cardamom being raised under *Alnus* is performing better.

3.1.7. Badrivan restoration programme at Badrinath Dham

Background

Badrinath Dham is situated in the gorge of Nar and Narayan hills at an elevation of 3,133 m above mean sea level and remains closed between middle of November to middle of May. In recent past, some government organisations have attempted tree plantations around the shrine and in adjacent areas. However, there has been little success. One of the reasons for this failure may be incorrect selection of species and age of the seedlings/saplings. Probably the species planted earlier did not tolerate the harsh climatic conditions during winter months. Therefore, proper selection of tree/shrub species would seem essential before initiating any afforestation drive in and around the shrine of Badrinath Dham.

Objectives

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

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

3. Revival of Badrivan.

Results and Achievements

1. Seedlings of 20 trees and 27 shrubs of less than 2 years and more than 2-3 years were collected from

their natural environment and planted for testing in and around the shrine of Badrinath Dham. The botanical names, local names in parentheses, of trees/shrubs used for testing in Badrinath Dham are given below :

Trees: *Quercus semecarpifolia* (Kharsu), *Q. floribunda* (Telonj), *Populus ciliata* (Syan), *Juglans regia* (Akhrot), *Alnus nepalensis* (Utis), *Betula utilis* (Bhoj-pattar), *B. almoides* (Saur), *Prunus cornuta* (Jamun), *P. jacquemontii* (Kursang), *Aesculus indica* (Pangar), *Acer caesium* (Kanchula), *A. acuminatum* (Rath-Kanchula), *Rhododendron arboreum* (Burans), *R. barbatum* (Semru), *Taxus baccata* (Thuner), *Abies pindrow* (Raga), *Pinus excelsa* (Kail), *Picea morinda* (Kathela), *Fraxinus xanthoxyloides* (Regcha), *Juniperus macropoda* (Palmar),

Shrubs: *Juniperus communis* (Jhora), *J. pseudo-sabina* (Bitaru), *Hippophae salicifolia* (Chuk), *Salix wallichiana* (Bhains), *S. elegans* (Bhotiana), *S. lindleyana, Cotoneaster disticha* (Kautia), *C. acuminata* (Cham-ruins), *C. microphylla* (Gheri), *C. lindleyi* (Dhuins), *Berberis asiatica* (Kingora), *B. jaeschkeana, B. kumaonensis, B. aristata, B. affinis, Ribes grossularia* (Lipchi), *R. orientale* (Darbag), *R. glaciale* (Darbia), *R. rubrum* (Kimkolia), *Viburnum cotinifolium* (Ghenu), *V. foetens* (Telanu), *V. stellulatum* (Maleo), *Rhamnus virgata* (Chedula), *R. prostrata* (Koni), *Rhododendron anthopogon, R. campanulatum* (Chimula), *R. lepidotum*.

2. It is interesting to note that seedlings of most of tree species (< 2 years) did not survive the harsh climatic conditions and died after 3 to 4 months of planting. However, seedlings of more than 2-3 years of age showed better survival. It should be mentioned that during winter, the aerial portions of seedlings of most of the species either died or got broken under the snow. Based on preliminary investigation and trials, following plant species have been identified for plantation in and around Badrinath Dham.

Tree species: (1) **Broadleaved** : *Betula utilis* (Bhoj-pattar), *Quercus semecarpifolia* (Kharsu), *Prunus cornuta* (Jamun), *Acer acuminatum* (Rath-kanchula), *Rhododendron barbatum* (Semru), (2) **Narrowleaved**: *Pinus excelsa* (Kail), *Taxus baccata* (Thuner), *Picea morinda* (Kathela Roga), *Abies pindrow* (Raga), *Juniperus macropoda* (Palmar), (3) **Shrub species** : *Cotoneaster acuminata* (Cham-ruins), *Hippophae salicifolia* (Chuk), *Salix wallichiana* (Bhains), *S. elegans* (Bhotiana), *Viburnum foetens* (Telanu).

3. It is strongly felt that if well acclimatized and hardened seedlings of more than 2-3 years of age of above-mentioned trees and shrubs are planted in Badrinath valley, and protected from grazing, heavy rain, wind and snow the chances of survival of these plants will be considerably enhanced.

4. The soil samples (0-30 cm in depth) were also collected from Badrinath valley and analysed. In general, soil from the valley is coarser in texture, acidic in nature, medium in cation concentration, rich in organic carbon and poor in water holding capacity. Therefore, soil stabilisation would be essential before initiating the afforestation programme.

5. A central nursery of broadleaved/ narrowleaved tree species is proposed/ being developed at Hanumanchatti, near Badrinath Dham, at an elevation of 2500 m amsl.

3.2. SUSTAINABL DEVELOPMENT OF RURAL ECOSYSTEM

3.2.1. Jhum and Sustainable Development of Village Cluster in Nagaland

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

Results and Achievements

As reported in the previous Annual Report, the main activities of the project have been completed, but the demonstration aspects remain to

be carried out. This requires active participation and cooperation from the Nagaland Gandhi Ashram (NGA). The process has been delayed due to the present disturbed situation in Nagaland, particularly Mokokchung district. It is hoped that the demonstrations can be carried out in the near future.

1. An assessment of the previous plantations done earlier was carried out in February, 1995. During the project, *Alnus* saplings were introduced in jhum fields to enhance soil fertility, check soil erosion and water losses and to provide a tree cover once the fields were abandoned. The *Alnus* saplings, planted three years back are now approximately 2-2.5 m high and provide an impressive tree cover in the fallows. Pure *Alnus* grooves planted at the beginning of the project are ready for pollarding and will be coppiced by NGA. Subsequently, monitoring of coppice rates, branching and regrowth rates will be carried out.

2. Cardamom slips were planted two years back in the open, without any tree cover, in addition to those under *Alnus*. These slips have established well in the NGA plots and bear evidence of fruiting (as observed in February, 1995). However, on inspection, it is evident that weeding is required for the healthy growth and fruiting of the plants.

3. On the request of villagers to ease collection of saplings, a nursery was established in the village land. The nursery contains saplings of *Alnus* and fruit trees.

4. In the reporting year, a record 13000 plus saplings of various plants have been distributed with the bulk consisting of *Alnus* saplings, which the villagers are planting in their jhum plots and home gardens (Table 2).

Table 2: Number of saplings of different species distributed from the Unit's nursery at Chuchuyimlang, Mokokchung, 1994.

Prunus nepalensis (Mesu)	800
Schima wallichii (Mesang)	770
Albizzia lebbek (Mokok)	400
Duabanga grandiflora (Kisamen)	570
Melia sp (Asha)	830
Melia sp (Ait)	551
Gmelina arborea (Zukong)	2005
Bucrera sp (Mungjaleshi)	500
Terminalia sp (Aowa)	557
Alnus nepalensis	7162
Total saplings distributed	13,525

3.2.2. Integrated Development of a Village Cluster in Nagaland, through Participatory Approach, involving Villagers and Traditional Village-level Institutions

Background

The confidence of the populace on the conventional development mechanisms has eroded over the years, given the slow rate of development in these areas, and in some instances, the stagnation in any activity connected to the welfare of the people. In such a scenario, the extension of opportunities to the people to decide, participate in and execute an exercise which determines the rate and type of development desired by them will be welcomed and may form a model to be followed as an example in the region, if sucessfully executed.

A village cluster has been identified, situated on the northwest of Mokokchung town, on the Changki range. The main village is Changki, with six to seven satellite villages under it. Preliminary discussions with Changkians have resulted in the villagers voluntarily offering the use of their fallow lands for experimental purposes to the Unit.
(This is a part of the project 3.1.3.)

Objectives

1. To identify development priorities of the villagers of a village cluster through PRA methods, involving village level traditional institutions.

2. To initiate a resource base on fallow lands of the village for demonstration and propagation purposes and also to serve as a genebank of local rsources.

3. To explore possibilities of income generation and value addition which require minimum or simple scientific/technical intervantions.

4. To try, ensure through these activities, that a sustainable development model can be generated, ensuring longterm development with biological conservation.

Results and Achievements

The project has been slow in taking off due to two reasons. It was felt necessary to have the full approval of the Village Council and the villagers before initiation of the actual work.

1. A formal arrangement has been made with the landowners through the Village Council for 3 acres of land to be made available to the Institute for the project period for establishment of a Resource Base. The latter will serve as a Repository of important plant species of the area, not only of conservation value, but also those that have potential economic use.

2. The factors perceived as responsible for lack or deacceleration of development of the area, as well as the inputs required to remove these bottlenecks have been outlined by the villagers. The bottlenecks centre around the following:

(i). Water management and infrastructural support for agro-based product development and the subsequent linkages for marketing, (ii). Lack of expertise (or access to technical support) and knowlegde for winter cropping, (iii). Lack of regular power supply for irrigation, post-harvest activities, (iv). Inadequate facilities for transportation of products, (v). Inadequate or total lack of facilities for storage of perishable agro-products, (vi). Improper introduction of agro/horticultural varieties - HYV paddy, coffee - resulting in losses to the villagers, (vii). Linking plantation area to subsidies for alternate crops to jhum, (viii). Inadequate facilities and improper management of processing units set up to encourage weaning of jhumiyas from jhum, (ix). Lack of proper technical backups for fisheries and other animal husbandry activities, (x). Lack of infrastructural support for market linkages, resulting in exploitation of farmers by middlemen and consequent inadequate returns to farmers, (xi). Lack of access to technical knowhow for setting up of agro- forest based entrepreneurship and related income generating activities.

An analysis of the information gathered reveal some interesting facts. Although they need evaluation, cross checking and quantification, it is interesting to note that the underlying cause for failure of government efforts has been the lack of micro-level planning and insensitivity to local conditions and customs.

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

This is an ongoing project. Please see previous Annual Report for Background and Objectives.

Results and Achievements

1. Standardization of a databank at village level, a schedule at household level and a questionnaire on knowledge, attitude and perception (KAP) at individual person level for data collection were finalised on March 30-31, 1995. The household schedule has around 35 attributes and 500 sub-

attributes while the KAP has 6 attributes and 200 sub-attributes. Five villages each from four development blocks have been sampled for intensive study (Table 3). Collection of secondary data on various datafiles was completed for four development blocks and twenty sample villages. Primary data collection has been completed for six sample villages. Analysis has been initiated. Land resource maps for 1952 and 1994 have been prepared for all the ten villages of the Jaunsaries. The same have been completed for ten villages of the Bhotias for 1962-63 only. Important physiographic maps on drainage, contour, landuse, slope, road, settlement etc. have been completed for all the four blocks.

2. The population growth rate in Dharchula (-16.03) and Munsiary (-2.69) from 1961 to 1991 registered negative trends, while that in Chakrata (39.15) and Kalsi (54.73) were substantially high. More than 70.0% of the main workers among the Jaunsaries are engaged in agriculture compared to 45 to 50 per cent in Bhotia community. A substantial percentage of workers among the Bhotias (37% in Dharchula and 28% in Munsiary) are engaged in manufacturing.

Table 3 : Significant geo-demographic features of the sampled villages.

Village	*Area (ha)*	*Altitude (m)*	*Distance from road (km)*	*Total population*	*Sex ratio (%)*	*Scheduled tribe population*	*Total literacy (%)*	*Female literacy (%)*
Development Block Chakrata								
Phatar	188.98	2200	0.5	436	839	82.39	28.7	11.6
Masak	203.96	2166	8.0	467	962	50.54	7.8	3.1
Dasau	233.10	1500	0.5	355	940	90.71	31.5	16.8
Khaturwa	376.38	2200	7.0	298	828	78.86	15.4	4.4
Chamagata	184.77	1600	2.0	562	885	63.88	22.2	11.0
Development Block Kalsi								
Thana	200.72	1600	0.5	563	827	85.17	31.1	22.3
Matiyawa	51.80	1400	8.0	256	741	75.10	25.4	9.2
Deo	133.72	1829	12.0	335	861	78.50	10.7	1.3
Chapem	58.74	1000	0.0	156	1108	-	14.7	1.9
G. Sakraul	170.21	1100	3.0	174	851	78.69	31.6	13.7
Development Block Dharchula								
Seepu	204.62	3586	51.0	96	959	92.71	40.6	25.5
Baun	278.67	3400	36.0	253	1144	75.08	29.2	18.5
Kuti	250.87	3742	94.0	119	1164	99.10	44.5	12.6
Sirkha	297.82	2348	8.0	377	1005	68.12	39.5	28.6
Charchum	76.01	815	0.0	372	1000	42.49	40.5	30.1
Development Block Munsiary								
Milam	140.48	3536	62.0	50	389	50.01	44.0	7.1
Panto	166.80	2335	17.0	254	1000	77.21	35.4	18.1
Darkot	99.19	1237	0.0	309	1223	67.04	60.5	54.7
Tomik	739.92	2400	23.0	473	931	72.49	32.5	12.7
Bhainskot	161.94	810	1.0	180	915	20.10	12.2	2.3

3. Landuse changes in village Chapnu showed marginal increase in area under agriculture (0.21 ha) over a period of 40 years (Table 4).

Table 4 : Changes in landuse pattern in village Chapnu.

landuse	*1952*		*1978*		*1992*	
	Plots	*Area (Ha)*	*Plots*	*Area (Ha)*	*Plots*	*Area (Ha)*
Agriculture	381	20.91	383	20.91	440	21.32
Barren land	42	5.59	51	5.59	43	5.15
Stream	3	0.21	3	0.21	3	0.21
Settlement	1	0.02	1	0.02	7	0.25
Road	5	0.53	5	0.53	5	0.53
Total	432	27.26	443	27.26	498	27.26

Total area of village and holdings increased from 27.26 ha and 432, respectively to 58.74 ha and 540, respectively, indicating the trend of increase in setteled area as well as fragmentation of holdings. Observations at village Sirkha, inhabited by the Bhotias suggest that liquor has substantially contributed to the economic self-sufficiency of women with sanctions of the society.

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

Background

This project, a bilateral cooperation of the Institute and Norwegian Centre for International Agricultural Development, and sponsored by Norwegian Agency for Development Cooperation, was initiated in 1992-93 for imparting advanced training to some of the Institute's staff at Norway, for advancing scientific knowledge on watershed processes and, for developing and demonstrating the utilization of local resources for sustainable rural development based on participatory approaches.

Objectives

1. To quantify soil loss, run-off and productivity in the selected watersheds.

2. To survey and review land use practices in the region in view of prevailing socio-economic conditions for groups and individuals including issues for entitlement, equity and gender.

3. To work out tree-crop-animal interactions in different agroforestry systems, need of the people and ecological and economic potential.

4. To evaluate the concept of cover approach in the agroforestry system for land management and its effect on the reduction of soil erosion and run-off.

5. To identify land management options capable of raising the overall productivity of the land and economic condition of the farmers.

6. To evaluate the impact of small dams on production systems.

7. To develop and demonstrate models of agroforestry systems through farmer's participation.

8. To explore the possibilities of development policy reorientation for ecologically sound development of rural areas in the hills.

Results and Achievements

1. Soil and water resource parameters including soil loss, hydrological processes and nutrient pools are being analysed under different land use practices in the selected watersheds.

2. Microhydel technology development and demonstration activity was completed in Pranmati watershed (District Chamoli, Uttar Pradesh). This technology introduced with people's participation became so much attractive to the villagers that many villages have come forward for voluntary

contribution to the best of their capacity for electrification of their villages. End uses of electricity with ultimate benefits in terms of forest conservation , rural income and social cohesion were planned for the following year.

3. Land use dynamics in Pranmati watershed was studied using remote sensing data and Geographical Information System (Fig 2).

4. Land suitability classification and mapping based on farmer's knowledge and perceptions was compared with the conventional science based system. The objective is to blend local knowledge and conventional science so that land use plans become practical and acceptable to the local farmers.

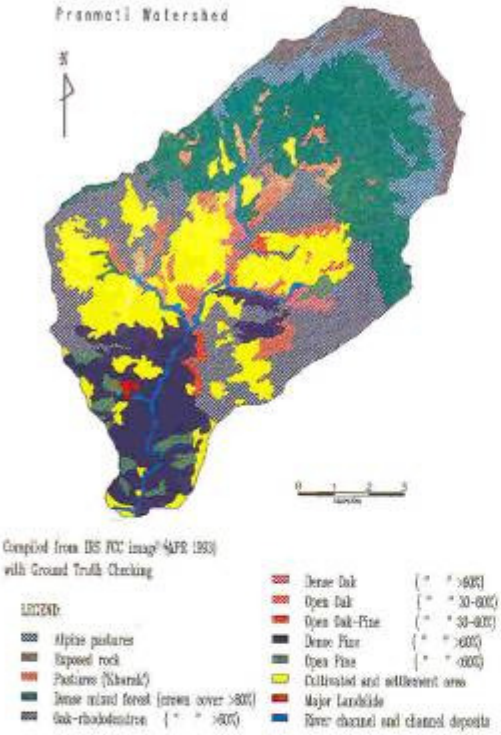


Fig. 2. Land cover & vegetation types in Pranmati watershed.

5. Feasibility of groundnut cultivation in the area was tested. Initial findings suggest it a promising crop from the point of crop diversification and improvement in soil fertility.

6. Impacts of horticultural growth in Chhakinal watershed (District Kullu, Himachal Pradesh) in terms of dependence on forests, crop diversity, soil fertility and monetary benefits were studied.

7. One of the staff, Mr Ranjan Joshi has completed advanced studies on natural resource management at Norwegian Agricultural University.

3.2.5. Institutional Strengthening for Sustainable Mountain Farming System

Background

Though agriculture is argued to be a major factor related to environmental degradation in the Himalaya, it remains the major subsistence and economic activity all through the Himalaya. This programme aims for a holistic consideration of variability in agricultural problems and prospects in a broader farming system perspective, involving participation of eight countries partly or fully covered in the Himalayan region. This Institute is the nodal agency for programme activities in India.

Objectives

1. To undertake research and development activities directly relevant to the problems and issues of mountain farming in a regional perspective

2. To promote exchange of knowledge, and improvement therein, between different countries for environmentally sound development in the Himalaya

3. To enhance expertise institutions through training/workshops/ reorientation capsule courses using pre-existing knowledge and output from activities

Results and Achievements

1. Present concerns of biodiversity focus on floristic/faunal diversity in the wild and its conservation. Biodiversity and its socio-economic and environmental values in diverse farming systems existing in the region have been neglected. There is need of providing new focus to recognize farm biodiversity as a resource for management and linking it with the conventional development system and decision making process. Comprehensive studies of existing knowledge on biodiversity management confined to farming sector in three rural areas (Himachal Pradesh, Uttar Pradesh and Meghalaya) have been initiated. These case studies would constitute the base material for discussion in a regional workshop of experienced persons who could contribute to the preparation of a manual for training of a wide range of target class. This workshop to be held at Y.S. Parmar University of Forestry and Agriculture, Solan, Himachal Pradesh is planned for the following year.

2. Ecozoning schemes considering the national as well as regional needs for sustainable mountain agriculture are being developed. Two case studies, one considering a Development Block as a spatial unit and the other considering a watershed as a spatial unit, have been initiated to develop the GIS based resource appraisal and management decision making. These studies would be used as a training material for professional and technical level courses to be organised in following years in collaboration with MENRIS staff of the ICIMOD.

3. Based on the experiences of land rehabilitation through Institute's own projects, technology development and demonstration for control of Lantana by designing alternative productive land uses for Lantana infested slopelands in a site in Himachal Pradesh has been planned in Chetroo panchayat in Rait development block of Kangra district of Himachal Pradesh. A NGO viz. Dhauladhar Public Education Society has come forward to participate in this project.

3.2.6. Rehabilitation of degraded land in mountain ecosystems: Indian Central Himalaya

Background

Land is a finite resource and has multiple utility values. Integrated resource survey by assessing the diverse utility values of land must be attempted so that indiscriminate land use and associated environmental and socio-economic problems created in the past are no more replicated. The Van-Panchayat of the Arah village (District Almora) came forward with a proposal for financial and technical assistance for rehabilitation of village degraded land. Keeping in view, the interest shown by the villagers, this programme was initiated in March, 1993.

Objectives

1. Improvement of productivity of degraded land in Indian Central Himalaya by application of technology package (SWEET) developed by the Institute.

2. Studies on socio-economic aspects with special reference to dependency of villagers on the forest and agricultural land.

3. Introduction of low cost water harvesting technology in the area.

4. Promotion of environmental awareness among the villagers through their direct involvement in the project activities.

Results and Achievements

1. Mechanical treatments such as levelling of terraces, plugging of gullies and making of check dams were undertaken at critical places in the target area.

2. A nursery of tree and grass species was developed. About 15,000 saplings were raised.

3. In order to ameliorate the Water stress, a critical factor contributing to land degradation, water from

two adjacent perennial sources was diverted and stored in polythene lined underground (low cost water harvesting technology) tanks.

4. Over 7,000 saplings of 12 species were planted including 2 grass species (winter grasses); these were done for diluting fuel wood, fodder and organic manure crises. Weed composting is being tried to supplement traditional manure.

5. To improve the fertility status of the soil, gram (*Cicer*), a nitrogen fixing crop was introduced. Large cardamom and maggar bamboo were also tried to ensure long term benefits to the villagers.

6. Biological treatments were identified on the basis of ecological and socio-economic analysis of the village. Impact of introduced interventions are being monitored in terms of improvement in vegetal cover, agricultural production, soil fertility and socio-economic benefits.

7. Environmental Awareness Programme: Discussions with the villagers and people from adjacent areas, have been regularly practiced. Nursery development, general environmental issues, protection and multiplication of the natural resources, health and sanitation, etc. are the common subjects of formal and informal discussions during the course of the project execution. Training camps for the Indian Army personnel, Ex-Army personnel, NGOs, villagers and women have already been organized at Arah and Balgari by the Institute. Formulation of a co-operative of the villagers to take over the responsibilities of the project site, after its completion, is under process.

3.2.7. Study of Resource Use in Kullu Valley to Evolve Sustainable Practices

Background

Khokhan in Kullu valley is a small sanctuary of about 16 km² in district Kullu ranging from 2400 to 4500 m amsl. All 15 villages within the sanctuary and 50 villages in its surroundings have the right to collect timber, fuelwood, fodder and leaf litter from the sanctuary. It was noted that Khokhan sanctuary is not able to support large population of these villages. Continuous depletion of resources and its improper management have disrupted environmental sub systems like forest, agriculture and agroforestry in the study area.

Objectives

1. To understand the structure and function of different ecosystems of the sanctuary.

2. To improve the existing farm forest-rural economy linkages in selected villages for promoting sustainable development.

Results and Achievements

1. Broad leaved species like *Quercus leucotrichophora* and *Q. semecarpifolia* in near vicinity of the villages were found to be excessively lopped for fodder. *Thamnocalamus* sp., a temperate bamboo, locally called ningal, which was once reportedly abundant in the sanctuary, was found largely depleted in most places due to over harvesting for handicraft and household uses.

2. Maximum number of trees were harvested from the Nagani forest compartment (82 trees/year) of the sanctuary followed by Khokhan (29 trees/year) and Oriban (11 trees/year). Out of total TD distributed, 60-80% trees were given from the Nagani forest compartment and rest from Oriban and third class forest of Khokhan.

3. Common agricultural practice found in and around the sanctuary was terraced cultivation. Rainy season crops were studied in Rolgi and Khokhan villages, comprising of areas within and out side the sanctuary.

4. Maize was the major crop and different combinations of other crops with maize were also

found. In addition to maize,crop species like soybean, greengram, cowpea, sunflower, sesame, hemp along with 13 types of vegetables were also recorded. Vegetables are grown as cash crops and its cropping area is rapidly increasing. In 1992, 0.2 % land was under vegetables and in 1994, it increased to 1.0 % representing a five fold increase in terms of area coverage.

5. Apple, a popular crop of this region is now being introduced in the system; currently 7.5% land has been converted into apple orchards.

6. Tree species were noted to be regenerating naturally on margins of terraces and are maintained by farmers for fodder and fuelwood. A total of 12 tree species were recorded out of which *Grewia oppositifolia*, commonly known as beol, is most important (IVI 120.5) followed by *Prunus armeniaca* (IVI 49.5) and *Ficus palmata* (IVI 22.6) and *Olea ferruginea* (IVI 18.4). Other species were *Pyrus malus, P. pashia, Prunus persica, Robinia pseudacasia* and *Celtis australis*.

3.2.8. A Study of the Landholding and land tenure system in an Ao village, having jhum and settled agriculture

Background

Jhumming or shifting cultivation is the predominant agricultural landuse pattern in the uplands of NE India; this is also true of the Mokokchung district of Nagaland. Jhumming is carried out under the traditional landholding and land tenure system, and all attempts to introduce settled agriculture have not been successful primarily because the modifications implied a change in the traditional landholding and/or land tenure system. Although landholding and land tenure systems vary with each tribe, and may occur even within a distance of 20 kms, the key to a gradual transition to settled agriculture has to be found within the existing land tenure mechanisms, if it is to succeed. An instance where jhumming and settled agriculture exist within the traditional system is an opportunity, therefore, to unravel this key; such a coexistence is practiced in Mokokchung district, particularly in Tuli, Tzutsung, Changki and Japu valley. A study of the agricultural landuse practised in these areas is expected to yield valuable information. The findings of this study may provide the basis on which an alternative to jhumming may be suggested.

Objectives

1. To study the incidence of coexistence of jhumming and settled agriculture in Mokokchung district.

2. To document the landuse pattern, landholdings and land tenure system in these areas.

3. To study the feasibility of developing a model for other areas in NE India.

Results and Achievements

1. Secondary data, the only existing published document on Ao land laws, has been collected.

2. Details of land holding/land ownership categories, ranging from village level to individual holdings, have been documented. Tenure rights as well as laws governing tenureship have also been documented.

3. Quantification of these categories at the village level will be carried out. Quantitative surveys will be started in 1995-96. Information on the traditional institutions which govern land- holdings and tenureship has been documented; details about the actual modum of operation, tax collections if any, levies or fines imposed and modalities regarding decisions thereof and the role of the state revenue and related departments have to be explored. These will be initiated and executed in 1995-96.

3.3. CONSERVATION OF BIOLOGICAL DIVERSITY

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

Background

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

Objectives

1. Identification, classification and mapping of important habitats.

2. Identifying degree of biotic and anthropogenic pressures causing fragmentation.

3. Identifying habitats which support important taxa.

4. Narrowing the gulf between *in-situ* and *ex-situ* conservation by developing techniques for enhanced economic utilization of *in-situ* resources in *ex-situ* situations.

Results and Achievements

Askot Wildlife Sanctuary in Kumaun, U.P.

1. Compositional diversity in forest vegetation within a representative area (Gori Ganga Catchment) was studied (Table 5).

Table 5 : Analytical features of the forest vegetation in AWLS

Forest (Altitude)	*TBA*	*Density*			*Sp. Richness*			*Diversity Index*		
		Tr	*Sh*	*Hb*	*Tr*	*Sh*	*Hb*	*Tr*	*Sh*	*Hb*
Riverine (1150 m)	29.9	586	5930	199.6	23	15	28	2.03	2.88	4.01
Pinus roxburghii (1225 m)	43.9	616	7800	182.4	14	10	45	0.92	2.65	5.16
Quercus leucotrichophora (1700 m)	35.3	1100	8950	190.4	16	11	65	2.39	2.99	6.30
Quercus lanuginosa (2125 m)	67.7	832	7850	164.8	23	09	47	2.06	2.41	4.76
Q. semecarpifolia (2950 m)	50.8	550	18540	49.0	09	10	29	1.41	1.36	4.18
Abies pindrow (3100 m)	78.9	660	15320	100.6	03	10	36	0.68	1.53	4.41
Betula utilis (3200 m)	21.4	470	2260	98.2	02	06	26	0.69	2.18	3.55

TBA- Tree basal area (m^2 ha^{-1}); Density Tree & Shrubs (indi. ha^{-1}) herbs (indi m^{-2}); Diversity Index- Shannon's index ($H' = \Sigma Ni/N \log_2 Ni/N$);Tr- tree,Sh- shrub, Hb- herb.

2. Possible changes in forest vegetation were assessed by investigating demographic (population) structure of each forest type and individual species within the forest through density- diameter relationships. The forest vegetation, in general, exhibits an expanding population with higher percentage (56.6%) of individuals in the recruitment class (seedling and saplings). A sharp decline of individuals in subsequent higher classes is indicative of inadequate establishment.

3. Prepondrence of recruitment class in riverine and *Pinus roxburghii* forests (63.8% and 61.3%, respectively) and distribution trend of individuals in subsequent higher classes is suggestive of a long term persistence and further expansion of such forests.

4. The analysis also reveals that *Rhododendron arboreum* and *Lyonia ovalifolia* (both undercanopy dominants) proliferate at the expense of *Quercus leucotrichophora* and *Q. lanuginosa* forests. This is significant because the former two species are much less preferred fuel and fodder species than the latter.

5. The trends clearly indicate that removal of older population is faster than the replacement from lower size classes.

6. Along a disturbance gradient, three sites (least disturbed - LD, moderately disturbed- MD and highly disturbed- HD) of *Quercus lanuginosa* forest were monitored for soil quality (June-July 1994). Soil colour varies as:LD- 7.5YR 4/3 brown and 7.5YR 3/1 very dark gray. MD- 10YR 6/4 light yellowish to 7.5 YR 3/3 brown. HD- 2.5 YR &/6, yellow and 7.5 YR 5/4 dark brown. Changes in other soil properties in different sites is presented (Table 6). To derive conclusions from soil data, more sampling is proposed in the comming year. Soil data will be correlated with the growth and recruitment of tree species as well as ground flora in all sites.

Table 6 : Soil quality in AWLS

Sl No	Site	pH	Org. C (%)n	TKN (%)	C/N	Total P mg/g	Elect. Cond u/cm
1	LD	4.34	6.09	0.220	27.7	0.012	37.33
2	MD	4.43	4.30	0.047	91.5	0.032	13.67
3	HD	4.76	2.12	0.032	66.3	0.056	17.67

LD- least disturbed, MD- Moderately disturbed, HD- highly disturbed

Kanawar Wildlife Sanctuary in H.P.

1. Major habitats of dominant woody taxa have been identified.

2. The elevation zone between 1900-2100 m constitutes the potential habitat for woody plants. Two ecotone zones for woody species composition and habitat diversity have been identified.

3. Analysis of the woody taxa revealed that 79.27% have fuelwood value, 58.54 as fodder and 48.78 as medicine (Fig 3). Analysis of their Use Pressure Index (UPI) revealed that *Quercus leucotrichophora* and *Q. floribunda* are top ranking fuel wood taxa, whereas *Morus serrata* is most preferred fodder and *Juglans regia* is most sought after timber.

4. Amogst the 30 important wild edibles, flowers of *Rhododendron arboreum* are marketed. Out of 31 potential medicinal plants, 16 are commercially exploited and most of these have threatened status.

5. Through demograhic and socio-economic surveys, it is assessed that about 19 kg and 37 kg fuel wood is consumed per household per day during summer and winter, respectively.

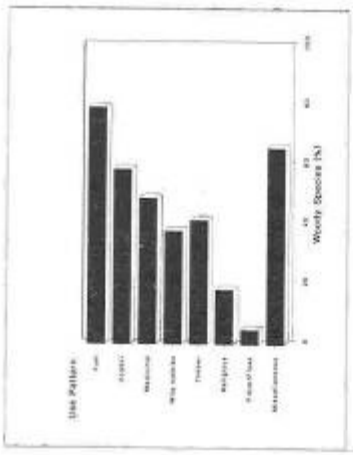


Fig. 3. Use pattern for total woody species, recorded along an altitudinal gradient in Kanawar Wildlife Sanctuary.

6. Among food crops 56 (13 cereals and grains, 9 pulses and legumes, 18 vegetables, 7 spices and oilseeds and 8 fruits) are grown in KWLS. Practice of growing *Amaranthus, Chenopodium, Echinochloa* and species of *Fagopyrum* is getting reduced over the years. A total of 19 crop combinations were recorded. Finger millet has been analysed as the most energy efficient crop.

7. Multiple cropping system is only moderately efficient over monocropping under previling rainfed condition of KWLS. However, Finger millet-soybean combination appeared to be most efficient agronomically.

8. Protected and disturbed sites along 1600-4800 m were identified for monitoring biodiversity.

3.3.2. Bioresource Inventory of the Himalaya

Background

Adequate base line data on biological resources of any biogeographical region help in the identification of species, population, communities, habitats, landscape elements and ecosystems. As such it is imperative to develop a computerised data base of existing bioresources of the Himalaya. Comprehensive base line data for the Himalayan bioresources is not available. Therefore preparation of inventory of bioresources (family wise, rare-endangered, ethnobiological, endemics, key stone species) has been initiated. The analysis of the data generated so far has proved useful.

Objectives

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

2. Identify gaps therein.

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

4. Make it available to any user for effective dissemination.

5. Prioritization of activities related to conservation.

Results and Achievements

1. Inventory of 663 wild edible taxa has been prepared. Himalayan wild edibles represent nearly 83% of total (ca 800) reported from India. Representation of these wild edibles in taxonomic groups and life form classes is presented (Table 7).

Table 7: Himalayan Wild Edibles : Diversity of taxonomic groups and life forms.

Taxonomic group	*Fami-*	*Gene-*	*Species*	*Life forms*					
				H	*S*	*T*	*Pt*	*Fu*	*Li*
Angiosperms	127	356	635	279	169	187	-	-	-
Gymnosperms	5	6	7	-	3	4	-	-	-
Pteridophytes	9	9	12	-	-	-	12	-	-
Fungi	6	6	7	-	-	-	-	7	-
Lichens	2	2	2	-	-	-	-	-	2
Total	149	379	663	279	172	191	12	7	2

H- herb, S- shrub, T- tree, Pt- pteridophyte, Li- lichen, Fu- fungi

2. Diversity of various floristic elements in Himalayan wild edibles has been worked out. Of the representative Himalayan taxa (282 spp.), thirty (10.6%) are endemic to Indian Himlalaya (Fig. 4) and 89 (31.6%) have range extensions in adjacent areas.

3. Spatial distribution of wild edibles (spp number) in different biogeographic provinces and altitudinal zones is analysed.

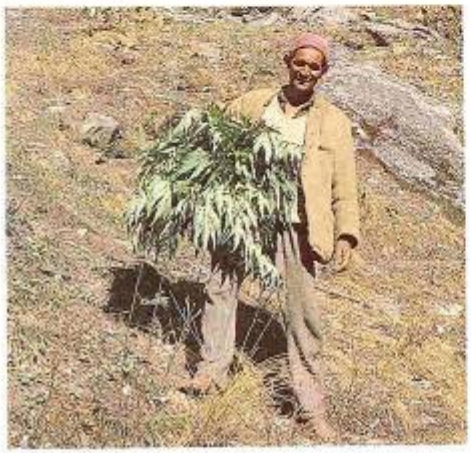


Fig. 4. *Megacarpaea polyandra* - a rare, near endemic.

4. Over 173 (26.1%) wild edibles are being used as medicine, whereas 34 species are potential oil yielding taxa. Nutritive value known for 48 wild edible taxa is comparable with the domesticated food crops.

3.3.3. Establishment and maintenance of a functional arboreta in Himalaya

Background

In order to develop a germplasm bank of Himalayan species and ensure ex-situ conservation, enrichment of germplasm in an arboretum at Kosi-Katarmal (Kumaun Himalaya) and maintenance of *Rhododendron* species at Sikkim are continuing. This project is envisaged to be extended to Himachal Pradesh. The activity will not only serve as a gene bank of different Himalayan life forms but also provide opportunities for facilitating research, training and developmental activities. For example, presently studies on developing propagation protocols of locally important tree species are in progress.

Objectives

1. Developing a gene bank of economically important native Himalayan taxa.

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

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

Results and Achievements

a. Arboretum (Kosi-Katarmal)

1. Infrastructural facilities such as development and extension of arboretum nursery for mass scale propagation of priority taxa was carried out.

2. Propagules of 50 species with varied uses were collected from different parts of Kumaun Himalaya. These species are being monitored for germination and growth performance. Monitoring of some of the species in different (i.e. nursery beds, polythene bags, net house and glass house) has been initiated.

3. The arboretum is being enriched from different Himalayan provinces.

4. Propagation through cuttings (with different chemical treatments) in 8 species was initiated. The performance is being monitored. Plants raised from cuttings (*Lagerstroemia indica* Linn., *Salix tetrasperma* Roxb. and *Forsythia viridissima* Lindl.)

were transplantated in various arboretum sites and campus area (July 1994) with 100% survival in the current season. Cuttings of *Gingkgo biloba* Linn. showed 72% survival.

5. To enrich germplasm through the development of orchidarium and fernarium, 18 species of orchids and 20 species of ferns were introduced.

6. From a total of 1555 individuals of 110 species planted in different sites, 1124 (72%) survived. Site D, which is the preferred habitat, showed highest survival (93%).

7. 1500 seedlings of 10 species raised in the arboretum nursery were used for the development of site in the campus area and 600 seedlings of 15 economically important tree species were used for the community land at Gangolihat.

8. Nutrient discharge from the top soil in arboretum site and studies on runoff and seepage are in progress. During the reporting period, analysis of one of the sites was completed (Table 8).

Table 8 : Quality of runoff and seepage water of arboretum (plot- C).

Sl No	*Parameter, Unit*	*Surface runoff*	*Seepage*
1.	Flow, LPM	0.188	0.107
2.	pH	7.400	6.900
3.	Elect. Cond. (EC),US/cm	33.000	53.000
4.	Ammonical- N, ppm	3.000	0.160
5.	Nitrate- N, ppm	0.006	0.024
6.	Total P, ppm	BDL	BDL

BDL- below detection limits

b. Development of Rhododendron Arboretum at Pangthang, Sikkim.

Following 20 species have been collected and planted at the Rhododendron Arboretum in Pangthang: *R. aeruginosum*, *R. falconeri*, *R. anthopogon*, *R. grandiflorum*, *R. arboreum*, *R. lepidotum*, *R. arboreum* var. *cinnamomeum*, *R. niveum*, *R. barbatum*, *R. pumilum*,*R. campylocarpum*, *R. thomsonii*, *R. ciliatum*, *R. triflorum*, *R. cinnabarinum*, *R. virgatum*, *R. cinnabarinum* var. *blandfordiiflorum* , *R. virginale*, *R. dalhausiae*, *R. wightii*.

Field observations

Fieldwork revealed that a few species are quite rare in the wild, e.g.- *R. camelliiflorum*, *R. leptocarpum*, *R. lindleyi*, *R. niveum*, *R. sikkimense* and *R. vaccinioides*. The subspecies and varieties are even more rarely found. A field count made this year for *R. niveum* at its habitat (Yakchay, North Sikkim) reveals 61 mature plants and 23 seedlings in an area of 13 ha.

3.3.4. Timberline and Snowline Vegetation of Kumaun in Central Himalaya: aspects of composition, diversity and conservation

Background

Ecotones and marginal ecosystems, such as, timberline and snowline, are considered candidate areas for investigations on some of the interrelated aspects of ecosystem functioning and biodiversity conservation. Present study has been initiated to answer some of the basic questions concerning vegetation diversity, composition and conservation aspects.

Objectives

1. To study and collect information on specific diversity, phenology of important species, and regeneration and population structure of tree species.

2. To identify endangered/threatened (sensitive) species and microhabitats for conservation.

3. To identify ethnobotanically important species and their habitat preferences in natural conditions so as to determine their extent of specificity.

Results and Achievements

1. Identification of 465 angiosperms ranging over 61 families and 209 genera in timberline flora has been done. The species diversity in all families and genera has been analysed and the proportional contribution of native taxa calculated.

2. Diversity of floristic elements in timberline flora has been analysed (Fig. 5). In terms of proportional contribution of alpine and temperate elements, former (58%) dominates over the latter (42%).

3. Growth form representation in timberline flora has been analysed as: trees- 4.3%;, shrubs -16.7%; erect forbs- 45.9%; cushion and spreading forbs- 17.7%; sedges, rushes and grasses- 15.9%; annual herbs -14.4%.

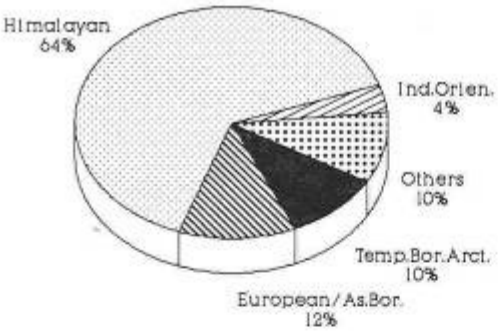


Fig. 5. Diversity of floristic elements in timberline flora.

4. All Himalayan (native) taxa (298 spp.) in timberline flora have been assessed for their existing phytogeographic status.

5. Studies on regeneration and population structure at timberline have been initiated. Seedling density ranged between 40-630 and sapling density between 70-480 individual/ha, showing low natural regeneration. Frequently regenerating species are *Betula utilis* (80.0%), *Rhododendron campanulatum* (80.0%), and *Taxus baccata* (50.0%). Survival percentage of seedling is maximum for *R. campanulatum* (56%), followed by *B. utilis* (53%). *Acer caesium, Euonymus fimbriatus, Prunus cornuta* seedlings, however, did not survive. The demographic profile of forest stands is being prepared by incorporating information on regeneration and data on density-diameter distribution.

6. Information collected under phenological and ethnobotanical studies is being compiled and computed for final analysis and interpretation.

3.3.5. Conservation and Propagation of Rare and Endangered Species of Northeast India

Background

Northeast India is rich in biodiversity, however, several species are rare or endangered due to various reasons. Conservation and propagation of such species becomes an unavoidable imperative given the tremendous pressures on habitats due to deforestation and other human pressures.

Objectives

1. Collection of rare or endangered species for setting up of a living genebank.

2. To develop simple propagation techniques for their mass conservation.

3. To standardise methods and disseminate knowhow for mass propagation and conservation among villagers in areas where they are used and also for tying up with income generation activities.

Results and Achievements

1. About ten species of rare or endangered orchids have been collected for the genebank. These are

presently in a nursery, temporarily established at Kohima.

2. Propagation methods were tried for *Taxus*, *Cephalotaxus* and Ginseng. The results are encouraging, especially for Ginseng. The propagules have shown satisfactory germination from tuber cuttings and demonstrate healthy growth.

3.3.6. Status survey of the Fish fauna of NE India including habitat survey of the Wetlands - Identification of factors responsible for declining populations

Background

Fish forms an important part of diet of the people of northeast. Being well endowed with waterbodies, the fish fauna of the region has a rich diversity. However, in the past few years the fish fauna, as reflected by availability in the markets show a disturbing trend. This declining status of the fish fauna suggests threats, either in the form of habitat destruction or overfishing and therefore, merits urgent investigation and longterm studies to ensure proper management and conservation.

Objectives

1. To carry out a status survey of the fish fauna on the basis of fish landing statistics and the ascertain the status of various species.

2. To carry out a survey for habitat assessment including identification of factors threatening the fish fauna.

3. Identify and inventorize fish fauna and categorize their present status.

4. Identify and categorize the threats and suggest measures to overcome these in order to ensure conservation.

Results and Achievements

1. A preliminary survey of the markets at Guwahati and Dhubri was carried out to assess the availability of riverine and other varieties.

2. A survey of the habitats were carried out in the north bank of the Bramhaputra for assessing habitat status and identifying threats.

3. Documentation and analysis of the landing statistics (and details) are underway in major landing sites (Dhubri, Guwahati, Dibrugarh).

4. Collection of fish specimens for inventory and identification purposes is underway.

5. Quantitative data collection on these aspects will be initiated in 1995-96.

3.3.7. Resident Ducks of NE India: Quantification of factors regulating the populations

Background

Out of twenty eight species of ducks reported from North East India, approximately 25% - six to be precise - are non-migratory or resident. Of these, the spotbill duck *Anas poecilorhyncha*, is the only ground nesting duck, nesting on pads of grass and weeds concealed in herbage on the edge of waterbodies, while the rest - *Sarkidiornis melanotos, Cairina scutulata, Dendrocygna bicolor, D. javanica* and *Nettapus coromandelianus* - are tree-nesters. The Whitewinged wood duck is rare, distributed very locally and is endemic to N E India, having been reported from Assam and Arunachal previously. Recently, there are suspicions that its distribution is becoming more confined. Out of the five resident tree dwelling ducks outlined above, two are already known to be rare or endangered. The status of the remaining three species has not been causing too much concern in relevant circles, but our observations suggest otherwise.

Objectives

1. To identify factors responsible for the decline in population and distribution of the tree-dwelling resident ducks.

2. To quantify and test the hypothesis generated, based on field observations, in regard to the factors responsible for the present status of the ducks.

3. To trace and establish the linkages essential for the survival of these species.

4. To suggest methods/ recommendations for the protection and conservation of these ducks.

Results and Achievements

1. Analysis of the published data on the census of the ducks has been carried out and is presented in Tables 9 & 10.

2. An attempt has been made, based on literature and field observations to list the primary and secondary associates responsible for preparing the nesting sites of the ducks to ensure the their breeding.

3. Quantification of the above will be initiated in selected study sites from 1995-96.

Table 9 : Population Counts of Resident Ducks in Assam and the number of sites covered (Source: Asian Waterfowl Census, 1989-93)

Year	*No. of Sites*	*Ducks sighted*				
		LWT	*CT*	*LaWT*	*CD*	*WWWD*
1989	8	3599	179	NS	NS	NL
1990	9	5524	79	1828	NS	NS
1991	18	9214	333	809	NS	NL
1992	28	24718	123	400	NS	NS
1993	31	40329	347	34	18	NL

(Abbreviations used in table:- LWT: Lesser Whistling teal; CT: Cotton teal; LaWT: Larger Whistling teal; CD: Comb Duck; WWWD: Whitewinged wood duck. NS: not sighted, NL: not listed)

Table 10 : Percentage increases in sites and duck sightings, based on Table 9.

Year	*Percentage changes Duck Counts*					
	LWT	*CT*	*LaWT*	*CD*	*WW*	*WD*
1989	-	-	-	-	-	-
1990	(+)12.5	(+)53	(+)55	-	-	-
1991	(+)100	(+)66	(+)321	(-)55	-	-
1992	(+)55.6	(+)168	(-)63	(-)50	-	-
1993	(+)72	(+)837	(+) 4	(-)95	-	-

3.3.8. Exploration of Lesser Known Crops of Garhwal Himalaya as food source

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

Results and Achievements

1. Information related to agronomic practices, traditional uses and ethnobotany of majority of the traditional crops has been collected while interviewing the farmers of different localities in the region.

2. Among the traditional crops, the crop by-products of all the millets are rich in protien, with maximum value for *Panicum miliaceum* followed by *Echinochloa frumentacea* and *Setaria italica*. The crop by-products of millets in general, have higher fat content, minerals, digestible protein and calorific value than pseudocereals and cereals (common food crops).

3.4. ECOLOGICAL ECONOMICS AND ENVIRONMENTAL IMPACT ANALYSIS

3.4.1. Environmental Assessment in and Around Valley of Flowers

Background

Today, the problem of solid wastes has not remained confined to metropolitan or urban areas

alone. These problems have made inroads even in high Himalayan spots of beauty and tourist/ religious interest. Though the problem in these areas is threatening to reach urban proportions, the solutions are much harder to come by as even the basic road transportation is not available to support the required infrastructure of collection, transportation and disposal of wastes. Keeping in view the large scale problem of litter in and around Valley of Flowers, a study has been initiated. The study started from Govindghat (1827 m), the last road head point, and included pathway from Govindghat to Ghangharia (3016 m), Ghangharia, pathway from Ghangharia to Valley of Flowers, Valley of Flowers, pathway from Ghangharia to Hemkund and Hemkund Sahib.

Objectives

1. Assessment of solid waste problem in the study area.

2. Assessment of other environmental problems.

3. Identification and/or implementation of suitable remedial strategies.

Results & Achievements

1. Broadly a large scale problem of Solid Wastes in all survey areas relating to packaging, bottles and polybags was noted.

2. Poor sanitation status of halt areas was another major problem.

3. In all 78 shops were documented along the 14 Km. stretch from Govindghat to Ghangharia. At the time of survey, a number of shops were also under construction. However, even this number represented 217% increase over the numbers recorded by Berkmuller *et. al.*, (1987). From Ghangharia to Hemkund, 36 shops were recorded. Though no previous data were available, based on interviews with shopkeepers, it was found that most shops were of recent origin.

4. The number of visitors to Valley of Flowers in 1993 were recorded to be 1814. This represented a decline over 1986 visitation of 2110 persons reported by Berkmuller (1987).

5. In Ghangharia, a major halt area prior to final ascent into the Valley of Flowers and Hemkund, the litter problem was found to be worst amongst all survey areas. A number of waste dumps resulting in about eight waste concentration areas were recorded.

6. In the Valley of Flowers, packaging wastes was evident. Also at the grave site in the valley, problem of subsurface waste was noted.

7. In Ghangharia, commercial facilities were prime generators of waste. During the survey commercial structures accounted for 67% of total constructions; of these, food and related shops accounted for 58%.

8. Improper toilet facilities and inadequate halt arrangements for porters and mules were other leading causes of poor sanitation status at Ghangharia.

9. On the spot trials carried out in the study area indicated that economy driven recycling is feasible and a possible solution to the problem. The matter has subsequently been taken up with the District administration.

3.4.2. Study of Biogeochemical Cycles in the Himalayan Eco-systems

Background

The atmosphere is an integral component of planetary life supporting system. Atmospheric processes are complex in nature and require multi-disciplinary studies of physical, chemical and biological cycles to anticipate the impact of natural and anthropogenic changes in the chemistry of lower atmosphere. There is an intimate interaction between the cycling of chemical elements through

soil, water, air and biomass. Study of different bio-geochemical cycles and their interaction is important for assessment of short and long term climate changes.

The fragile Himalayan ecosystem was selected as an ideal area to study changes in atmospheric chemistry, due to its influence on local climate, diverse altitudinal and vegetation patterns. Additionally, the composition of atmosphere in Himalayan region can be taken as being least affected by anthropogenic activities. However, it was felt important to document the background concentrations, as a part of ongoing exercise, to document changes in natural environment. The project was conceptulised in collaboration with Indian Institute of Tropical Meteorology, Pune to study interaction in biogeochemical cycles in Himalayan ecosystem and its impact on climate change.

Objectives

1. Assessment of background concentrations of air pollutants

2. Atmospheric chemical transformations in the Himalayan Eco-systems

Results and Achievements

A field observational programme was carried out at Kosi during pre-monsoon season. The preliminary results of the analysis suggest the following:

1. The average total suspended particulate (TSP) concentration was 153 ug/m^3 during the pre-monsoon season. This was found to be higher than that observed in post-monsoon season (October, 93). This may be due to high turbidity conditions normally observed in pre-monsoon season.

2. The mass size distribution of aerosols showed a bimodal distribution with one peak in fine mode and another in coarse mode. Similar distributions were observed during post-monsoon sampling during the previous year.

3. The coarse size particles contributed 59% to the total aerosol mass in the pre-monsoon season whereas they accounted for 69% during post-monsoon season. High turbulence in the pre-monsoon suspension and relifting of fine size particles can give rise to higher percentage contribution of fine particles in pre-monsoon season.

4. The average concentration of Aitken nuclei was 5571/cm^3 during pre- monsoon season.

3.4.3. Development of roads and its socio-economic impact: An analysis of the Kapkot Block, Kumaun Himalaya

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

Results and Achievements

1. In order to achieve the objectives of the study, three villages were selected on the basis of their distance from the road. Agriculture in the Central Himalaya is mostly rainfed, and any increase in production requires considerable inputs which are affected by transport network (e.g., improved varieties of seed, chemical fertilizer, biocides and irrigation). It is, therefore, not surprising that cereal trading is not practiced in the study area. A large portion of the population is dependent on wages either through private or in government jobs.

2. Another 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. This phenomenon was observed in Sama and Leeti villages. For example, a portion of population (about 20% households) has managed to achieve an increase in income by producing cash-

crops. After the development of roads, potato cultivation has started in these villages in the last 15 years, and occupies about 25-30% of cultivated land.

3. Government agencies have also made efforts to introduce Kufri seed of potato in Sama village, which gives higher yield in comparision to local seed. On the basis of energy budgeting and cost-benefit analyses it is apparent that machine based transportation is more efficient than animal based transportation, both economically (Table 11) as well as ecologically.

Table 11 : Cost-benefit analysis for potato production system (,000 Rs per ha)

	Village			
	Sama		*Lasi*	*Khati*
	Kufari	*Common*		
INPUT				
At Farm Level Production				
Seed	29.64	-	-	-
Chemical Fertilizer	0.31	0.31	0.25	-
Biocides	0.08	0.08	-	-
Total	30.03	0.39	0.25	-
At Market Level Trade Transportation	-	10.37	-	44.46
OUPUT	385.32	133.38	86.94	160.06
Output:Input Ratio				
At village	12.83	342.09	347.78	-
At Market	-	12.39	-	3.60

3.4.4. Ecology and Socio-Economy of Transhumance Communities of Central Himalaya

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

Results and Achievements

1. Agroecosystems of the Bhotiya transhumant communities of Garhwal, namely, Marchhas, Tolchhas and Jaadhs have been evaluated in order to study the cropping and yield patterns, crop rotations, cropping intensity, energetics, cost-benefit analyses, traditional practices for sustaining productivity and social customs related to this.

2. Ethnobiological studies have been completed for the three sub - communities of the Bhotiyas at their summer and winter dwellings to assess the role of natural/wild resources in their village ecosystem, particularly those with food value. These communities use various plant species as medicine, food, essence, fuel, fodder, agricultural tools, housing materials, fiber and for religious purposes, etc.

3. Social and cultural aspects e.g. folklores, taboos, rituals, marriages, and festivals of the Bhotiyas have been studied. The folklores of the Bhotiyas are varied. Folklores were derived through myths and legends, dreams, spiritual divination, story telling, cultural ceremonies, and the worship of dieties. Folklores are respected, they have a basis in structuring social norms and values, and have significance in the social setting of tribal communities.

4. Livestock rearing is an important economic activity of the Bhotiyas. Sheep and goats comprise about 63% and 24%, respectively, of the total livestock population of this community. Others, e.g., cattle and pack animals (horses) are below 4% in all the villages studied during present investigation.

3.4.5. Carrying Capacity Assessment of Kullu Manali Complex: Phase II

Background

This study was initiated in 1993-94. In the first phase an assessment with respect to accommodation was carried out at Kullu and Manali. Also the tourist flows and use of various modes of transport were documented. It was noted that Kullu Valley is facing a major infrastructural

constraint relating to solid waste management. As tourism in this area can be adversely affected by general degradation of surroundings, it was proposed to focus attention on this problem.

The problem of wastes was noted at various levels. The stress on services was significant during summer and festival seasons. Since a number of places are beyond municipal limits, this further compounds the problem.

Objectives

1. Kullu Dussehra is a major event and an integral part of the tradition of the area. It is also an event of considerable tourist interest. An assessment of this event was carried out with the following objectives:

(a) Estimation of quantity and volume of solid wastes and its characteristics, (b) Assessment of peoples perception regarding infrastructural facilities and cleanliness, (c) possible management options.

2. Mohal is a small settlement between Kullu and Bhuntar airport. Though outside municipal limits, the area has experienced substantial growth over past decade. There are no municipal mechanisms for waste collection, transportation and disposal. Accbrdingly, a study was formulated with following objectives: (a) To assess general state of cleanliness in the study area, (b) To carry out a general census and land use survey and to document growth of settlements and urbanization, (c) To conduct house hold surveys regarding solid waste disposal practices. (d) To present appropriate management options.

Results and Achievements

Kullu Dussehra

1. A total of 1308 shops were recorded at Dussehra ground. 67% were clothing shops, 21% shops vended shoes, toys and other domestic items.

2. During the survey sweeping was noted to be efficient, however, number of dustbins were found to be inadequate. Only three dustbins and seven open waste collection points, far removed from the bins, were noted.

3. The municipal fleet comprised of a tractor and a small truck making three trips per day. The solid waste collected per day was 10.5 MT. The total waste generated during the festival (seven days) was accordingly estimated to be about 75MT (5040 cubic ft.). The current disposal practice was dumping into the river, close to confluence of Sarwari & Beas.

4. For garbage characterization, seven samples collected on two different days were separated, weighed and averaged. Waste materials were classified in three broad categories: Readily biodegradable (72%), biodegradable (11%) and non-biodegradable (17%).

5. Other facilities in Dussehra ground included 2 toilet blocks, 10 water tanks and four handpumps. According to a survey 72% respondents admitted open defecation and felt that appropriate toilet facilities should be created. 58% respondents rated water supply as an acute problem. 51% respondents also found state of general cleanliness to be inadequate. The electricity supply was, however, rated as satisfactory by 63% respondents.

6. Detailed management options relating to proper waste disposal initiatives, design and placement of bins, adequate toilet and other related facilities are being looked into.

Mohal

1. A survey conducted around houses and commercial establishments in Mohal indicated that out of 206 places surveyed, over 60% were found to be dirty suggesting a large scale need for solid waste management initiatives.

2. The analysis indicated that the number of constructions increased to 190% during 1980-90 and to 258% during 1980-95 based on 1980 records. Furthermore, residences and commercial establishments accounted for 77% and 16%, respectively. Mixed land use practices were also seen and 4% settlements were found to be residential cum commercial. Institutional and non-profit entities accounted for 3% of settlements.

3. A general census conducted in the study area indicated a total of 318 households with a population of 1190 persons, with an average family of 4 persons.

4. A survey of prevalent garbage disposal practices showed that 67% respondents threw their garbage either in the immediate vicinity of their houses or in a common dump area, and only one third population is able to internalize its waste. Further, in the absence of municipal facilities final disposal practices included dumping into river (32%), composting (45%), burning (31%) or land filling (4%).

5. In the area a total of 103 cattle owners were recorded with a total cattle population of 237. Cattle owners mostly carried out composting of their waste, after mixing it with animal dung.

6. During 1995-96, it is proposed to carry out a household level survey, with greater emphasis on the views of women to ascertain viable option(s) for centralized and/or decentralized solid waste management practices.

3.5. ENVIRONMENTAL PHYSIOLOGY AND BIOTECHNOLOGY

3.5.1. Microbial inoculants for improved plant performance in the Himalaya

Background

A variety of microorganisms are used for inoculation of plant species for better establishment in the soil. Using basic knowledge, development of beneficial associations by inoculation of seeds, seedlings or growing plants, with selected microorganisms can be used for effective plant-microbe association leading to increased productivity. Major groups of these associations are: Rhizobium-legumes; free living microorganisms-variety of plants; Frankia-actinorrhizal plants, and mycorrizae-host plant. Rhizosphere provides an opportunity for the isolation of microorganisms that can be used for biotechnological applications. Most studies on the rhizosphere have, however, been carried out on short duration plant species. The microbial community in an established tree rhizosphere should be more specific owing to the prolonged length of time occupied by the plant species, and due to the interaction amongst different types of microorganisms. This study includes isolation and purification of microbes from the rhizosphere soil. These isolates are being studied for their biological properties. The selected beneficial isolates can then be used for inoculation of seed, cutting/tissue culture raised plants. The microorganisms support plant growth in several ways: (1) By fixing atmospheric nitrogen, (2) By producing antimicrobial metabolites, (3) By synthesising and secreting phytohormones, vitamins and siderophores, (4) By solubilising the rock phosphates, thus making it available to plants.

Objectives

1. To study plant-microbe and microbe-microbe interactions in tree rhizosphere. This includes three microbial communities- bacteria, actinomycetes and fungi.

2. *In vitro* screening of isolated microorganisms for biotechnological applications.

3. Selection of efficient root colonisers from isolated strains.

4. Developing inoculants of promising isolates for improved establishment of plant species.

5. Maintenance of these isolates.

6. Inoculation of crops with free living bacteria.

Results and Achievements

1. Isolation of bacteria, actinomycetes and fungi are being carried out from rhizosphere of *Cedrus, Taxus, Pinus* and tea. These isolates are being screened for their biotechnological properties.

2. Microbiology of tea rhizosphere: Studies on succession of microorganisms with age at species level, from various Himalayan locations, has been completed. An established tea rhizosphere harbours strongly antagonitic microbial species, providing a natural source for isolation of biocontrol agents. The screened antagonistic bacterial isolates are being used in tissue culture and with cutting raised tea plants.

3. Improvement of *Taxus* seed germination through various microbiological treatments: A detailed experiment has been carried out for improving *Taxus* seed germination. Various microbiological treatments included use of rhizosphere soils of *Taxus, Cedrus, Pinus* and non-forest soil and also pure bacterial and actinomycetes cultures isolated from *Taxus* and *Cedrus* rhizosphere. Germination improved in various treatments. Over seventy per cent germination (maximum) was observed in non-forest soil.

4. Maize experiment: A detailed experiment has been carried out at different elevations in Mamlay watershed, Sikkim. Local maize varieties were bacterised (seed inoculation) with five cultures of known free living bacteria (three strains of *Azotobacter chroococcum* and two of *Azospirillum brasilense*). The experiment resulted in improved plant performance at 1200m (Kamrang). Yield increase upto an extent of 115% over control was recorded. The experiment, however, did not yield promising results at higher elevations. This might be due to lack of resistance to low temperature in the used bacterial strains, indicating need for isolation of native bacterial strains, which can later be developed as inoculants for higher altitudes. A large scale screening has been done for selection of efficient native beneficial bacterial isolates from rhizosphere and rhizoplanes. Two Gram -ve rhizobacteria have been selected on account of several important physiological properties- viz., (a) nitogenase positive activity, (b) antifungal property, (c) phosphate solubilisation and (d) resistance to low temperatures.

5. Water microbiology: The natural spring and river (3 different sources each) water samples were examined for the detection of *Escherichia coli*, a pathogenic indicator. The spring water was almost bacteria - free, water of two rivers; Kosi and Nanakosi harboured only soil borne, non-pathogenic bacteria. Water samples from the Jageshwar river (Jata Ganga) gave relatively higher bacterial counts. Water samples were also analysed during festival time which is celebrated annualy at Jageshwar during monsoon season. These samples gave very high *E. coli* counts indicating human interfernce as the major source of river pollution.

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

Background

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

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

overcoming the problems of poor viability, dormancy, etc.), vegetative/ clonal propagation are equally important, and can be supplemented by the development of newer technology of plant tissue culture for target taxa of each region.

Objectives

1. To identify physical and chemical treatments, including plant growth regulators, for successful rooting of cuttings and to standardize techniques for large scale applications.

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

3. Conservation of endangered/ threatened species.

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

Results and Achievements

1. Clonal propagation of *Taxus baccata*, a source of anticancerous drug taxol, had been reported (Annual Report 1993-1994) using young shoots of 1st year growth. Besides the auxin, indole-3-butyric acid which has been found to be an effective root inducer (90% success), a systemic fungicide and several other chemicals have been found suitable. These included another auxin a-napthalene acetic acid (>70%), a combination of IBA + NAA (35%), a phenolic compound, phloroglucinol (40%), and a systemic fungicide bavistin (80%). This result has enabled us to recommend the most suitable chemical for commercial clonal propagation, and to understand the physical and biochemical basis of adventitious root formation in *T. baccata* cuttings (Fig. 6).

Fig. 6. Representative photograph of rooting response obtained following various chemical treatments.

2. The seasonal effect on rooting capacity of *T. baccata* cuttings was examined and the most appropriate time of the year was found to be when cuttings were collected, planted and raised in the rainy season (July) in comparison to that in autumn (October), winter (January) and spring (April). High humidity is present during the rainy season and special efforts are not required to create humid conditions necessary for root initiation.

3. The performance of cutting-raised plants in a polyhouse at an altitude of 1150m (Kosi) has been monitored; growth (>95% increase over initial height) and survival rate (>85%) have been excellent even 10 months following rooting. It must be mentioned that the growth of 2 year old cutting raised plants was comparable with that of 6 year old seedling.

4. In an attempt to conserve this species in its natural habitat, more than one hundred clonally propagated plants were transferred in the forest (Jageshwar). Growth (65% increase over initial height) and survival (68%) following 8 months after transfer indicated satisfactory performance. These findings do imply that clonally propagated plants could be used for large scale afforestation programmes and that this threatened species can be conserved.

5. Attempts have been made to develop *in vitro* protocols for multiplication of *T. baccata*, and callus

culture has been developed from young stem segments on a solid medium supplemented with hormones.

6. The problem of dormancy exixts in several forest and alpine seeds. For example, in *Taxus baccata* regeneration is extremely poor (only 8%) with germination occurring in the second year under natural conditions. At Kosi, experiments have been initiated to optimize germination conditions. Under polyhouse conditions, germination was found to increase markedly in seedling trays. In a separate experiment, seeds were given various physical and chemical treatments and sown in a nursery bed at Institute. Scrubbling the seeds and HCl had promotive influence on germination (from 8% to 18%); however, GA_3 and BAP did not show any response.

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

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

Results and Achievements

1. Effects of short-term increase in CO_2 concentrations at varying temperatures on photosynthetic characteristics of *Ougeinia dalbergioides* (normal and variant) were studied.

2. Both normal and variant showed maximum photosynthetic activity at 30°C in ambient air (Fig. 7a).

3. Both normal and variant showed higher photosynthetic activity at 25°C when CO_2 concentration was 175 ppm. However, a significant decrease in photosynthetic activity was recorded when measurements were made at 35°C (Fig. 7b & 7c).

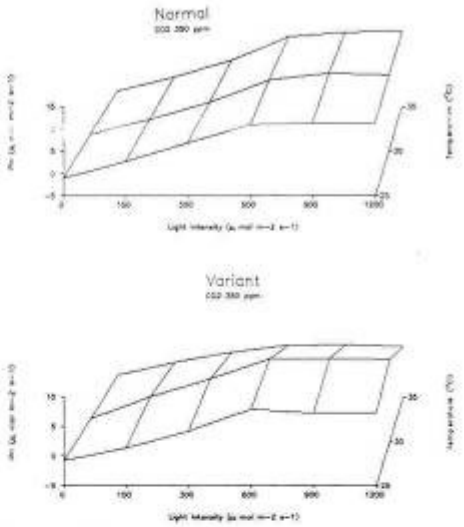


Fig. 7a. Light-temperature interaction on net photosynthesis of *O. dalbergioides* at 350 ppm CO_2.

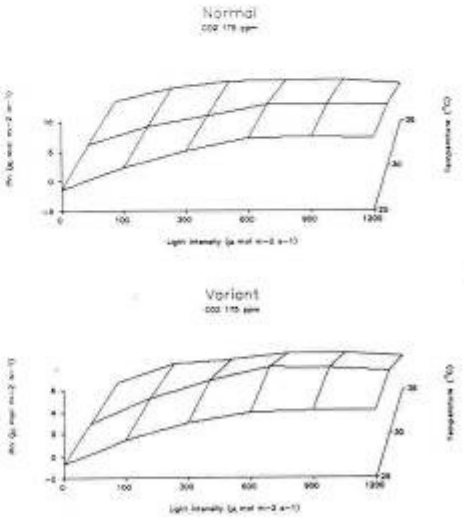


Fig. 7b. Light-temperature interaction on net photosynthesis of *O. dalbergioides* at 175 ppm CO_2.

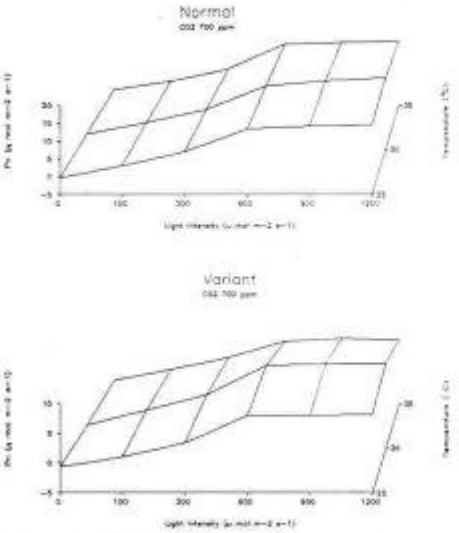


Fig. 7c. Light-temperature interaction on net photosynthesis of *O. dalbergioides* at 700 ppm CO_2.

4. Normal plants of *O. dalbergioides* responded better with higher CO_2 concentration as compared to variant. An increase of approximately 27% in net photosynthesis was observed in normal plants as compared to just 5% in variants.

5. An interesting feature of the present investigation was that though the variant showed low photosynthetic activity as compared to normal plants, it responded better at higher CO_2 concentration (700 ppm) and at higher temperature (35°C). At later conditions (CO_2-700 ppm and temperature-35°C), normal plants showed only 9% increase in photosynthetic activity whereas the photosynthetic activity of variant was increased by 60%.

6. Both normal and variant showed a significant decrease in stomatal conductance and a significant increase in water use efficiency at higher CO_2 concentrations.

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

Background

Progressive degradation of natural resources in the Himalayan region under the impact of heavy biotic pressure has assumed serious dimensions. Due to depletion of green hills, Himalaya are rapidly changing into barren or waste lands and people are facing severe environmental crises, rural poverty and unemployment. Revegetation of such lands by raising appropriate mulptipurpose trees is the best way to combat this problem. The project envisages the importance of initiating plantations of economically viable selected tree species of the region by developing simple nursery and *in vitro* packages, which will be eventualy made available to the local populace . This can serve the dual purpose of meeting the optimum demands for renewable energy resources and also to uplift the economic status of the local inhabitants.

Objectives

1. Identification and quantification of the resource availability.

2. Monitoring intra-specific morphogenetic variability of selected species.

3. Identifying temporal and edaphic constraints in nursery culture techniques.

4. Drawing specific qualifying attributes for initiating *in vitro* culture.

5. Evolving suitable tissue culture techniques for selected species.

6. Monitoring biological/edaphic adaptations of seedlings raised through tissue culture.

7. Developing propagation protocols both for nursery and *in vitro* methods.

Results and Achievements

1. After an extensive study for different parameters (i.e. annual fruit productivity, seed weight, etc.) an elite individual has been selected from the natural *Sapium* populatuion. Plant material from the elite tree is being utilized for the mass multiplication through biotechnological tools.

2. Seed germination studies for *Bauhinia* revealed that soaking in GA_3 enhanced germination as well as subsequent seedling growth, however, in case of *Diploknema* seed imbibition was found to be effective resulting in 90% germination. *Sapium* seeds showed early germination when chemically scarified with sulphuric acid.

3. Prominent root formation was observed in *Bauhinia* cuttings treated with IBA in spring season. In case of *Diploknema* cuttings, amongst the various treatments tried, auxin combination gave best results in terms of root number and length, whereas higher concentrations of auxin promoted callus formation. *Sapium* cuttings exhibited foliar sproutings but failed to root even with the aid of rooting hormones.

4. Multiple shoot induction has been achieved from hypocotyl segment of *in vitro* raised seedlings in case of *Bauhinia*. *In vitro* propagation procedure from seedling explant of *Diploknema* has been standardized. Complete protocols for micropropagation and callus regeneration from mature Sapium has been prepared and *in vitro* raised plantlets have been transfered to soil for acclimatization.

3.5.5. Conservation and Multiplication of Himalayan Threatened Plant Species

Background

In the recent past, habitat destruction and over exploitation of high altitude plants from the Himalayan region has resulted in a considerable decrease in the population size of several species. In particular, frequency and density of medicinal herbs in their natural habitat has declined sharply and many of them have been declared threatened, rare or endangered. Considering the medicinal and economic value of some of these species and their present status, there is an urgent need to conserve this unique germplasm using conventional as well as modern biotechnological methods. In an attempt to initiate multiplication and conservation of these species, this project was sanctioned by the Department of Biotechnology with the following objectives:

Objectives

1. Identification of target areas and selection of endangered medicinal and economically important species.

2. To identify and overcome constraints in propagation through improved nursery practices and application of biotechnology.

3. To multiply elite clones of a few multipurpose species of local importance in large numbers for distribution.

4. Initiating *in vitro* multiplication where propagation through conventional means is difficult or very slow.

5. To impart training and awareness towards conservation.

Results and Achievements

1. Extensive surveys of Garhwal Himalayan region were conducted to assess the distribution and present ecological status of medicinal species. In the first phase of the project, the high altitude areas from Kedarnath Musk Deer Sanctury to valley of Flowers (District Chamoli) and Dayara (District Uttarkashit) have been identified as target sites.

2. Based on their economic and medicinal importance and decreasing population size, six species, namely *Aconitum balfourii, A. heterophyllym, A. violaceum, Nardostachys grandiflora, Picrorhiza kurroa* and *Podophyllum hexandrum* were selected as target species. The importance of these species is well documented in the literature. Field studies indicate that in most of the surveyed areas, the density of these species was very low (in some cases 5-7 individual plants/ha).

3. Seeds, rhizomes and other propagules of all the species and their various populations were collected and planted at the high altitude field station in Tungnath (3600m) and at Srinagar (550 m).

4. Studies on growth behaviour of these high altitude species indicate that most of them can bear thermal load and grow successfully at lower elevations. We have been able to raise a nursery of *P. hexandrum* at Srinagar (Fig 8).

Fig. 8. *P. hexandrum* flowring (left) and vegetative shoot (right) growing at Srinagar.

5. Seed germination behaviour of all the six species has been studied. To overcome constraints in germination, various hormonal treatments were used.In general, gibberellic acid (GA_3) treatment was found to enhance seed germination. Except for *A. balfourii* and *N. grandiflora* where seed germination was low (about 50-60%) due to empty or non-viable seed, in all other species, 90-100% germination was achieved at 25°C, 16h light/8h dark (Fig. 9). However, temperate populations of *P. hexandrum* showed very poor seed germination and scarification of seeds was found to be very effective as compared to hormonal or temperature treatments.

Fig. 9. Seed germination in *P. hexandrum* (25°C, 16 hr light/ 8 hr dark).

6. Using various hormonal treatments (auxins and cytokinins), conditions suitable for vegetative propagation of all the species have been standardized. Indole-3- butyric acid (IBA) was found to be very effective in root initiation.

7. Protein and isoenzyme patterns of seeds indicate that polypeptides and certain isoenzymes are species specific and can be used as molecular markers in the identification of different species.

8. Among the species mentioned above, *P. hexandrum* has been identified as a species with maximum genetic diversity. Seeds of nineteen different populations have been collected and

analyzed. Our results indicate that these populations show not only morphological variations (plant height, leaf size, leaf number, fruit size and seed colour) but also, differences in their biochemical characteristics (qualitative and quantitative differences in protein profiles and isoenzyme patterns). Thus, various populations can also be identified using these molecular markers. This variation is a clear indication of a considerable genetic diversity in this species and selection of elite clones should be possible after a detailed characterization of individual populations.

9. Conditions suitable for large scale propagation of these species using tissue culture are currently being standardized. Using various nutrient media and hormonal combinations, suitable conditions for the induction of viable callus cultures for *P. kurroa, A. balfourii* and *A. heterophyllum* have been established.

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

Background

Woody debris in the form of snags, logs, large branches and small twigs, and other detrital pools forms a major structural feature with many crucial ecological functions as habitat for other organism, in energy flow and nutrient cycling, thus influencing soil and sediment transport and storage in a forest system. The present study was undertaken in chir pine (*Pinus roxburghii*) at 1600 m amsl, banj oak (*Quercus leucotrichophora*), mixed (*Q. leucotrichophora, Rhododendron arboreum* and *Lyonia ovalifolia*) and tilonj oak (*Q. floribunda*) forests (all at 2500 m amsl).

Objectives

1. To quantify input of woody debris

2. To quantify input of leaf litter

Results and Achievements

1. Total wood fall was recorded in the range of 0.8 (mixed forest) to 3.5 (tilonj oak forest) t/ha.

2. Of the total wood fall, about 57% (tilonj oak forest) to 73% (chir pine forest) was recorded during summer season, followed by winter season (19- 31 %).

3. Total leaf fall was in the range of 1.1 (mixed forest) to 6.1 (banj oak forest) t/ha of which about 60-93 % was contributed by dominant species in their respective forests.

4. Input of miscellaneous litter (bark, reproductive parts, etc.) varied between 0.1 to 0.6 t/ha.

5. Total organic matter (wood + leaf + miscellaneous litter) entering the detrital pool was in the range of 2.2 to 8.6 t/ ha of which about 23 to 40 % was contributed by wood.

3.5.7. Network programme for mass propagation and improvement of tree species of the Himalayan region

Background

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

Objectives

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

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

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

4. Standardization of accelerated- optimal-growth conditions for reducing nursery time before transplanting in the field.

5. Optimization of hardening conditions and successful lab to land transfer of tissue culture raised plantlets, with emphasis on understanding of physiological/ biochemical/structural changes.

6. Studies on microbial inoculation, including mycorrizae for better establishment of seed/ cutting/tissue culture raised plants.

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

Results and Achievements

1. Clonal propagation of maggar bamboo and tea has been achieved.

2. Tissue culture protocols for tea and maggar bamboo are being standardised for large scale implementation.

3. Tissue culture raised plants of *Dendrocalamus strictus* (2 clones) and cutting raised plants of *D. hamiltonii* (maggar bamboo) have been planted at a number of locations in Kumaun, Garhwal and Sikkim.

4. Seed biology work is in progress on *Pinus wallichiana* and *Cedrus deodara*.

5. Accelerated-optimal growth conditions have been standardized for a number of tree species. In general, polypit has been found to be most suitable.

3.5.8. Asian Biotechnology and Biodiversity subprogramme of UNDP- FARM project: A case study of Haigad watershed

Background

The Asian Biotechnology and Biodiversity subprogramme is one of the seven sub programmes of the FARM (Farmer Centered Agricultural Resource Management) programme initiated by UNDP/FAO/UNIDO. FAO is the executing agency and the Department of Biotechnology, Govt. of India is the main implementing agency, with the overall responsibility for Regional Cordination and Monitoring. Participating Countries include China, India, Indonesia, Nepal, Philippines, Sri Lanka, Thailand and Vietnam. The programme as a whole is targeted to enhance the capabilities of resource poor farmers for equitable and sustainable developments in order to achieve improved conservation, management and utilisation of natural agricultural resources and systems through participatory approach. The sub-programme specifically aims at providing information on new biotechnologies and assessing these to determine their potential to contribute to natural resource management.

Objectives

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

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

3. To undertake trials on the potentials of new biotechnologies to contribute to the characterisation, conservation and utilisation of biodiversity by the farming communities.

Results and Achievements

1. Land use systems in the Himalayan region of India comprise forests, agriculture, horitculture, agroforestry, and animal husbandry. These components are interdependent and play a vital role in maintaining the economy of the region. These factors are being assessed and have been partly documented in the Haigad Watershed (29° 55' N to 30° N latitude and 79° 30' E to 79° 34' E longitude, Fig. 10), located in the northern part of District Almora, and having an area of 19 sq km. The watershed comprises 7 villages along an elevational gradient of 1180 m to 2338 m.

2. Information with respect to relief and physiography, climate, forest vegetation, population, landuse, crops and cropping patterns, horticulture and agroforestry have been compiled.

Fig. 10. Harigad watershed.

3. Further prospects of agroforestry in relation to silvi-pastoral and silvi-horticultural systems have been identified.

4. The documentation of rural biotechnological practices prevailing in the watershed have been studied. These include preparation of alcoholic drinks (kachhi), leather tanning and extraction of fibres through retting.

5. A number of high quality stocks of fruit trees (e.g., apricot, apple, peach, pear, pecan nut, almond and walnut), and vegetables have been introduced. Good quality seed and seedlings of seasonal vegetables are provided from time to time. Cash crops, e.g., Bulgarian rose, saffron and tea have been planted for trial.

6. Trials have been initiated with respect to weed composting and the use of bio-fertilizers on some locally grown crops.

3.6. QUICK APPRAISAL STUDIES

3.6.1. Remote-Sensing Applications for Snow Cover Characterization in the Morphogenetic Regions of Upper Tista River Basin, Sikkim

Background

Tista river is a snow-fed Himalayan river and drains through entire Sikkim state. Its upper basin includes its morhpogenetic regions with perennial snow cover and glacier, which constitute an

Fig. 11. Satellite FCC showing the snow cover of upper Tista river basin.

impressive volume of frozen water deposit. The snow cover and glacier mapping have the scope of establishing the hydrological parameters of run-off and discharge of Tista river. For this, seasonal snow-melt trends are important and are widely recognized for forecasting seasonal run-off discharge pattern for various purposes. Efficacy of remote-sensing applications for snow cover delineation, characterization and permanent snow line determination have been worked out using IRS LISS II satellite imageries. IRS satellite scenes in the spectral bands of 1 (0.45-0.52 μm), 2 (0.52-0.59 μm), 3 (0.62-0.68 μm) and 4 (0.77-0.86 μm) with FCC (Fig.11) composition of bands 2, 3 and 4 were found to be useful for snow and glacier ice cover mapping. Application methodology and utility have also been worked out.

Observations:

1. Snow cover map (Fig. 12) prepared for November 1992 during post-melting and pre-snow fall season shows the following snow and glacier ice cover types with their spatial distribution for a total area area of 1106.05 km^2: Full snow cover - 9%, Partial snow cover - 18%, Scanty snow cover - 66%, Glaciers - 7%.

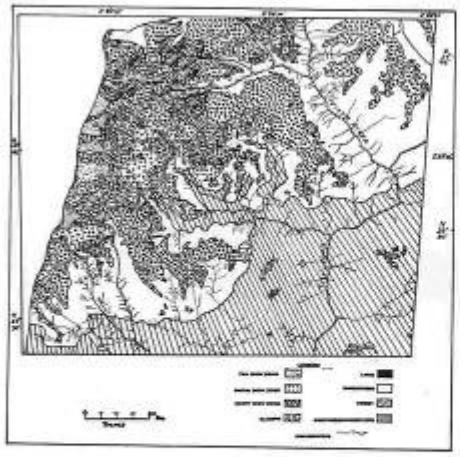


Fig. 12. Snow cover map of upper Tista river basin interpreted from satellite FCC.

2. The major glaciers identified and their relative per cent area cover is as follows:

Zemu - 39; Talung - 16; Changsang - 7; Tongshiong - 7; Onglakthang - 5; Jumthulphuk - 5; East Rathong - 5; Simvo and Siniolchu - 4; Twin - 4; Lhonak (North and South) - 4; Umramkhang - 3.

3. A superimposition of snow cover map on topographic sheets for altitudinal information has yielded permanent snow line altitudenal range of 4870 m to 4885 m in this region.

4. Snow covered area (SCA) and snow water equivalent (SWE), on seasonal basis, coupled with hydrometeorological data on snowfall, rainfall and temperature are expected to help in run-off and discharge predictions for this river.

3.6.2. Eco-Tourism in Sikkim

Background

There has been a constant increase in the number of tourists visiting Sikkim over the years. Number of foreign tourists has also increased since 1990 due to opening of many restricted areas. However, most tourists visit Gangtok and nearby areas only, and hence there is a vast scope to divert this tourist flow to other areas of Sikkim with enormous potential for nature lovers. Such decentralized tourist activities can provide opportunities to the local and remotely placed people into new enterprises, if Eco-tourism (nature oriented tourism) is planned carefully. With this view a survey was made in various parts of Sikkim to see the possibility of eco-tourism activities, and the role of the local community to take benefit out of this. Some important points have emerged while visiting different parts and discussing with local people in a two months survey :

Observations:

1. Tourist traffic has increased in recent years in Sikkim from about 15,434 tourists in the year 1980 to 99,322 in 1994. While the majority of tourists (60-70%) visited for recreational purposes, about 35% of foreign tourists were trekkers; 21% tourists (domestic and foreign) visited for official/business purposes. Majority of Indian tourists were from West Bengal (65%), followed by Delhi (10%), Bombay (6%), Madras (5%) and others were from the north-east region and from within Sikkim.

2. Yuksam (1500 m)-Dzongri (3939 m) trail in the west Sikkim is most popular trekking route and gives a good view of thick forests, and is popular for bird watching and other wildlife, alpine pasture and Kangchenjunga mountains. Tsangoo (3600 m, east Sikkim) is another point of tourist attraction due to a high altitude lake and nearness to Gangtok. About 90% of tourists coming to Sikkim visit this place. Lachung and Yumthang areas in north Sikkim are famous for *Abies* and *Rhododendron* forests. There are other potential areas which are least exploited, e.g. Fambong Lho wildlife sanctuary, Kangchenjunga National Park, Green lake, Maenam wildlife sanctuary, Versay *Rhododendron* sanctuary, and thus holds considerable hope for future expansion of tourism activities.

3. While there are many attractions in these routes/ areas, there has been some land degradation in recent years due to huge quantity of firewood being used, timber extraction, livestock grazing, litter along the routes. These pose threats to general vegetation and wildlife.

4. Discussion with the locals revealed that there is scope to expand eco-torism activities and preserve biodiversity in these areas. Local people can be benefitted by new economic activities in view of the influx of tourists. A tourist fee can be used to initiate a programme to clean the environment, e.g., by litter and garbage collection, and plantation of indigenous plant species.

3.6.3. Medicinal Plants of the Sikkim Himalaya : Status, Usage and Potential

Background

The hills of Sikkim and Darjeeling are well known for a wealth of medicinal plants, especially the upper regions of Sikkim Himalaya. A standard reference work on the subject, however, has not been available so far. The Institute ventured to work on this long-felt need and compiled a comprehensive document, which has been published in the form of a book.

Observations:

More than 40 medicinal herbs were identified and described; these were classified into the following 5 groups in terms of their efficacy and market potential:

1. Plants claimed as drug source (proven value plants) and marketed in large quantities (*Aconitum ferox, Nardostachys grandiflora, Picrorhiza kurrooa, Piper longum* and *Swertia chirata*).

2. Plants claimed as drug source (proven value plants) but marketed in small quantities (*Acorus calamus, Astilbe rivularis, Bergenia ciliata, Heracleum wallichii, Holarrhena antidysenterica, Mesua ferrea, Orchis latifolia, Podophyllum hexandrum, Rhus semialata, Terminalia belerica, Terminalia chebula, Viscum articulatum* and *Zanthoxylum alatum*).

3. Plants with effective use but not marketed (*Artemisia vulgaris, Clematis buchananiana, Costus speciosus, Drynaria cordata, Eupatorium cannabinum, Ficus cunia, Pteris biaurita, Rumex nepalensis* and *Urtica dioica*).

4. Plants which have been recently explored (*Panax pseudo-ginseng, Prezwalskia tangutica* and *Taxus baccata*).

5. Plants claimed as being medicinal (potential or latent value plants) *Dichroa febrifuga, Fraxinus*

floribunda, Hynenodictyon excelsum, Hydrocotyle asiatica, Litsaea citrata, Oroxylum indicum, Paederia foetida, Physalis minima, Phytolacca acinosa and *Thysanolaena maxima.*

Since the medicinal plants trade is an established business in the region, a sketch on the origin of business points, different channels and markets were covered. Different governmental and voluntary bodies involved in the culture, extension and other spheres of medicinal plants trade were also detailed. Various unexplained features surfaced after the investigation and consequently future programs were chalked out. The extent of extraction and environmental impact of the practice, as well as personnel involved in the process have also been identified. The availability record of medicinal plants at different areas in the Sikkim Himalaya is also projected. Different local practices in the use of medicinal plants have been documented, and for the first time an exhaustive bibliography on the subject has been compiled.

3.6.4. Cloudburst: the disastrous natural calamity in Kullu District, Himachal Himalaya

Background:

During the rains of 1994, a series of cloud burst events created terror among the residents and

Table. 12 : General attributes and resource loss due to cloudburst at different places in Kullu, Himachal Himalaya

Attributes	*Shat*	*Phojal*	*Baladhi*
General			
Tragedy (day,date and time)	Monday July,11 4.45pm	Wednesday August,10 2.25am	Monday August,22 10-30pm
Place (village and nullah)	Shat Garh, Shat	Phojal, Phojal	Baladhi, Baladhi
Distance from Kullu (km)	26	20	30
Elevation of village (m)	1360	1780	1357
Elevation near cloudburst (m)	2500-3000	2200-3000	2500-2800
Heavy precipitation time (minutes)	15-30	30-45	50-80
Occurrence		twice	twice twice
Water flow height in nullah (m)	7-8	3-5	5-7
Nullah width before cloudburst (m)	25-33	5-7	2-3
Nullah width after cloudburst (m)	65-75	15-25	25-30
Debris deposition in nullah (m)	7-8	3-5	1-2
Resource loss (Number and area)			
Casualty (human)	27	11	9
Casualty (animal)	70	-	14
Injured person	14	-	2
Bridge (cantilever)	1	1	-
Bridge (wooden)	-	1	1
Residential house	7	4	3
Sheds/Khokha	12	21	2
Watermills	14	5	4
Washed vehicles	4	3	-
Uprooted forest trees	2500-3000	1200-1500	300-500
Uprooted horticultural trees	125-150	75-100	110-135
Agro-horticultural damages (ha)	3-4	4-5	2-3

caused havoc in many area of Himachal Pradesh. A total of 43 human and 353 animal casualties were reported. Moreover, 219 houses and cowsheds, 59 water mills and 15 tea and other shops were washed away. District Kullu in particular was badly affected by this abnormal rain. Other adversely affected districts included Una, Solan, Chamba, Kinnaur, Hamirpur, Kangra, Lahaul-Spiti and Bilaspur. A preliminary survey was made at three badly affected sites, i.e. Shat, Phojal and Baladhi in Kullu district of Himachal Himalaya to record the damage. Table 12 gives details of resource loss at three major affected areas of Kullu district.

4. INSTITUTIONAL NETWORKING AND HUMAN INVESTMENT

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

This programme has enabled Institutional Networking for the development of a comprehensive action oriented research during the year. Under two broad thrust areas, namely technology development and research for integrated eco-developed, and technology demonstration and extension, 54 project proposals were considered and examined critically by the PEC members in 1994-95. As per the recommendations of the Project Evaluation Committee, 17 projects (10 to universities, 15 to autonomous organisations/ institutions and 02 to NGOs) were processed for funding during the year.

For the regeneration of degraded lands in the hills of Indian Himalaya 7 project proposals were recommended for funding by the PEC during the year on the theme of SWEET (Sloping Watershed Environmental Engineering Technology), a package developed and tested by the Institute. At present this activity is undergoing in 7 states (i.e. J&K, H.P., Assam, Arunachal Pradesh, Mizoram, Hills of U.P. and W.B.) of the Indian Himalaya. In all, 45 projects are being carried out in the reporting year, and 1 project, sanctioned by the Institute, has been completed during the year. IERP activities have spread out to 10 states of Indian Himalaya at present.

The details of the project proposals, sanctioned during the year, are as below :

1. Landuse and land capability mapping in part of Kumaun lesser Himalaya. (Dr. P.C. Tiwari, Deptt. of Geography, Kumaun University, Nainital).

2. Evaluation of Agro-Silvi- Horticultural system as an appropriate pattern of landuse for development of the hilly tracts of Arunachal Pradesh. (Dr. Binay Singh, Deptt. of Forestry Science, NERIST, Nirjuli, Itanagar, Arunachal Pradesh).

3. Studies on the eco-biology of selected tributaries of river Ganga between Devprayag-Rishikesh. (Dr. B.D. Joshi, Indian Academy of Environmental Sciences, Hardwar, U.P.).

4. Microbiological and biochemical studies of the traditional fermented beverages of Darjeeling Hills and Sikkim. (Dr. J.P. Tamang, Deptt. of Botany, Sikkim Government College, Tadong, Sikkim).

5. Demographic, biological and cultural proximates of health and disease in Arunachal Pradesh. (Dr. A.K. Ghosh, Deptt. of Anthropology, NEHU, Shillong).

6. Domestication of potential indigenous wild/ semi-wild vegetables of Manipur for conservation and possible utilization of Marshy/marginal lands for vegetable production. (Dr. M. Rohini Kumar Singh, Deptt. of Plant Breeding and Genetics, College of Agriculture, Central Agriculture University, Imphal, Manipur).

7. Assessment of biodiversity and infraspecific variation among two reputed medicinal plant genera *Aconitum* L. (Ranunculaceae) and *Podophyllum* L. (Podophyllaceae) in the Himalaya. (Dr. R.R. Rao, NBRI, Lucknow, U.P.).

8. An approach to rejuvenate the wastelands of North-West Himalaya through dually (Rhizobium and VAM) inoculated seedlings of *Robinia pseud-acacia*. (Dr. K.P. Raverkar, Deptt. of Soil Science, Dr. Y.S. Parmar UHF, Nauni, Solan, H.P.).

9. Environmental monitoring and management of watersheds in Himalayan region - A case study of Sirkhad in Himachal Pradesh. (Prof. H.N. Misra, Deptt. of Geography, H.P. University, Shimla, H.P.).

10. Demonstration of Sloping Watershed Environmental Engineering Technology for restoration of degraded lands in Garhwal Himalaya. (Dr. N.P. Todaria, Deptt. of Forestry, HNB Garhwal University, Srinagar, U.P.).

11. Model Development of Agro-Horti-Silvi system using Sloping Watershed Engineering Technology in Yangmakung village at the foothills of Kalimpong in the eastern Himalaya. (Mr. S.D. Lama, Federation of Societies for Environmental Protection, Darjeeling, W.B.).

12. Application of Sloping Watershed Environmental Engineering technology for restoration of degraded Jhum land in Arunachal Pradesh. (Dr. S.P. Singh, Deptt. of Forest Genetics, SFRI, Itanagar, Arunachal Pradesh).

13. Vegetating the barren soils along Nikki-Tawi river bed using SWEET. (Dr. A.K. Koul, Deptt. of Bio-Sciences, Jammu University, Jammu, J & K).

14. Demonstration of Slopping Watershed Environmental Engineering Technology for restoration of degraded lands in Himachal Pradesh. (Dr. S.D. Bhardwaj, Deptt. of Silviculture and Agroforestry, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P.).

15. Degraded soil and plant restoration in Jhalukbari hill slopes using SWEET. (Dr. Sarda Kanta Sarma, Deptt. of Botany, Gauhati University, Guwahati, Assam).

16. Establishing models for rehabilitation of degraded Jhum land in a watershed using SWEET in Mizoram Himalaya. (Dr. L.K. Jha Deptt. of Forestry, School of Agricultural Science and Forestry, NEHU - Mizoram Campus, Aizwal, Mizoram).

17. Biotransformation of lantadenes, the pentacyclic triterpenoids from Lantana (*Lantana camara*). (Dr. Om Prakash Sharma, IVRI, Regional Station, Palampur, H.P.).

In addition to above projects, financial commitments of 28 projects, sanctioned earlier, were also fulfilled during the year. One project has been successfully completed during the year and recommendations of this project have been sent to the concerned departments of state/central Govt. for follow-up action. Furthermore, follow-up action on 82 completed project files (transferred by the Ministry of Environment and Forests, Govt. of India to the Institute in 1992- 93) has also been initiated during the year.

Two meetings under the IERP were organised during the year: Fifth Project Evaluation Committee (PEC) meeting (17-18 October, 1994, Itanagar, Arunachal Pradesh), and Sixth Project Evaluation Committee meeting (March 13, 1995, Lucknow, U.P.).

4.2. Environmental Awareness Programmes

The participation of students to ensure timely spread of conservation message and to generate long term involvement for environmental protection has long been felt. To start with, one day programme in this regard was organised by the Garhwal Unit at Prof. K.K. Nanda Memorial Hall, HAPPRC, Srinagar, Garhwal. 150 students of St. Theresas' Convent and Central School participated in the programme. Environmental awareness programme involving school children of a local school (Trinity School) was also launched by the Himachal Unit during the year. A field based

awareness camp was also organised by both the Units; cleaning of surounding areas by removing pollutants such as plastic/polythene bags/other garbage and planting of tree seedlings were undertaken.

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 Head Quarter- Kosi, Almora. The day was also celebrated by some of the scientists of the Institute in the premises of a local primary school at village Arah (1540 m amsl; 5 kms up from the main township of Garur, Almora). The function was attended by the villagers/women, school children, NGOs; the function concluded by planting of seedlings and visit to the 8.5 ha development site at Bulgari (Arah). Himachal Unit at Kullu also organised the function by involving local school children in essay and slogan competition which was followed by prize distribution ceremony. N.E. Unit of the Institute celebrated the World Environment Day at Changki Village, Mokokchung District, Nagaland which was attended by the members of Changki village council, the Changki Students' Union and teachers of the Changki High School. Saplings of Banyan (*Ficus bengalensis*) and other local species were planted by the members of the village council and teachers. Banyan trees were also planted by the students, signifying their commitment to the environmental cause.

A meeting on 'Perception of Peoples' representatives on environment and development' was also organised in Joshimath (Chamoli, Garhwal, U.P.) on the occasion of World Environment Day. Among others, the participants included Maj. Gen. (Retd.) B.C. Khanduri, M.P.; Shri K.S. Fonia, MLA; Shri Ramesh Pokhiyal, MLA; Shri R.P. Tamta, MLA and Shri N.B. Joshi, ex MLA of the Central Himalayan region. In all, about 80 participants attended the meeting. The meeting recommended the restoration of degraded lands in and around Badrinath Dham. The recommendations also focussed on the need to develop and strengthen environmental awareness and education campaign in remote areas so that the impoverishment of the natural resources could be prevented.

4.3. Training Programmes

Nine days training programme on Tree Plantation Techniques to Army Personnel (Environment and Nature Conservation) was organised in the Institute from 20-28 January, 1995. Six army personnel nominated from different sectors (i.e. from 8 RAJRIF, 1/9 GR and 99 BDG Signal Coy) attended the training course. This preliminary training programme was imparted for the first time during the year. The positive response from the trainees indicated that there is an urgent need to create environmental awareness among various segments of the society. Therefore, it is proposed to hold short term training courses during the next financial year at different locations in the Indian Himalaya. The proposed short term training programmes will have a component of on site field/ practical demonstrations and will be imparted to ex-service men/ army personnel, villagers/farmers/rural women and NGOs on Nursery Development, Tree Plantation Techniques and Natural Resource Conservation and Management.

4.4. Dissemination of information through Networking

In conformity with the mandate of the Institute, the Core is actively involved in the dissemination of knowledge through inhouse publications, such as Hima-Paryavaran to various institutions (traditional, academic and research) working in the Indian Himalaya. In this context a number of NGOs and academic institutions are seeking technical inputs from the Institute which are being provided by the scientists. It is expected that this activity will be strengthened in due course.

4.5. INSTITUTIONAL COLLABORATION AND PUBLICATION

4.5.1. Tropical Soil Biology and Fertility Programme Coordination Centre

Funding for a large programme with the focal objective of analysing the factors and processes affecting soil biology and fertility in representative agricultural systems across the Himalaya was pursued. An attempt on analysis of existing and ongoing efforts in soil biology and fertility in the perspective of the programme is being made.

4.5.2. ENVIS Centre

Environmental Information System for Himalayan Ecology carried forward its activities of information storage, retrieval and dissemination. Some computer based audio-visual aids were added to the preexisting hardware during the year. These additions are expected to improve the process of technology transfer, disseminataion of experiences of success stories and environemtal education and awareness.

4.5.3. Kaifal - A promising under exploited tree crop of the Himalaya

Woody plant species play a crucial role in meeting the needs of Himalayan people. The work was undertaken to evaluate the potential of one of the important under exploited tree species, namely *Myrica esculenta* (Kaiphal), of the Himalaya. In particular the prospect of Kaiphal in generating hill economy has been studied.

4.5.4. Environmentally Friendly Hill Development- An approach for District Chamoli

(see last Annual Report for details)

4.5.5. Medicinal Plants of the Sikkim Himalaya: Status, Uses and Potential

(see under quick appraisal studies)

5. MISCELLANEOUS ITEMS

5.1. SOCIETY AND GOVERNING BODY MEETINGS

During this year the G.B. Pant Society of Himalayan Environment & Development met on November 11, 1994 in New Delhi under the chairmanship of the President, Honourable Minister for Environment & Forests, Shri Kamal Nath. The Governing Body of the Institute met thrice during the year, on July 19, 1994 at New Delhi, on October 24, 1994 at Guwahati and on January 17, 1995 at New Delhi. The Project Evaluation Commitee held meetings on October 18-19, 1994 (Itanagar) and on March 13, 1995 (Lucknow).

5.2. ADDITIONS TO LABORATORY AND LIBRARY

Research activities of the Institute have been further strengthened. An Ultrasonic Cleaning Bath (Decon Lab), MilliQ Water Purification unit (Millipore), a set of trinocular research microscopes (Nikon), Seed germinators and BOD incubators (both NSW) have been installed at Kosi-Katarmal. A complete Electrophoresis System with an Image Analysis unit (Bio Rad) has been installed, a Plant Tissue Culture Laboratory and Soil Analysis facilities have been developed at Srinagar Unit. An Electronic balance (Afcoset), Refrigerated Centrifuge (Remi), Nitrogen Analyset (Tecator), Research Microscope (Nikon), and BOD incubator (NSW) have been procured at the Sikkim Unit.

With the addition of books during the year 1994-1995, the total number of books available in the Library is now 6000. A number of good books on Information Science have been transferred from the Environmental Information System (ENVIS) Centre; some books were also received from Norwegian Centre for International Agriculture Development, Norway.

5.3. MEMBERSHIP OF SPECIALIZED COMMITTEES/SOCIETIES

- Prof. A.N. Purohit was nominated from Asia in International Organising Committee on Mountain Agenda.
- Dr. L.M.S. Palni was elected member of the New York Academy of Sciences, USA.
- Drs. P.P. Dhyani, K.S. Rao & R.C. Sunddriyal have been elected Fellows of the National Institute of Ecology, New Delhi.
- Dr. E. Sharma has been selected as a resource person on Mountain Farming Systems of Hindu Kush Himalayan Region by ICIMOD, Nepal.
- Drs. S.S. Samant & D.S. Rawat as well as the Institute were awarded first prize in an exhibition organised by U.P. Science & Technology Council at Bageshwar (13-14 January, 1995).

5.4. PUBLICATIONS OF THE FACULTY

5.4.1. Scientific Papers & Reviews

Arya, A.S., **V. Joshi**, T.V.R. Murthy, A. Narayana, **K.G. Saxena**, J.K. Garg and A. Narain (1994). Landslides : A review and feasibility using remote sensing. Scientific Note. Space Application Centre, Ahmedabad. 1-27.

Awasthi, O.P., E. Sharma & L.M.S. Palni (1995). Stemflow : A source of nutrients in some naturally growing epiphytic orchids of Sikkim Himalaya. Annals of Botany 75: 5-12.

Badola, H.K. (1994). Bud phenological studies as an aid to forestry research: an overview. In: P.D. Dogra and R.C. Dhiman (eds.), Forestry Research and Education in India. Diamond Jubilee Publication, Indian National Science Academy, New Delhi. 142-153.

Bhadula, S.K. & A.N. Purohit (1994). Adaptational strategies of plants at high altitudes and future prospects for the conservation of biodiversity. In: K.C. Sahani (ed), Advances in Plant Sciences Research. International Book Distributors, Dehradun. 1-24.

Bhadula, S.K. and P.D. Shargool (1995). Glutamate dehydrogenase: Purification, properties and regulation. In: H.S. Srivastava & R.P. Singh (eds.), Nitrogen Nutrition in Higher Plants. Assosiated Publishing Company, New Delhi. 205-217.

Dhar, U. (ed.) (1995). *Himalay Ki Jav Vividhta Main Janta Ki Bhagidari* (in Hindi). GBPIHED, Almora. p 60.

Dhyani, P.P. (1995). Wild edible plant resources in Indian Central Himalaya - Need for Conservation (in Hindi). In: U. Dhar (ed), Himalay Ki Jav Vividhta Main Janta Ki Bhagidari. Gyanodaya Prakashan, Nainital. 25-31.

Dhyani, P.P. & U. Dhar (1994). Box Myrtle (*Myrica esculenta*, Kaiphal) - A promising underexploited tree crop of the Himalaya. Himavikas Occasional Publ. No. 3, GBPIHED, Almora. p. 33.

Farooquee, N.A., P.K. Samal, & K.G. Saxena (1994). Adaptation, culture and sustainability in a high land society - case of Bhotyas. Man and Life 20: 201-208.

Farooquee, N.A. & K.G. Saxena (1994). Adaptation, Conservation and livestock management in high hills of Central Himalaya : Indigenous knowledge and Practice. In: R. Somvanshi and R.R. Lokeshwar (eds.) Current Advances in Veterinary Science and Animal Production in India. International Book Distributing Co. Lucknow. 123-129.

Jain, A.P. (1994). Solid waste management in India. Proc. 20th WEDC Conference on Affordable Water Supply and Sanitation, Colombo, Sri Lanka. 177-182.

Joshi, S.C. and P. Tandon (1994). Sulfhydryls and leaf gall formation in *Ci-namomum tamala*. Geobios 21: 265-268.

Krishna, A.P., S.C. Rai & E. Sharma (1994). Land-use change detection through remote sensing : A case study of Mamlay watershed of the Sikkim Himalaya. J. Hill Research 7(2): 93-101.

Kumar, K. & Rawat, D.S. (1994). Impacts of domestic sewage disposal on natural water springs of Almora town. Uttaranchal 3: 35-40.

Maikhuri, R.K., R.L. Semwal, A. Singh, & M.C. Nautiyal (1994). Wild fruits as a contribution of Sustainable rural Development: A case study from the Garhwal Himalaya. International Journal of Sustainable Development and World Ecology 1: 56-68.

Maikhuri, R.K., A. Singh & R.L. Semwal (1994). *Prinsepia utilis* Royle: a wild edible oil shrub of the higher Himalaya. FAO/IBPGR Plant Genetic Resources 98: 5-8.

Nautiyal, A.R. & **G.C.S. Negi** (1994). Multipurpose tree species with potential for introduction in the Himalayan mountains. In: P. Singh, P.S. Pathak & M.M. Roy (eds.), Agroforestry Systems for Degraded Lands. Oxford & IBH Publishing Company, New Delhi. 269-278.

Nandi, S.K., A. Pandey & L.M.S. Palni (1994). Cancer cure from the Himalayan Yew. CHEA Bull. 7: 41-47.

Nandi, S.K. & L.M.S. Palni (1994). Shoot growth and winter dormancy in tea. J. Plantation Crops 21 S: 328-332.

Nandi, S.K., L.M.S. Palni & G.J.M. deKlerk (1995). The axial influence on the reserve mobilization and its replacement by cytokinins in germinating lupin seeds. J. Experimental Botany 46: 329-336.

Negi, G.C.S (1994). High yielding vs. traditional crop varieties : A socio-agronomic study in a Himalayan village in India. Mountain Research and Development 14(3): 251-254.

Palni, L.M.S. & A. Pandey (1994). Plant Biotechnology: Opportunities and Challenges. In: R. Somvanshi and R.R. Lokeshwar (eds.) Current Advances in Veterinary Science and Animal Production in India. International Book Distributing Co. Lucknow. 174-188.

Palni, L.M.S. & P. Farooqui (1994). Brainstorming session in Plant senescence- A Report. Current Science 67(6): 425-436.

Pandey, A. & S.T. Shende (1994). Comparative studies on microbial activity in *Azotobacter chroococcum* inoculated wheat (*Triticum aestivum*) rhizosphere by plate count and manometric methods. Microbial Research 149: 379-384.

Purohit, A.N. (1994). Ecophysiology of fast and slow growing trees and some emerging trends. J. Tree Science 13(1): 1-12.

Purohit, A.N. (1995). The Murmuring Man (Man in search of environmentally sound development). Bishen Singh Mahendra Pal Singh, Dehradun. p. 80.

Purohit, A.N. & A.R. Nautiyal (1994). Ecophysiology of trees: A prerequisite to improve tree productivity. In: P.D. Dogra and R.C. Dhiman (eds.), Forestry Research and Education in India. Diamond Jubilee Publication, Indian National Science Academy, New Delhi. 106-122.

Rai, L.K. (1994). Forestry and Conservation Issues in the Sikkim Hills. In: M. P. Lama (ed), Sikkim: Society, Polity, Economy and Environment. Indus Publishing Co., New Delhi. 255-271.

Rai, L.K. & E. Sharma (1994). Medicinal Plants of the Sikkim Himalaya: Status Usage and

Potential. Bishen Singh Mahendra Pal Singh, Dehra Dun. p. 150.

Rai, S.C., E. Sharma & **R.C. Sundriyal** (1994). Conservation in the Sikkim Himalaya : Traditional Knowledge and Land Use of the Mamlay Watershed. Environmental Conservation 21:30-34 & 56.

Rai, T.D. & **L.K. Rai** (1994). Trees of the Sikkim Himalaya. Indus Publishing Co., New Delhi. p. 120.

Rai, Y.K. & **L.K. Rai** (1994). *Citrus reticulata* in the Mamlay watershed, South Sikkim: Agroforestry practice and market system. J. Hill Research 7(2): 157-160.

Ramakrishnan, P.S., **A.N. Purohit, K.G. Saxena,** & **K.S. Rao** (1994). Himalayan Environment and Sustainable Development. Indian National Science Academy, New Delhi. p. 84.

Rao, K.S. & **K.G. Saxena** (1994). Sustainable Rural Development and Rehabilitation of Degraded Village Lands in Himalaya. Himavikas Publication No. 8, Bishen Singh Mahendra Pal Singh, Dehradun. p. 287.

Rao, K.S. & **K.G. Saxena** (1995). Effect of landuse on *Dendrocalamus hamiltonii* Nees & Arn. ex. Munro regeneration during early secondary successional stages in north east India. J. Tropical Forest Science 7: 347-354.

Rawal, R.S. & Y.P.S. Pangtey (1994). Altitudinal zonation of high altitude forests in Kumaun Central Himalaya, India. Ind. J. For. 17(4):332-344.

Rawat, D.S. & **K. Kumar** (1994). Drinking water scenario in villages of U.P. Himalaya. Uttaranchal 3: 41-46.

Samant, S.S. & I.S. Mehta (1994). The folklore medicinal plants of Johar Valley. Higher plants of Indian sub continent. Ind. J. Forestry (add. ser.) 3: 143-159.

Samant S.S. & Y.P.S. Pangtey (1994). Aquatic, marshy and wetland flora of district Pithoragarh (Kumaun Himalaya). J. Econ. Tax. Bota. 18 (1): 47-54.

Saxena, K.G., Y. Kumar, **K.S. Rao, K.K. Sen, U. Rana, G.S. Singh, B.S. Majila,** & **A. Pharswan** (1994). Hydropower Management for Sustainable Rural Development in Remote Unelectrified Zones of Himalaya (Microhydel - adapting the Technology and management with People's Participation in Pranmati Watershed in Ganga Catchment). Himavikas Publication No. 7, GBPIHED, Almora. p. 28.

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

Sharma, R., E. Sharma & **A.N. Purohit** (1994). Dry matter production and nutrient cycling in agroforestry systems of cardamom grown under *Alnus* and natural forest. Agroforestry Systems 27(3): 293-306.

Sharma, S. & S.P. Singh (1994). Energy use pattern and susatinable development: A case study in Central Himalaya. Landscape and Urban Planning 29: 19-24.

Singh, S.P., **G.C.S. Negi** & M.C. Pant (1994). Resource costs and environmental sustainability of agriculture-based and forest-based systems in Central Himalaya. In: M. Balakrishnan, R. Borgstrom and S.W. Bie (eds.), Tropical Ecosystems: A Synthesis of Tropical Ecology and Conservation. Oxford & IBH Publishing Company, New Delhi. 289-308.

Sood, A., **L.M.S. Palni**, M. Sharma, D.V. Rao, G. Chand & N.K. Jain (1994). Micropropagation of tea using cotyledon culture and encapsulated somatic embryos. J. Plantation Crops 21 S: 295-300.

Sundriyal, R.C (1994). Eco-conservation of microbial fauna in Himalayan agroclimate - utility and techniques. Manual on Integrated Pest Management Concept in Rice. Central Integrated Pest Management Centre, Govt. of India, and Department of Agriculture, Govt. of Sikkim. 26-28.

Sundriyal, R.C., E. Sharma, L.K. Rai & S.C. Rai (1994). Tree structure, regeneration and woody biomass removal in a sub-tropical forest of Mamlay Watershed in the Sikkim Himalaya. Vegetatio 113: 53-63.

Sundriyal, R.C., S.C. Rai, & E. Sharma (1994). Watershed-based participatory development strategy in Sikkim. In: M.P. Lama (ed.), Sikkim: Society, Polity, Economy and Environment. Indus Publication House, Delhi. 178-194.

5.4.2. Popular Articles by Faculty

Avasthe, R.K., R.C. Sundriyal, P. Singh and S. Pradhan (1994). Eco-restoration efforts of the Indian army in Mensithang, North Sikkim- A case study. SSS Newsletter 7(4): 21-23.

Choudhury, D.S. & S. Changkija (1994). Teenagers motivate villagers. Hima-Paryavaran 6(1):8.

Dhyani, P.P. (1994). Integrated eco-development research programme (IERP) in the Himalayan region. ENVIS Bull. 2(1): 45-49.

Farooquee, N. A. (1994). Transhumance in Central Himalaya. ENVIS Bull. 2(1): 53-56.

Jain, A.P. (1994). Solid Waste Management-Problems & Perspectives. ENVIS Bull. 2(2): 9-19.

Jain, A.P. & H. Kumar (1994). R & D funding in Himalayan region in India: A comparision. Hima-Paryavaran 6(1): 10-11.

Jain, A.P. & H. Kumar (1994). Environmental Information Management at GBPIHED. ENVIS Bull. 2(1): 1-4.

Jain, A.P. & H. Kumar (1994). Extramural R & D projects in the Himalayan region. ENVIS Bull. 2(2): 49-57.

Krishna, A.P. (1994). Environment and ecology - their assessment and management components. SSS Newsletter 7(2): 18-20.

Krishna, A.P., L.K. Rai & E. Sharma. (1994). Climatic data for the Sikkim Himalaya. SSS Newsletter 7(4): 18-20.

Kumar, K. (1994). *Ucch shikhariya chhetro me sor tapeya padap grahon ke prasangikta: ek aaklan* (in Hindi). Hima-Paryavaran 6(1): 17-19.

Kumar, K. (1995). *Jaiv vividhata ke sarakhshan main nrada aivam jal ki bhumika* (in Hindi). In: U. Dhar (ed.), *Himalay Ki Jav Vividhta Main Janta Ki Bhagidari*. GBPIHED, Almora. 48-50.

Maikhuri, R.K. & A. Singh (1994). Ames (*Hippophae rhamnoides*) from Garhwal Himalaya- a success story. Hima-Paryavaran 6(2): 9-10.

Maikhuri, R.K., and **A. Singh** (1994). Ames: A potential new crop for Himalayan Wastelands. Himalayan Paryavaran 2: 42-45.

Palni, L.M.S. (1994). Innovative model for replication- SASAC. Hima-Paryavaran 6(2): 4-6.

Palni, L.M.S., B.P. Kothyari, H.C. Rikhari, S. Bhuchar, G.C.S. Negi, E. Sharma, S.S. Samant, S. Bisht & D. Choudhury (1994). *Thysanolaena maxima* (Roxb.) Kuntze : A multipurpose perennial grass of high fodder value. Hima-Paryavaran 6 (1): 9.

Palni, L.M.S., S. Bhuchar & B.P. Kothyari (1994). A simple polypit can greatly reduce nursery time of tree seedlings. Hima-Paryavaran 6(2): 10-11.

Prasad, R.C. (1994). Some economic features of Indian Himalayan regions. ENVIS Bull. 2(2): 41-47.

Prasad, R.C. (1994). Biological production systems and land management approaches in the Himalaya. ENVIS Bull. 2(2): 91-93.

Rai, L.K. & E. Sharma (1994). Status of medicinal plants from the Sikkim hills. SSS Newsletter 7 (2): 4-8.

Rai, L.K. & T.D. Lachungpa (1994). Yarcha Gonbook : the Peter Pan of Sikkim Himalaya. SSS Newsletter 7(2): 3.

Rai, S.C. & Y.K. Rai (1994). Tourism in the Sikkim Himalaya : A spatio temporal analysis. ENVIS Bull. 2(2): 96-98.

Rai, Y.K., L.K. Rai & M. Sundriyal (1994). On the availability and marketing aspects of wild edible plants in Mamlay watershed : A pilot report. SSS Newsletter 7(4): 11-17.

Rana, U., K.K. Sen & Y. Kumar (1994). Making power sector and water management more sustainable in remote mountain villages- an attempt in Pranmati Watershed (District Chamoli). Hima-Paryavaran 6(2): 7-9.

Rawal, R.S. (1995). *Himalaya ki jaiv vividhata sarkshan main janata ki bhagidari: kab, kyon aur kaise* (in Hindi). In: U. Dhar (ed.), *Himalay Ki Jav Vividhta Main Janta Ki Bhagidari*. GBPIHED, Almora. 51-56.

Rawat, D.S. (1994). *Parvatiya chhetro ke vikas me sarak margaon ka yogdan* (in Hindi). Hima-Paryavaran 6(2): 20-21.

Rawat, D.S., H. Kumar & A.P. Jain (1994). A demographic analysis for Himalayan region. ENVIS Bull. 2(1): 33-43.

Samal, P.K., K.S. Rao & D.S. Rawat (1994). Sex ratio in Central Himalaya: An analysis. ENVIS Bull. 2(1): 5-14.

Samal, P.K. & N.A. Farooquee (1994). The Himalayan Development and cultural Imperatives: An Analysis. ENVIS Bull. 2(2): 21-29.

Samant, S.S. (1994). Scientific and ecological expedition to Nanda Devi- 1993: An overview. ENVIS Bull. 2(2): 65-72.

Samant, S.S. (1995). *Himalaya ke jari bootiyan* (in Hindi). In: U. Dhar (ed.), *Himalay Ki Jav Vividhta Main Janta Ki Bhagidari*. GBPIHED, Almora. 25-31.

Samant, S.S., R.S. Rawal & U. Dhar (1995). *Gangolihat vikas khand ki Jaiv vividhata: ek avalokan* (in Hindi). In: U. Dhar (ed.), *Himalay Ki Jav Vividhta Main Janta Ki Bhagidari*. GBPIHED, Almora. 16-24.

Sharma, A.K. & **H. Kumar** (1994). Geographic Information Systems: Principle and Applications. ENVIS Bull. 2(2): 1-8.

Singh, R.G. (1995). *Takee bacha rahe yeh Himalaya* (in Hindi). In: U. Dhar (ed.), *Himalay Ki Jav Vividhta Main Janta Ki Bhagidari*. GBPIHED, Almora. 5-9.

Singh, G.S., J.C. Kuniyal & S.C. Ram (1994). Cloudburst in Kullu: A report. Hima-Paryavaran 6(2): 11-12.

Sohani, S.K. & G C.S.Negi (1994). Capturing moisture to make afforestation programme a success in true sense. Himalayan Paryavaran 2(1): 30-31.

5.5. PARTICIPATION IN SYMPOSIA/ CONFERENCES

Seminar/meeting on "Perception of people's representatives on environment and development", Joshimath, U.P. 5 June, 1994. (P.P. Dhyani).

Himalayan Conservation Programme Governments - People Participation. Vigyan Bhawan, New Delhi. 27-28 June, 1994. (U. Dhar).

20th WEDC Conference, Colombo, Sri Lanka. 21-26 August, 1994. (A.P. Jain)

7th HIMTAB-1994, Manali. 26-28 August, 1994 (J.C. Kuniyal)

National Seminar on Landuse conflicts in the wake of urban development in India with special reference to urban fringes in U.P. G.B. Pant Institute of Social Sciences, Allahabad. 26-27 September, 1994. (N. A. Farooquee).

National Seminar on A Decade of Orchid Research and Development, New Delhi. 24-25 October, 1994. (L.K. Rai).

Seminar on Ecology and Environment, Guwahati, Assam. 26 October, 1994. (L.M.S. Palni & K.G. Saxena).

Fourth International Congress of Ethnobiology, N.B.R.I., Lucknow. 17-21 November, 1994. (S.S. Samant & S. Changkija).

First Conservation Congress. New Delhi. 19 November, 1994. (U. Dhar).

Intrnational Symposium on Plantation Crops. Calicut, Kerala. 30 Nov-3 Dec, 1994 (S.K. Nandi).

Regional Conference on Sustainable Development of Fragile Mountain areas of Asia. ICIMOD, Nepal. 13-15 December, 1994 (A.N. Purohit).

International NGO Consultation on Mountain Agenda. Lima, Peru. 22-27 February, 1995. (A.N. Purohit).

3rd International Conference on Appropriate Waste Management Technologies for Developing Countries, NEERI, Nagpur. 25-26 February, 1995. (A.P. Jain)

National Seminar on "Earth Resources, Industrial Development and Environmental Issues", University of Rajasthan, Jaipur, Maorch 20-22, 1995. (Kireet Kumar)

5.6. TRAINING COURSES/WORKSHOPS

Training on SALT Programme at ICIMOD, Nepal; Philippines; Thialand. (S. Changkija).

Workshop on Research and Monitoring in Corbett Tiger Reserve. Kalagarh. 18 May, 1994. (U.Dhar and D. Choudhury)

Start-up workshop of the ODA (UK) assisted H.P. Forestry Project on Joint Forestry Plannning and Management Approach. Department of Forest Farming and Conservation (H.P.), Mohal (Kullu). 17 June, 1994. (H. K. Badola)

Regional planning workshop on Appropriate Soil Conserving Farming Systems in the Hindu Kush Himalaya. ICIMOD, Kathmandu. August, 1994. (K.G. Saxena)

Workshop on Automatic Weather Stations (AWS), GBPIHED Unit, Sri Nagar, Garhwal. 21-22 July, 1994. (S.C. Ram, H. Kumar, V. Joshi, R.K. Das).

Workshop on Asian Biotechnology & Biodiversity sub-programme of UNDP-Farm Project, Department of Biotechnology, New Delhi. 27 Sept. 1994. (A.N. Purohit & L.M.S. Palni).

Workshop on Medicinal Plants and Orchids, Gangtok, Sikkim. 21-22 October, 1994. (A.N. Purohit, L.M.S. Palni & Staff of Sikkim Unit).

National workshop on Advances in Hydrological Instrumentation, Roorkee, 25-26 October, 1994. (J.C. Kuniyal).

Workshop on Ethnobiology, N.B.R.I., Lucknow. 12-15 Nov., 1994. (Subrat Sharma).

Start-up workshop on Biodiversity Conservation in Great Himalayan National Park. Department of Forest Farming and Conservation (H.P.), Mohal (Kullu), 14 November, 1994. (H.K.Badola)

International Workshop on "Rehabilitation of degraded lands in mountain ecosystems of the HKH region", Baoshan city, Yunnan Province, China. 19-22 December, 1994. (P.P. Dhyani and B.P. Kothyari).

Workshop on Horticultural Crops. Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, 14-15 December, 1994. (S.C. Ram).

Planning Workshop on Biodiversity Conservation. British Council Division, New Delhi. 2-3 March, 1995. (U. Dhar).

Workshop on "People's participation in Himalayan Biodiversity Conservation", Gangolihat, Pithoragarh, U.P. 21-22 March, 1995 (U. Dhar, P.P. Dhyani, S.S. Samant, R.G. Singh, K. Kumar, R.S. Rawal, J. Upreti, S. Airy, I.D. Bhat, A. Tewari, J. Bisht).

5.7. MEETINGS

MacArthur Foundation Meeting. ICIMOD, Nepal. April, 1994. (A.N. Purohit).

Environmental Council Meeting. Delhi. April, 1994. (A.N. Purohit).

Meeting with Director General, ICIMOD, Nepal & Secretary, Ministry of Environment and Forests, Govt. of India. New Delhi. April, 1994. (A.N. Purohit).

Meeting on Review of research in Nanda Devi Biosphere Reserve. Wildlife Institute of India, Dehradun. May, 1994. (S.S. Samant).

Meeting on Sustainalbe Utilization of Indian Germplasm by Networking Research and Industry Support (SUIGENERIS). Ministry of Environment and Forests, New Delhi. June, 1994. (U. Dhar)

Meeting at Deptt. of Biotechnology. New Delhi. July, 1994. (L.M.S. Palni & U. Dhar).

Meeting on Joint management of Protected Areas. New Delhi. September, 1994. (D. Choudhury).

Planning meeting on Ecozoning in the Hindu Kush Himalaya. ICIMOD, Nepal. September, 1994. (K.G. Saxena)

Meeting of Project Evaluation Committee. Itanagar, Arunachal Pradesh. October, 1994. (U. Dhar & P.P. Dhyani).

ICIMOD Board of Governors and Support Group Meeting. New Delhi. November, 1994. (A.N. Purohit).

Meeting on Sustainable landuse alternatives for shifting cultivation in Nagaland. November, 1994. (D. Choudhury).

Meeting on Biodiversity, INSA, New Delhi. January, 1995. (D. Choudhury).

III Task Force Meeting. Deptt. of Biotechnology, New Delhi. March, 1995. (U. Dhar).

Dr. S.S. Samant delivered lecture in Spring Dales School to School/College students on 13 June, 1994, organized by SEWAK and sponsored by Ministry of Human Resource Development, Lucknow.

6. STATEMENT OF ACCOUNTS*

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

22 Paltan Bazar
(Above Frontier Jewellers)
Dehra Dun - 248 001
Tel.:0135-24941, 28255, 25368
Tlx.: 0585-280-DDBC IN
Fax: 0135-25152, 22727

To

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

Dear Sir,

We have examined the balance sheet of **G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT** as at 31st March 1995 and the Income and Expenditure account for the year ended on that date which are in agreement with the books of account maintained by the said Institution.

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

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

(i) in the case of the Balance Sheet, of the state of affairs of the above named institution as on March 31, 1995 and

(ii) in the case of Income and Expenditure Account, of the income of its accounting year ending on March 31, 1995.

(iii) in the case of Receipt and Payment Account, of the receipts and payments during the accounting year ending on March 31, 1995.

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

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

Dated: May 30, 1995
Place: Dehra Dun.

* Detailed annexures are available for inspection at the Institute.

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

22 Paltan Bazar
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NOTES FORMING PART OF THE STATEMENT OF ACCOUNTS FOR THE YEAR ENDING ON MARCH 31, 1995 AND ANNEXED TO THE BALANCE SHEET OF EVEN DATE

1. Books of accounts have been maintained on cash basis subject to para 4 below.

2. No depreciation on Fixed assets has been provided in the accounts and value shown at cost. Amount of Rs 46,39,403.69, being depreciation on fixed assets as shown in the balance sheet for the year ending March 31, 1994 has since been reversed.

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

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

5. Full form of Short names reflected in the statement of accounts is as under:

NORAD	:	Norwegian Agency for Development Corporation.
ICIMOD	:	International Center for Integrated Mountain Development.
IERP	:	Integrated Eco Research Program.
ENVIS	:	Environmental Information System.
DST	:	Department of Science & Technology.
CSIR	:	Counsel of Scientific and Industrial Research.
DST (RWH)	:	Department of Science & Technology. (Rain Water Harvesting)
DST (SF)	:	Department of Science & Technology. (Soil Fertility)
INSA	:	Indian National Science Academy.
BIOTECH	:	Department of Bio Technology.
NEC	:	North Eastern Council.
NWDRA	:	National Watershed Development Project for Rainfed Areas.
UNDP	:	United Nation's Development Programme.
UNESCO	:	United Nation Educational Scientific and Cultural Organization.
UNICEF	:	United Nation Children Fund.

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

7. During the year vehicle No UTS 2199 was sold for Rs 69,000/- which was transfered free of cost under IERP Project.

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

9. Annexure 'A' to 'Z' are integral part of Statements of accounts prepared for the year.

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

(Sd/-)
(HARISH C. KAPOOR)

Dated: May 30, 1995
Place : Dehra Dun.

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT
KOSI, ALMORA
Balance Sheet as on March 31, 1995

PARTICULAR	ANN	AMOUNT	AMOUNT	AMOUNT
SOURCE OF FUNDS:				
* General Fund:				
Last Balance:			1,935,841.81	
Less: Trf to Endowment Fund:			1,738,920.01	
			196,921.80	
Add: Additions For the Year:			892,315.34	
				1,089,237.14
* Endowment Fund:				
Transfer from General Fund:			1,738,920.01	
Add: Interest Accrued:			23,231.00	
				1,762,151.01
* Fixed Assets Fund:				
Last Balance:		33,176,179.39		
Add: Additions For the Year:		14,730,460.92		
			47,906,640.31	
Less: Sale During the Yr.:			162,679.00	
				47,743,961.31
* Construction Fund - CCu:				
Last Balance:		54,204,377.00		
Add: Additions For the Year:		33,202,000.00		
			87,406,377.00	
Less: Transf. during the Yr:			0.00	
				87,406,377.00
* Project Funds:	'A'			
Research & Development Fund:			4,058,803.48	
Construction Fund:			80,580.00	
NEC Shillong Fund:			43,470.00	
IERP Project Fund:			2.49	
ENVIS Project Fund:			(3,817.00)	
DST (SKB) Project Fund:			850,000.00	
NWDRA Project Fund:			102,315.00	
DST (RSR) Project Fund:			1,032.00	
UNDP Project Fund:			82,748.00	
DST (RKM) Project Fund:			40,934.00	
CSIR Project Fund:			4,165.00	
BIOTECH (I) Project Fund:			275,288.00	
BIOTECH (II) Project Fund:			521,915.00	
BIOTECH(III) Project Fund:			4,056,937.00	
Balance Carried Forward:			10,114,372.97	138,001,726.46

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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
KOSI, ALMORA
Balance Sheet as on March 31, 1995

PARTICULAR	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:				138,001,726.46
Project Funds (Brought Forward):			10,114,372.97	
UNESCO Project Fund:			109,393.00	
INSA Meeting Fund:			0.00	
ICIMOD Meeting Fund:			0.00	
NORAD Project Fund:			(1,183,530.79)	
TSBF Project Fund:			362,386.00	
ICIMOD Project Fund:			(26,679.95)	
INDO CANADIAN Project Fund:			39,851.00	
ICIMOD SALT Project Fund:			216,566.00	
ICIMOD ISMA Project Fund:			636,685.00	
				10,269,043.23
* Other Liabilities				
Security Deposit:			59,743.00	
Group Saving Link Insurance:			1,098.15	
CPF Payable:			2,903.00	
TDS Payable:			671.00	
				64,415.15
TOTAL Rs..				148,335,184.84
APPLICATION OF FUNDS:				
* Fixed Assets:				47,743,961.31
* Deposits with:				
CCU for Construction:			87,406,377.00	
SP. LAO for Land:			80,000.00	
				87,486,377.00
* Security Deposits:				31,075.00
* Closing Balances:	'Z'			13,073,771.53
TOTAL Rs.				148,335,184.84

(Sd/-)
(Finance Officer)

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

(Sd/-)
(Officer Incharge)

(Sd/-)
(Director)

Dated: May 30, 1995
Place: Dehra Dun.

As per our separate report of even date.
For M/S HARISH C. KAPOOR & CO.
Chartered Accountants

(Sd/-)
(HARISH C. KAPOOR)

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
KOSI, ALMORA

Income & Expenditure Account for the Year Ending on March 31, 1995.

PARTICULAR	ANN	AMOUNT	AMOUNT	AMOUNT
Grants in Aid:				
Designated Project Grants:				
* Research & Development and Other Expenses:			20,250,000.00	
* Construction Work:			33,202,000.00	
* NEC Shillong:			75,000.00	
* IERP:			3,993,007.41	
* ENVIS:			210,000.00	
* DST (SKB):			850,000.00	
* NWDRA:			199,800.00	
* DST (RSR):			50,000.00	
* UNDP:			93,600.00	
* DST (RKM):			40,000.00	
* CSIR:			43,495.00	
* BIOTECH (I):			238,000.00	
* BIOTECH (II):			0.00	
* BIOTECH (III):			0.00	
* UNICEF:			127,500.00	
* INSA (Meeting):			0.00	
* ICIMOD (Meeting):			65,000.00	
* NORAD Project Fund:			0.00	
* ICIMOD Project Fund:			311,888.00	
* TSBF Project Fund:			331,197.00	
* INDO CANADIAN Project:			459,617.00	
* ICIMOD SALT Project:			748,574.00	
* ICIMOD ISMA Project:			779,765.00	
				62,068,443.41
Less: Trf. to Designated Funds:				
* Research & Development and Other Expenses:			20,250,000.00	
* Construction Work:			33,202,000.00	
* NEC Shillong:			75,000.00	
* IERP:			3,993,007.41	
* ENVIS:			210,000.00	
* DST (SKB)			850,000.00	
* NWDRA:			199,800.00	
* DST (RSR):			50,000.00	
* UNDP:			93,600.00	
* DST (RKM):			40,000.00	
* CSIR:			43,495.00	
* BIOTECH (I):			238,000.00	
* BIOTECH (II):			0.00	
* BIOTECH (III):			0.00	
Balance Carried Forward:			59,244,902.41	62,068,443.41

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

22 Paltan Bazar
(Above Frontier Jewellers)
Dehra Dun - 248 001
Tel.:0135-24941, 28255, 25368
Tlx.: 0585-280-DDBC IN
Fax: 0135-25152, 22727

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
KOSI, ALMORA

Income & Expenditure Account for the Year Ending on March 31, 1995.

PARTICULAR	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:				62,068,443.41
Balance of Trf. to Designated Funds (Brought Forward):			59,244,902.41	
* UNICEF:			127,500.00	
* INSA (Meeting):			0.00	
* ICIMOD (Meeting):			65,000.00	
* NORAD Project Fund:			0.00	
* ICIMOD Project Fund:			311,888.00	
* TSBF Profject Fund:			331,197.00	
* INDO CANADIAN Project:			459,617.00	
* ICIMOD SALT Project:			748,574.00	
* ICIMOD ISMA Project:			779,765.00	
				62,068,443.41
				0.00
Interest From Banks:				640,833.34
Other Incomes:				
* Licence Fee:			11,428.00	
* Water Testing Fee:			1,125.00	
* Nursary:			6,011.00	
* Miscellaneous:			111,537.00	
				130,101.00
Designated Grants Utilised:				
* Research & Development and Other Expenses:			18,490,362.70	
* Construction Work:			33,202,000.00	
* NEC Shillong:			31,530.00	
* IERP:			3,993,015.00	
* ENVIS:			308,390.00	
* DST (SKB):			0.00	
* NWDRA:			97,485.00	
* DST (RSR):			74,702.00	
* UNDP:			10,852.00	
* DST (RKM):			33,698.00	
* CSIR:			43,495.00	
Balance Carried Forward:			56,285,529.70	770,934.34

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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
KOSI, ALMORA

Income & Expenditure Account for the Year Ending on March 31, 1995.

PARTICULAR	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:				770,934.34
Desig. Grants Utilised Contd:			56,285,529.70	
* BIOTECH (I):			1,368,072.00	
* BIOTECH (II):			4,022,341.00	
* BIOTECH (III):			524,713.00	
* UNICEF:			18,107.00	
* INSA (Meeting):			82,947.00	
* ICIMOD (Meeting):			30,000.00	
* NORAD Project Fund:			1,913,684.00	
* ICIMOD Project Fund:			150,185.00	
* TSBF Project Fund:			370,491.00	
* INDO CANADIAN Project:			419,766.00	
* ICIMOD SALT Project:			532,008.00	
* ICIMOD ISMA Project:			143,080.00	
				65,860,923.70
TOTAL INCOME (A):				66,631,858.04
EXPENDITURE:				
Project Expenditure:				
* Research & Development and Other Expenses:	'B'		9,460,455.70	
* Construction Work:	'C'		0.00	
* NEC Shillong:	'D'		31,530.00	
* NORAD Project Fund:	'E'		1,715,272.00	
* ICIMOD Project Fund:	'F'		370,491.00	
* TSBF Project Fund:	'G'		150,185.00	
* IERP:	'H'		3,993,015.00	
* ENVIS:	'I'		197,154.00	
* DST (SKB):	'J'		0.00	
* NWDRA:	'K'		97,485.00	
* DST (RSR):	'L'		74,702.00	
* UNDP:	'M'		10,852.00	
* DST (RKM):	'N'		33,698.00	
* CSIR:	'O'		43,495.00	
* BIOTECH (I):	'P'		242,714.00	
* BIOTECH (II):	'Q'		548,992.00	
* BIOTECH (III):	'R'		288,077.00	
* UNICEF:	'S'		18,107.00	
* INSA (Meeting):	'T'		82,947.00	
* ICIMOD (Meeting):	'U'		30,000.00	
* INDO CANADIAN Project:	'V'		291,702.00	
* ICIMOD SALT Project:	'W'		178,277.08	
* ICIMOD ISMA Project:	'X'		69,312.00	
				17,928,462.78
Balance Carried Forward:				17,928,462.78

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

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(Above Frontier Jewellers)
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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
KOSI, ALMORA

Income & Expenditure Account for the Year Ending on March 31, 1995.

PARTICULAR	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:				17,928,462.78
Net Loss on Sale of Vehicle:				41,298.00
Capital Exp. Trf to CCU:				33,202,000.00
Capital Expenditure:				
* Research & Development:				
Library:		2,020,192.00		
R & D Equipments:		5,925,264.00		
Office Equipments:		80,100.00		
Furniture:		1,004,351.00		
		9,029,907.00		
* NORAD Project:		198,412.00		
* ICIMOD Project:		0.00		
* INDO CANADIAN Project:		128,064.00		
* ICIMOD SALT Project:		353,730.92		
* ICIMOD ISMA Project:		73,768.00		
* ENVIS Project:		111,236.00		
* BIOTECH (I):		1,125,358.00		
* BIOTECH (II):		3,473,349.00		
* BIOTECH (III):		236,636.00		
			14,730,460.92	
Less: Cost of Assets Sold:			162,679.00	
				14,567,781.92
TOTAL EXPENDITURE (B):				65,739,542.70
EXCESS OF INCOME OVER EXPENDITURE [(A) - (B)]:				892,315.34

(Sd/-)
(Finance Officer)
(Sd/-)
(D.D. Officer)
(Sd/-)
(Officer Incharge)
(Sd/-)
(Director)

Dated: May 30, 1995
Place: Dehra Dun.

As per our separate report of even date.
For M/S HARISH C. KAPOOR & CO.
Chartered Accountants

(Sd/-)
(HARISH C. KAPOOR)

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

22 Paltan Bazar
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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
KOSI, ALMORA

Receipt & Payment Account for the Year Ending on March 31, 1995.

PARTICULAR	ANN	AMOUNT	AMOUNT	AMOUNT
RECEIPTS:				
Opening Balance:	'Y'			14,150,476.22
Grants in Aid:				
* Research & Development and Other Expenses:			20,250,000.00	
* Construction Work:			33,202,000.00	
* NEC Shillong:			75,000.00	
* IERP:			3,993,007.41	
* ENVIS:			210,000.00	
* DST (SKB):			850.000.00	
* NWDRA:			199,800.00	
* DST (RSR):			50,000.00	
* UNDP:			93,600.00	
* DST (RKM):			40,000.00	
* CSIR:			43,495.00	
* BIOTECH (I):			238,000.00	
* BIOTECH (II):			0.00	
* BIOTECH (III):			0.00	
* UNICEF:			127,500.00	
* INSA (Meeting):			0.00	
* ICIMOD (Meeting):			65,000.00	
				59,437,402.41
Interest from Bank:				640,833.34
Other Receipts:				
* Security Deposit:			18,791.00	
* Group Savings Link Ins.:			898.00	
* Licence Fee:			11,428.00	
* Water Testing Fee:			1,125.00	
* Nursary:			6,011.00	
* Miscellaneous:			111,537.00	
* Sale of Vehicles:			121,381.00	
* TDS & CPF Recoveries:			1,689.00	
				272,860.00
Advances Recovered:				
* Blue Star Ltd. (BIOTECH - I):			157,048.00	
* Krishna Plast Ind (BIOTECH - I):			206,010.00	
* Saveer Electro. (BIOTECH - II):			81,732.00	
* Garhwal Unit (BIOTECH - II):			165,000.00	
				609,790.00
TOTAL RECEIPTS Rs.				75,111,361.97

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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
KOSI, ALMORA
Receipt & Payment Account for the Year Ending on March 31, 1995.

PARTICULAR	ANN	AMOUNT	AMOUNT	AMOUNT
PAYMENTS:				
Project Payments:				
* Research & Development and Other Expenses:	'B'		9,460,455.70	
* Construction Work:	'C'		33,202,000.00	
* NEC Shillong:	'D'		31,530.00	
* IERP:	'H'		3,993,015.00	
* ENVIS:	'I'		197,154.00	
* DST (SKB):	'J'		0.00	
* NWDRA	'K'		97,485.00	
* DST (RSR):	'L'		74,702.00	
* UNDP:	'M'		10,852.00	
* DST (RKM):	'N'		33,698.00	
* CSIR:	'O'		43,495.00	
* BIOTECH (I):	'P'		242,714.00	
* BIOTECH (II):	'Q'		548,992.00	
* BIOTECH (III):	'R'		288,077.00	
* UNICEF:	'S'		18,107.00	
* INSA (Meeting)	'T'		125,000.00	
* ICIMOD (Meeting):	'U'		65,000.00	
				48,432,276.70
Capital Expenditure:				
* Library:			2,020,192.00	
* R & D Equipments:				
RESEARCH & DEVELOPMENT:		5,925,264.00		
ENVIS:		111,236.00		
BIOTECH (I):		1,125,358.00		
BIOTECH (II):		3,473,349.00		
BIOTECH (III):		236,636.00		
			10,871,843.00	
* Office Equipments:			80,100.00	
* Furniture:			1,004,351.00	
				13,976,486.00
Security Paid:				23,205.00
F.C. Inter Account:				694,323.00
Balance Carried Forward:				63,126,290.70

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
KOSI, ALMORA
Receipt & Payment Account for the Year Ending on March 31, 1995.

PARTICULAR	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:				63,126,290.70
Closing Balance:				
* Cash & Bank Balance:				
Case in Hand (IC A/C):				
Almora:		21,598.90		
Srinagar:		5,578.49		
Sikkim:		3,544.81		
Kullu:		10,712.36		
Dimapur:		5,068.37		
			46,502.93	
Cash at Bank (IC A/C):				
CBI Kosi A/C No. CD-14:		1,223,629.20		
SBI Almora A/C No. 22752:		7,997,520.55		
SBI Tadong A/C No. CA/4/65:		95,505.21		
SBI Kullu A/C No. 50201/7		9,030.62		
SBI Srinagar A/C No. 3/615:		157,231.72		
SBI Dimapur:				
A/C No. C&I/6/22:		30,621.24		
SBI Almora A/C No. 23884		5,000.01		
			9,518,538.55	
* Advances:				
House Building Advance:			108,024.00	
Units of Institute:				
Srinagar (Garhwal Unit):		136,345.00		
Sikkim (Sikkim Unit):		6,810.00		
Dimapur (N.E. Unit)		23,000.00		
			166,155.00	
* Fixed Deposit:				
With SBI-Endowment Fund:			1,509,789.00	
Balance Carried Forward:			11,349,009.48	63,126,290.70

HARISH C. KAPOOR & CO.
CHARTERED ACCOUNTANTS

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G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
KOSI, ALMORA

Receipt & Payment Account for the Year Ending on March 31, 1995.

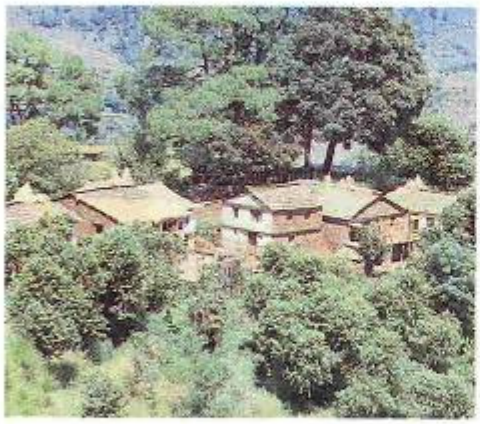
PARTICULAR	ANN	AMOUNT	AMOUNT	AMOUNT
Balance Brought Forward:				63,126,290.70
Closing Balance Continued:				
* Advances Brought Forward:			11,349,009.48	
Due - Staff/Others (IC A/C):				
Director - IARI:		26.50		
G.C.S. Negi (CSIR):		2,000.00		
Pan Singh:		385.00		
A.S. Parihar:		389.00		
K.K. Pandey:		4,000.00		
CPF:		129.00		
N.R.S.A. Hyderabad:		11,200.00		
Shivalik Agro Products:		677.00		
Maruti Udyog Ltd.:		543,326.39		
Klenzaids Con. Controls Pvt. Ltd:		57,175.00		
M.P.C.B.:		16,382.00		
Group Sav. Link. Ins.:		371.90		
			636,061.79	
				11,985,071.27
TOTAL Rs.				75,111,361.97

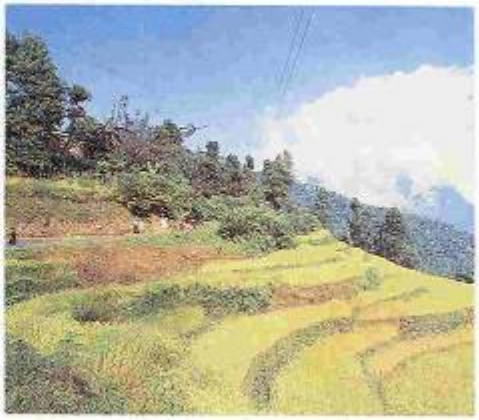
(Sd/-)
(Finance Officer)
(Sd/-)
(D.D. Officer)
(Sd/-)
(Officer Incharge)
(Sd/-)
(Director)

As per our separate report of even date.
For M/S HARISH C. KAPOOR & CO.
Chartered Accountants

(Sd/-)
(HARISH C. KAPOOR)

Dated: May 30, 1995
Place: Dehra Dun.





INSTITUTE PUBLICATIONS

1991

- Agriculture Economy of Himalayan Region, Vol I Kumaun.

1992

- Himalayan Environment & Development: Problems and Prspectives
- 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

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

REGULAR PUBLICATIONS

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