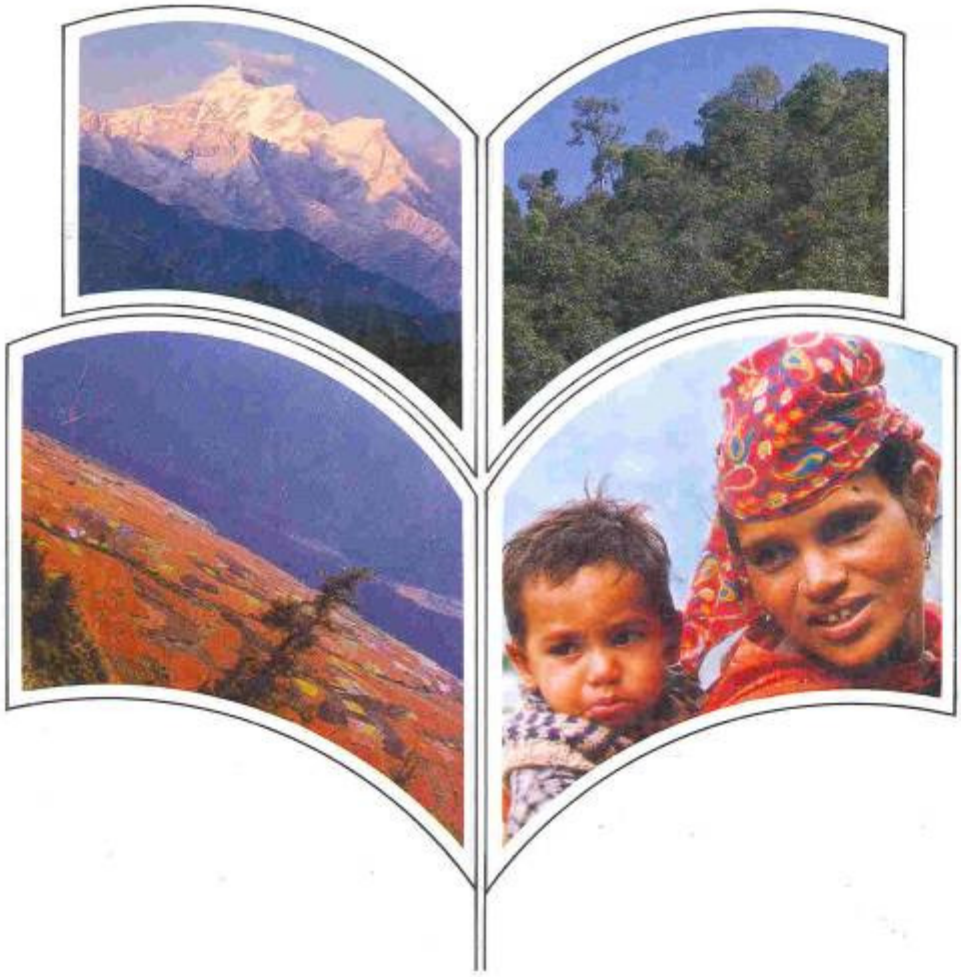
annual report

1992-93



G.B. Pant Institute of Himalayan Environment and Development
(An Autonomous Institute of Ministry of Environment & Forests, Govt. of India)
Kosi, Almora-263643
INDIA

ANNUAL REPORT

1992-93

G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT
(An Autonomous Institute of Ministry of Environment & Forests, Government of India)
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THE YEAR 1992-93 : AN OVERVIEW

On reflection, the year 1992-93 has been full of activity - academic and other including strengthening of staff, infrastructure expansion, creation of new facilities, initiation/strengthening of collaboration with national and international agencies, effective networking and dissemination of R & D outputs.

We feel happy that the issues highlighted in Chapter 13 UNCED of Agenda 21 constitute the focus of mandate of this Institute. While at global level Agenda 21 was released at UNCED, held in Rio de Janeiro in June 1992, the Hon'ble Minister for Environment & Forests, Government of India, Sri Kamal Nath released to the nation a document "Action Plan for Himalaya" prepared by the Institute.

A number of new scientists joined the Institute. This resulted in effective strengthening of expertise for existing programmes and in initiation of new programmes, particularly those involving biotechnological interventions. Inflow of funds from the Department of Biotechnology, Government of India has started, for the first time, with promise of increased support in the coming years. Laying of the foundation stone of the Institute's building last year at Katarmal, Almora paved the way for commencement of construction activity. Land acquisition process for Himachal Pradesh and Sikkim unit has also been completed.

International cooperation was further augmented during the year and linkages with ICIMOD resulted in initiation of two programmes : Mountain Environment Resource Information System (MENRIS) and a programme on ecosystem rehabilitation. Effective collaboration with NORAD has started and support for Tropical Soil Biology and Fertility Programmes was received. Institute organized three successful Workshops/Symposia which facilitated interaction of experts from the country with those from overseas. Efforts initiated sometime ago have resulted in a UNESCO sponsored regional Seminar cum Workshop on conservation aspects, to be held during September, 1993.

As usual the Annual Day, celebrated this year at Gangtok, Sikkim on September 14, 1992 was a grand event and the IInd Pt. G.B. Pant Memorial lecture delivered by Dr. T.N. Khoshoo on the occasion has already been published and distributed to relevant agencies.

From 1988 to 1991 the Institute basically concentrated on identifying the priority issues, working out the research based simple solutions to these and establishing in-house small scale experimentation and demonstration projects. Our attempts on development of low cost waste water harvesting technology and regeneration of degraded lands have been successful. The detail documents on these are under preparation.

The initiatives for development of degraded lands by orienting scientific approaches to socio-cultural set up of hill societies initiated by the Institute are becoming increasingly visible. The Institute is committed to develop 'Badri Van' in Badrinath area of district Chamoli in collaboration with the U.P. Government. *Rhododendron arboretum* has been established at Pangthang (Sikkim).

Himalayan Eco-development Programme transferred from the Ministry of Environment & Forests to the Institute in the preceding year widened Institutional Networking for comprehensive action oriented research.

Publication of R and D efforts of the Institute, based on studies and experiences centered around a watershed in Sikkim, and finalization of final drafts of two more volumes to be published shortly, one on conservation strategies for the preservation of Himalayan biodiversity and the second on the tree fodders, are other satisfying achievements. Hima-Paryavaran, a biannual newsletter, entered the fourth year of its publication.

The Annual Report for 1992-93 presents a summary account of the contribution of the Institute, in coming a little closer towards realization of its goals, during the year.

A.N. Purohit
Director

1. INTRODUCTION

The reporting year 1992-93 is the fourth financial year of research and developmental activities being executed by the Institute in various parts of Himalaya and addressing region specific issues, with constant emphasis on seeking tangible solutions, centered around four Core Programmes. Two projects were concluded during the year. The detail documents on these are being prepared and will be made available to the users shortly. The progress of in hand projects and a brief account of other academic activities is given in the report.

2. MILESTONE EVENTS

Keeping alive the tradition of celebrating its Annual Day to mark the birth anniversary of Pt. Govind Ballabh Pant, the Institute organized this academic activity focussing on IInd Pt. Govind Ballabh Pant Memorial Lecture delivered by Jawahar Lal Nehru Fellow, Padma Bhushan Dr. T.N. Khoshoo at Gangtok, Sikkim on Sept. 14, 1992. The lecture provided a gamut of information on Plant Diversity in the Himalaya touching upon diverse issues viz., climate, rock, soil, vegetation, endemism, spatial distribution of plant forms, agroecosystems, conservation of biota, bioproductivity and their intricate relationships for creating a healthy environment. Some of the suggestions made in his lecture are:

* Declare biological diversity a national resource, its conservation a national goal and its implementation a national priority.

* Evolve a national policy on conservation of biodiversity and periodically update the same.

* Review the existing Protected Area Network (PAN), which must include biosphere reserves, national parks, wildlife sanctuaries, sacred groves, fragile and unique ecosystems, game and genetic reserves, etc.

* Review present conservation effort on different biota and prepare a special management plan for conservation of marine and freshwater habitats, forest trees and microorganisms.

* Draw up a plan to establish a representative PAN.

* Establish minimal databases for each Protected Area.

* Draw up plans for both *in-situ* rehabilitation of the priority threatened / endangered species and for purposes of restoring and reintroducing the natural populations.

* Domesticate, where required, those wild biota that have a trade value but are under constant threat.

* Draw up plans for education and awareness about various aspects of PAN for students, public, administrators, decision-makers, and politicians.

* Support PAN with an effective network of biological gardens, arboreta, aquaria, and bio-banks concerned chiefly with *ex-situ* conservation.

* Guarantee continued financial support.

The Institute completed the task of preparing the "Action Plan for Himalaya" assigned to it by the Society.

The Governing Body meetings were held twice, the Science Advisory Committee met once and the Eco-development Project Evaluation Committee held two meetings during the reporting period.

3. RESEARCH AND DEVELOPMENT PROGRAMMES

The research and development activities of the Institute are based on a sound multi-disciplinary approach, linking natural and social sciences for environmentally sound development in the

Himalaya. The present efforts revolve around four core programmes viz., Land and Water Resource Management, Sustainable Development of Rural Ecosystems, Conservation of Biological Diversity, and Ecological Economics & Environmental Impact Analysis. Depending upon the area under consideration in the ecologically as well as socially heterogeneous Himalaya, the project sites are located at different places. Location specific problems and their likely solutions are addressed through time-bound research projects. Rigorous data collection and analysis coupled with development and demonstration of science and technology inputs for an all-round betterment constitute essential project work elements. Most projects entered into second or third year of operation during the reporting year. A few were initiated during the year 1992-93. The year when the projects were initiated are indicated with parenthesis in each project title. Highlights of the work done in 1992-93 alongwith a contextual background, specific objectives and main achievements are summarized below for individual projects.

3.1 LAND AND WATER RESOURCE MANAGEMENT

3.1.1 Integrated Watershed Management - A Case Study in Sikkim Himalaya (1989-90)

Background

Watershed has been recognized as an appropriate unit for analyzing development vis-a-vis resource problems, for designing appropriate solutions of the identified problems and, eventually testing the efficacy of prescribed solutions in the mountains. Watershed approach also helps in tackling the ecological and socio-economic problems in an integrated manner. In view of limited information available on the watersheds of Himalaya in general and those of eastern Himalaya in particular, this project was undertaken as a multidisciplinary effort with the goal of facilitating integrated management for improving the ecology and economy in the Mamley watershed located in South district of Sikkim. The watershed is spread over an area of 3009 ha at an altitudinal range of 300-2500 m and falls in the upper catchment of Rangit river. In the previous years efforts were directed towards the collection of data/information (primary as well as secondary) in order to have an in-depth understanding of structure, function and problems in the watershed. In the current year efforts were made to record the perception of farmers on environment, traditional practices and conservation ethics, soil changes in respect to land use and dominant agricultural and forest systems. This is essential for designing appropriate management strategies to achieve economic development of the region which is also sound from ecological point of view.

Objectives

1. Structural analysis of the watershed: studies on vegetation, soil, geology, socio- economics and their integration.
2. Intensive study of the dominant land use systems.
3. Analysis of interactions of dominant land use systems.
4. Identification of integrated resource management models and on site testing.

Results and Achievements

1. Considerable change in land use from other forms to agriculture and intensive low input farming systems on steep uplands of the watershed are enhancing soil erosion and resulting in low soil fertility levels. This has resulted in decreased crop yields as pointed out by majority of the respondents.
2. The watershed presents a viable system having a gradient of altitude where almost all types of land uses and ethnocultural groups of Sikkim are present. Terraced and unterraced slope gradients under rainfed conditions at 40 different sites of the watershed were studied

Table 1. Availability of wild edible plants in the weekly market at Namchi, South Sikkim

Plant species	Local name	Plant part used	Time of availability	Market price (Rs.)	Remarks
Spondias axillaris	Lapsi	Fruit	Oct-Nov	4.00*	Fruits are eaten, made into pickles also
Emblica officinalis	Amala	Fruit	Oct-Jan	4.00*	Fruits are eaten, made into pickles also
Castanopsis tribuloides	Katus	Fruit(nut)	Feb-Apr	40.00*	Fruits are eaten, raw and roasted
Juglans regia	Okhar	Fruit	Sep-Nov	20.00#	Fruits are eaten, raw
Bassia butyracea	Chiuri	Fruit	Jun-Jul	3.00*	Fruits are eaten, seed made into butter
Ficus benjamina	Kabra	Tender Shoot	Feb-Mar	8-10.00*	Shoot tips (buds) made into pickles
Diplazium spp.	Ningro	Tender Shoot	Jun-Aug	7.00+	Tender shoot used as vegetable
Urtica dioica	Sisnoo	Shoot tip/flower	Feb-Mar	5.00+	Tender shoots and flowers used as vegetables
Agaricus spp.	Chyau	Fruiting body	Jun-Sep	10-12.00*	Fruiting body eaten as vegetable
Nasturtium officinale	Simsayo	Vegetable shoot	Nov-Jan	4.00+	Tender shoot eaten as vegetable
Dioscorea spp.	Bantarul	Rootstock	Jan-Feb	5.00*	Rootstock (sold boiled/raw)
Swertia chirata	Chireto	Vegetative	May-Oct	10.00*	Medicinal. Sold dried also
Machilus edulis	Pomsee	Fruit	Jan-Feb	10.00*	Fruits
Elaeocarpus lanceafolius	Bhadrasay	Fruit	Apr-Jun	10-20.00*	Fruits
So far unidentified	Chimfing	Fruit	Jul-Aug	2.00+	Ground and used as pickle
Rumex nepalensis	Halhale	Shoot tip	Year round	10.00*	Medicinal. Sold in dried form
So far unidentified	Pakhanbet	Shoot/root	Year round	35.00*	Medicinal. Sold in dried form
Viscum album	Harchur	Vegetative	Year round	5.00*	Medicinal. Sold in dried form
Terminalia chebula	Harra	Fruit	Feb-Mar	10.00*	Medicinal. Sold fresh/dried
Terminalia bellirica	Barra	Fruit	Year round	20.00*	Medicinal. Sold dried
Cinnamomum spp.	Sinkauli	Stem bark	Year round	30.00*	Spices, sold dried
Tamarindus indica	Timri	Fruit	Feb-Mar	5.00*	Pickle material
Dendrocalamus hamiltonii	Bamboo	New Shoot	Jun-Oct	12.00*	Vegetable (boiled, raw or fermented)

Legend * per kg, # per 100 units, + per bundle

and significant correlation was found between gradients of cultivated surface and the parent undisturbed slopes ($r = 0.59$; $p < 0.01$; d.f. = 38) indicating that the change was not drastic. This ensures that the traditional practices in the watershed helped in the conservation of landscape. Traditional adaptation, indigenous knowledge and perception of conservation amongst farm-owning families in the watershed are remarkable.

3. An increase of 12.79% in agricultural land-use at the cost of diversion of other land uses was recorded during a period of 40 years. The effect of change in land use on soil properties and fertility revealed that percentage of stones in the first 30 cm depth of the soils in recently converted agricultural land was lower than in the soils of other agricultural areas, under cultivation for long time.

4. A total of 23 wild edible plants were recorded in the watershed, out of which 8 species are used as fruits, 9 species as vegetables/pickles and 6 species as medicines (Table 1).

5. Pattern of fuel wood consumption revealed that 69% of the total wood is used for cooking purposes, 9% for animal food preparation, 7% for water heating, 6% for house warming, 6% for local wine preparation and the remaining for festival and other purposes.

6. Farmers balance the production of cash crops and cereals for inhouse use so as to meet their consumption. A total of 6 species of food grains, 8 species of pulses and 40 types of vegetables and 9 types of fruits were recorded.

7. Litterfall was highest under mixed canopy cover in a sub-tropical natural forest and under *Alnus nepalensis* cover in a temperate natural forest. Of the total litterfall, 83 to 94% was leaf litter and remaining 6 to 17% was contributed by wood/branch. Wood/ branch debris was highest during rains while leaf fall was maximum during summer and winter season.

8. It was noticed that a considerable portion of tree wood biomass production is being removed resulting in a decline in net ecosystem productivity. Of 17.83 Mg/ha/year net primary productivity, about 22% is being removed in the form of tree boles in

sub-tropical natural forest. Removal of wood biomass was much pronounced in temperate natural forest where out of 5.32 Mg/ha/year of net primary productivity, about 55% is being removed leaving only 2.39 Mg/ha/year of wood biomass in the form of net annual ecosystem productivity.

3.1.2 Development of Agroforestry Model in Garhwal Himalaya (1989-90)

Background

Agroforestry is argued to be a sound land management option meeting both environmental and developmental imperatives in the hills, particularly on the slopes. Agriculture, forests and animal husbandry are interlinked across the Himalaya. However, the nature and magnitude of these linkages vary. Agriculture in the Himalaya continues to be of subsistence type and productive potential of cropland depends upon the organic inputs derived directly from the forest in the form of litter or indirectly through animal dung. The Himalayan dwellers still depend heavily upon fuelwood to meet their energy needs. In central Himalaya food crop cultivation on terraced slopes, often as steep as 40-45°, is also seen as a major threat for aggravating the environmental degradation. Introduction of trees which provide a perennial canopy cover, meet multiple needs (food, fodder, fuel), add to the fertility of soil. This approach is likely to result also in dual benefits of maintaining productive potential of land and increasing protective cover. The traditional land use in central Himalaya reflects a practice of maintaining trees on the slopy cropland. However, under the present pressure of high population, agroforestry systems are getting weakened. There is a need of evaluating the costs and benefits of introducing trees in cropland, identifying potential species, standardizing the propagation and cultivation techniques of the identified species and rejuvenating the traditional agroforestry systems with appropriate science and technology inputs. This project aims to answer questions like: which species should be introduced, what should be the scientific criteria for species selection and, what are the socio-economic reasons behind diminishing trends of tree- crop mixture. The experiences of a pilot project completed last year in Garhwal indicated a need for diversifying the agricultural systems not only by means of introducing trees but also by altering the traditional cropping pattern in ways which render short term benefits to the poor farmers. It was also realized that development and demonstrations of land management technology should be undertaken as a fairly long term collaborative programme after taking the people of the target area in confidence before the project is executed. Interaction of scientists and the people led to transfer of 5.5 hectares of barren land by Jalai Village Panchayat near Banswara (about 16 km from Rudraprayag on way to Kedarnath in District Chamoli) on lease to the Institute for a period of 10 years.

Objectives

1. To identify agricultural land use practices suited to the ecological and socio- economic attributes of the area and their implementation in the field on experimental basis.

2. To evaluate the acceptability of the identified management practices by the people.

3. To undertake fundamental researches so as to design refinements in the existing/ identified agricultural land use practices for sustainable development.

Results and Achievements

1. Survival assessment was carried out at half yearly intervals following plantation on both the sites (agroforestry and restoration). Although survival differed significantly between species, the average survival in the agroforestry site was found to be over 90% after 18 months of plantation. With the exception of *Bauhinia variegata* (33 %) all other species including *Ficus glomerata, F. rumphi* and *Prunus cerasoides* showed above 75%

survival. The survival was found to be only around 55% after 18 months of plantation in the restoration site. While two thirds of planted species had over 50% survival, *Aesculus indica* and *Boehmeria rugulosa* showed low survival; most successful species were *Prunus cerasoides* (76%) and *Grewia optiva* (72%).

2. Eighteen months after plantation, species showing highest growth were *Dalbergia sissoo, Albizzia lebbeck* and *Alnus nepalensis* (agroforestry site), *Albizzia stipulata, Celtis australis* and *Alnus nepalensis* (restoration site). Measurements of diameter at collar height and average number of branches per plant were also done following 6, 12 and 18 months of plantation at both the sites.

3. Plants which failed to survive due to heat/frost or other reasons were replaced by fresh plantations during the rains in 1992.

4. Two nurseries have also been developed, one at Banswara and another at Srinagar. A total of more than 8000 seedlings/ saplings of many multipurpose trees were raised, including *Acacia* spp., *Albizzia lebbek, A. stipulata, Celtis australis, Dalbergia sissoo, Hippophae rhamnoides, Ougeinia delbergioides, Quercus incana, Sapindus mukorossi* and *Sapium sebiferum.*

5. Cost benefit analysis was carried out to compare the economic yield of cash crops like *Brassica campestris* and *Lens esculentum*; the former was found to be economically more suitable.

6. Studies on ecophysiology of some of the multipurpose trees were conducted for selection and evaluation of site specific plants. These studies made use of modern techniques like chlorophyll fluorescence supported with photo-synthesis measurement compact mini cuvette system. Performance of planted species was found to be adversely affected by environmental stresses, particularly during summer and winter. Some species like *Olea glandulifera,* however, showed fast recovery following a period of stress.

7. Data on photochemical efficiency, leaf area and leaf duration indicated a close correlation with growth parameters, validating the use of chlorophyll fluorescence techniques for rapid assessment of plant species.

8. Data for chlorophyll content, total soluble carbohydrates, amino acids, moisture and proline content have also been determined during summer and winter.

3.1.3 Biological Mechanisms in the Maintenance of Soil Fertility under Varied Land Use Practices in Kumaon Himalaya (1991-92)

Background

This project sponsored by the Department of Science and Technology, Government of India is focussed on seeking answers for three specific questions: what are the key factors and processes regulating soil fertility and their manifestations in terms of crop yields? To what extent has soil fertility declined and what are the reasons thereof? What are possible options for maintaining/ improving soil fertility levels, specifically the avenues of improved utilization of locally available resources? The work plan is based on village/farm level ecological and socio-economic approaches of analysing soil fertility in a systems analysis perspective.

Objectives

1. To quantify nutrients/water demand and supply in managed, degraded and protected ecosystems in Kumaon hills.

2. To analyze the biological mechanisms of maintenance of soil fertility already existing or which have a possible scope in the region.

3. To study the impact of different land use/cultural practices on soil fertility processes and identification of appropriate

biological amendments.

Results and Achievements

1. Among a multitude of factors and processes regulating soil fertility, the ones found most crucial to Kumaon hills include a) a shift in emphasis from coarse grains to wheat and paddy b) expansion of canal based irrigation under the control of Government c) reduction in forest area and forest based resources accessible to farmers d) soil fertility problems are more serious in the mid hill region than in high elevation remote areas.

2. Wheat and paddy, in terms of crop yields, responded more to low levels of soil moisture and nutrients when compared with millets, pseudomillets and other coarse food crops.

3. Soil organic carbon and nitrogen pools were found to be much less variable than the inorganic pools. In many instances, significant relationships between organic carbon and nitrogen levels in the soil during the crop growth were not found indicating the need of amendments which synchronize release of nutrients from the organic residues/soil organic matter with the demands of the crops.

4. Project would be completed in the following year.

3.1.4 Symbiotic Nitrogen Fixation and Maintenance of Soil Fertility in the Eastern Himalaya (1991-92)

Background

The maintenance of soil fertility in natural and derived ecosystems through biological processes is an alternative, well recognized realised issue. Biological nitrogen fixation is one of the key processes in building up the soil fertility. Symbiotic N_2-fixation contributes significantly to the nitrogen economy of agricultural and natural ecosystems. Angiospermic plants have two distinct groups of symbiotic associations: (i) *Rhizobium* symbiosis - restricted to the family *Leguminosae;* and (ii) *Frankia* symbiosis distributed in eight families of angiosperms other than Leguminosae. Proper listing of such species in the eastern Himalaya is lacking. The project aims to screen out N_2-fixing symbiotic association, to estimate their effectiveness of N_2-fixation and to evaluate their contribution in the maintenance of soil fertility.

Objectives

1. Extensive investigation for sorting out the symbiotic N_2-fixing species and their association in the eastern Himalaya.

2. To test the effectiveness of symbiotic association on N_2-fixation.

3. To estimate the N_2-fixation efficiency and nitrogen accretion in some important associations.

4. To evaluate the role of some of these species on the maintenance of soil fertility.

Results and Achievements

1. Leguminous and non-leguminous symbiotic associations have been sorted out. About 80 species belonging to family Leguminosae including 65 species of sub- family *Papilionoidae,* 10 species of sub-family *Mimosoidae* and 5 species of sub- family *Caesalpiniodae* have been sorted out. Four genera (*Alnus, Coriaria, Elaeagnus* and *Hippophae*) of actinorhizal plants have also been identified. The altitudinal range of distribution of these plants is from foothills to alpine conditions.

2. *Alnus* + Cardamom combination with a control site in the natural forest without N_2-fixing symbiosis + Cardamom, and *Albizzia* and other agroforestry species + cropland with a control site of non N_2-fixing agroforestry + cropland were extensively investigated to see the effect of N_2-fixing *Alnus* and *Albizzia* on ecosystem functioning with respect to soil fertility.

3. The performance of large cardamom is better under *Alnus*; more than double the number of tillers and higher production were recorded compared to the natural forest stand.

4. The light interception by tree species for crops in agroforestry systems has revealed that *Alnus* (24%) and *Albizzia* (28%) showed much less light interception as compared to other agroforestry and forest trees (ca 50%).

5. Per cent organic carbon and total nitrogen were highest in natural forest + cardamom followed by *Alnus* + cardamom, *Albizzia* + cropland and lowest in cropland with no N_2-fixing agroforestry species stand.

6. Mineral-P was found to be 69% of total-P in cropland with non N_2-fixing trees while it is 39% in *Albizzia* + cropland, 17% in *Alnus* + cardamom and just 9% in natural forest + cardamom. In absolute values also mineral-P followed the same sequence as above and much higher mineral-P was recorded in cropland with non N_2-fixing trees and *Albizzia* + cropland.

3.1.5 Land and Water Resource Management Strategies in Himachal Pradesh and Uttar Pradesh Hills (1992-93)

Background

Long term availability of fundamental resources in the Himalaya is now a priority consideration in the development policy and programmes. Experiences of the past led to a change in development policies for setting the target of environmentally sound socio-economic development in the region. Development programmes started laying emphasis on integrated resource management over sector oriented management. New approaches defining the targets of natural resource uses, diverse, unique and abundant at times and places, and identifying new trade-offs between short term income objectives and long term environmental objectives are called for achieving the goal of sustainable development in the Himalaya. It has been argued that many of the unsustainable trends could be avoided in the mountains if resource management strategies and development programmes are formulated considering watershed as the Planning Unit. Integrated watershed management approach has been tried in a few sectors of Himalaya in the recent past. These efforts undoubtedly played a catalytic role in promoting environmental orientation to conventional sector oriented economic approaches of development. However, the outcome also unravels need for further refinements in design as well as execution of integrated watershed management packages. This project is a collaborative venture of the Institute and Norwegian Centre for International Agricultural Development under the bilateral cooperation between Governments of India and Norway supported through Norwegian Agency for Development Cooperation. The project aims to enhance the knowledge system for sustainable development in the Himalaya through research, technology development and demonstration, in two small watersheds, one in Uttar Pradesh hills and the other in Himachal Pradesh initiated in October, 1992.

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 the socio- economic conditions prevailing for groups and individuals including issues for entitlement, equity and gender.

3. To work out tree-crop-animal interactions in different agroforestry systems, needs 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 conditions of the farmers.

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

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

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

Results and Achievements

1. Location of watersheds selected for studies are given in Fig. 1.

Fig. 1. Location Of Project Sites In INDIA

2. Water resource in both the cases has been utilized for hydropower generation but the benefits flow more to the towns than to the villages. The project areas are characterized by poor communication and transport services.

3. Socio-economic conditions, resources, resource production and use systems are being investigated so as to identify changes in the traditional systems and the reasons there of, and the critical bottlenecks needing science and technology inputs. Efforts were made to identify and design interventions considering aspirations of the people in conjunction with ecological and economic constraints and opportunities.

4. Efforts were made to install and operationalize a geographical information system (GIS) to facilitate problem appraisal and watershed management planning in ways more effective than the ones presently used.

5. A survey of local medicinal plants, agricultural crops and orchard plants has been done.

3.2 SUSTAINABLE DEVELOPMENT OF RURAL ECOSYSTEM

3.2.1 Designing Ecologically Sound Natural Resource Management Strategies for Sustainable Rural Development in Kapkot Block (District Almora) in Central Himalaya (1989-90)

Background

A major failure of our development planning strategy was perhaps over- emphasis on economic growth. Economic growth, apart from being inequitable in the past has not resolved social issues, many of which have been inherited by us from the past. The prejudice against and the inferior status of women in society, religious persecution in both subtle and overt ways are among serious issues. Many issues are of more recent origin, especially the perceived degradation of the environment, both as a result of improvident cutting down of forests and of some of development policies. Social, political and professional institutions are getting eroded. The present lifestyle of some sections of people is unsustainable and though the people wish for them, we do not have resources to provide the same to the aspired by the people. Thus the

social tensions that are now beginning to appear cannot be contained unless we move towards a more egalitarian society.

Objectives

1. To analyse the current problems and consequences of ringal based cottage industry.

2. To identify appropriate land management practices and resource uses so as to mitigate the current problems.

3. To define integrated resource management on a geographical unit vis-a-vis administrative unit.

Results and Achievements

1. Long term monitoring of interventions tried are continued.

2. An attempt has been made to collect germplasm of the crops and other plants for conservation and propagation purposes.

3. *Nardostachys jatamansi, Swertia chirata, Aconitum heterophyllum, Rheum emodi,* and *Mentha* spp. were tried in village degraded land and found suitable for cultivation.

4. The success of restoration experiment has generated peoples awareness. People from various villages have started to submit proposals for restoration of degraded lands in their villages to various agencies.

3.3.2 Jhum and Sustainable Development of a Village Cluster in Nagaland (1989-90)

Background

Shifting cultivation, locally known as 'jhum', is the predominant agricultural practice in the hilly terrains of Northeast India. 1.5% of the land area is brought under jhum cultivation annually and a minimum of 5.7% of the region is under jhum at a given time. In the state of Nagaland, 1.15% of the land is annually under shifting cultivation, while 11.54% is under this practice at any one time; 1,16,046 families are reported to be involved in jhumming in the state.

A project was planned and initiated three years back to identify technological interventions which arrest and/or revert the ongoing trends of environmental degradation, originating from the distortions of traditional jhum. The target area of the project included three villages, viz. Yaongyimsen, Salulmang and Chuchuyimlang in the Mokokchung district of Nagaland. The approach involved interaction with individuals, the local NGO (Nagaland Gandhi Ashram) for participatory actions. Activities such as introduction of ameliorative tree species in the jhum fields, diversification of traditional cropping patterns by introducing new crops, introduction of water harvesting technology to support cash crop cultivation and scientific evaluation of introduced interventions and their comparison with traditional systems constitute the work plans.

Objectives

1. To find out ways and means of hastening the recovery of soil fertility in jhum cultivation.

2. To explore the possibilities of introducing new crops.

3. To identify fast growing native tree species valued by the tribals and, to standardize their culture techniques.

4. To develop and demonstrate low cost water harvesting technology ensuring availability of water during the lean periods and,

5. To create awareness on the consequences of forest degradation, exploitation and conservation through involvement of local people in the project activities.

Results and Achievements

1. *Alnus* trees were introduced in an area of 2 ha in 1990; the area was increased to 3.5 ha in

1992-93. In 1.5 ha of the planted area, *Terminalia, Albizzia, Melia* and 'Alammathung', a local species, were interplanted with *Alnus*. The trees were planted in the jhum plots as a means to check irreversible losses in soil fertility. In addition, the plants in due course of time would yield fuelwood, fodder and timber.

Alnus from Sikkim and Nagaland had been planted. A preliminary examination of the results showed almost identical performance by the saplings from Sikkim as well as Nagaland (Table 2). Detailed statistical analysis, however, is required to assess the performance and the suitability of each collection; further chemical analysis is also required to evaluate N_2 accretion to the soil. In addition regular data collection has been carried out on hydrological parameters in these fields, subjected to various treatments. Data on surface runoff, percolation and sedimentation have been collected from (i) traditional jhum fields, (ii) traditional jhum fields but with 1 yr *Alnus* saplings introduced, (iii) 1 yr jhum fallow and, (iv) 1st yr jhum fallow with *Alnus* introduced.

The results, indicate that a good ground cover and adequate tree cover achieved through simple biological treatments can accompany significant reduction in runoffs and soil losses. Crop yields from the traditional jhum fields (with/without alder) have also been recorded.

2. A comparative study of the performance of cardamom (*Amomum*) under different growth conditions has been initiated. Local villagers have also shown interest in plantations, and the Unit has disbursed 1000 clumps of cardamom, 1,250 saplings of *Alnus* and 670 saplings of hollock.

3. In the area of non-traditional crops and/ or new crop, the project was started by the Nagaland Gandhi Ashram (NGA) with technical collaboration of the Unit. Mustard was grown in the period intervening two jhum cultivation. Sunflower was also tried, but did not perform satisfactorily. It may be mentioned that the local farmers emulating the example of NGA had planted mustard.

4. Apart from the above, some efforts have been put in to collect local land varieties of rice (17 varieties), maize (3 varieties) and other crops.

Table 2. Growth characteristics of Nagaland and Sikkim collections of *Alnus*

Parameters	Nagaland Collection	Sikkim Collection
Height (cm)	112.78±21.99	104.08±23.39
DBH (cm)	2.15±0.76	1.53±0.74
Branch Recruitment	15.67±2.84	13.78±2.73
Branch length (cm)	25.07±6.01	19.77±5.88
Branch girth (cm)	0.44±0.07	0.34±0.22
Branch Numbers	0.77±0.66	7.56±1.39

3.2.3 Development Dilemma : National Context and Rural Scenario in the Himalaya (1991-92)

(Summary of completed project; please see last annual report for details)

The dilemma of development and the increasing expectations of the people, intensifies the contradiction of development culture and environment. In the Himalayan context, the three studied villages do not project any scope of agricultural intensification, nor do the prevailing conditions in the hills permit this. The population is on perpetual explosion, and the growing interaction, exposure and expectations are increasing the rural resentment. This is further intensified with the fast rate of urbanization and the involvement of rural areas in the development of urban centres. Rural migration to the cities, the neglect of rural cottage industries, cultural uprootedness and the growing selfishness are putting acute pressure on already depleted forest resources. It is recommended that people should be informed in advance of all these maladies, and be allowed to decide their own future with consensus and rationality.

3.2.4 Institution Building at Community Level: Elucidating the Constraints from a Micro-analysis (1991-92)

(Summary of completed project; please see last annual report for details)

The project, undertaken by the Institute on request from Central Himalayan Environment Association (CHEA), Nainital was completed in April 1992. The findings and conclusions were presented in the interaction seminar on Sustainable and Replicable Eco-development in Uttranchal conducted by CHEA on 25-26 April, 92 at Sitlakhet, Almora. The findings stressed that the basic issues in institution building necessitated the clarity of concept, understanding the community dynamics and defining the constituents like economic imperatives, resource links, cultural intricacies, development adversaries and many others, particularly those which emerge from eco-culture centres of the community. The dynamics of the community have to be studied and appropriately incorporated into the development strategy so that people act as catalysts rather than inhibitors in the process of institution building.

3.2.5 An Empirical Study of Development of Tribal Communities from Eco-cultural Perspectives: A Study in the Central Himalayan Region of India (1992-93)

Background

The tribes and their tracts constitute a very significant part of the backward people and region of the Indian Republic. In the Central Himalayan region of India, 5 major tribal communities namely the Bhotia, the Buxa, the Raji, the Jaunsari and the Tharu inhabit, constituting around 3.75 percent of the total population of the region. With the conceived notion of socio-economic handicaps of the tribal people, programmes under Backward Class Sector have been undertaken in addition to the General Development Programmes to develop them. Year marked provisions for their development have been made, beginning with the First Plan itself. However, no significant study of a holistic nature has been undertaken so far on the tribes of Central Himalaya to categorically understand factual impact of these programmes on them. However, experiences of tribal development planning elsewhere in the country show that despite the efforts made to ameliorate the well being of tribal people, the programmes failed to provide befitting substitutes to the traditional value oriented life style of the tribal people. Further, though the interlinks between community resources, socio-economics, culture and environmental needs have been recognised, they have not been articulated in terms of clear policies and programmes. With this in view, an attempt has been made here to understand the tribal culture in its totality and its connotations with regard to ecology and economy.

Objectives

1. To study the integrated nature of the tribal culture and its influences on resource use and management.

2. To understand the concept development from tribals' perception.

3. To study the linkages of culture with development.

4. To identify the markers responsible for sustainable development and nature of variation of these markers in different tribal communities.

5. To quantify the degree of diffusion of development programmes and their impact on social structure and community culture.

Results and Achievements

1. Two tribal communities - the Bhotia, a semi nomadic community and the Jaunsari, that practise polyandry and bonded labour, were selected for a comparative study. So far the investigations have been carried out in 5 villages in Kapkot block of Bageshwar tehsil in Almora distt. and the survey is continuing.

2. Adopting a hierarchial methodology with block, village and family as components of the study, secondary data was collected and compiled at block and village level on natural resources, demography, socio-economic, agro-economic and infrastructure, in addition to the primary data on sample villages (Table 3).

Table 3. Geo-demographic Particulars (1991)

Village	Altitudinal Location (m)	Distance from Bus Point (km)	Total Geographical area (in ha)	Total Population	Total Tribal Population	Density (per sq km.)
Harkot	1900	8.0	6410.0	217	96	36
Rithabagad	1250	0.0	-	161	104	-
Kanoli	1300	12.0	3024	275	61	91
Dhanyad	1600	10.0	77.6	137	50	178
Jakrola	1550	5.0	26.8	23	23	88

3. Bhotias of the area could be categorised into Harkotias, mostly confined in high altitude villages of Saryu catchment and Joharias, confined to Ramganga and Pungar catchments with distinct lifestyles. All surveyed villages in the study, however, are intercommunity villages, inhabited by both Bhotias and other caste groups.

4. The low sex ratio (SR), as found in some study villages, appeared to be due to shorter life span of the females as SR declined drastically in the age group above 50. This was more conspicuous among the Harijan Bhotias and Harijans.

5. No significant difference in general literacy was observed between various communities, though, difference between male and female literacy was the highest among the Harijan Bhotias, followed by Harijans, Thakurs, Bhotias and Brahmins. More numbers of professional literate were found among the Joharia Bhotias than any other including the Harkotias.

6. Higher percentage of joint families were found among Thakurs followed by the Bhotias, while more number of nuclear families were found among Harijans followed by Harijan Bhotias. Number of household with females as head was highest among the Harijan Bhotias and lowest among the Harijans.

7. The Harkotias practise cultivation like caste Hindus, while Joharias mostly subsist on woolen and other trading. The chief crops at the high altitude village (above 1800 m) of Harkot was ragi (*Eleusine coracana*) occupying around 84.4% of the cropped land followed by wheat (*Triticum aestivum*) occupying 79.0% of the cropped land. In the low altitude villages (below 1800 m) of Kanoli, Dhanyad and Jakrola, paddy (*Oryza sativa*) occupies around 80.84% of the cropped land followed by wheat (*Triticum aestivum*), occupying 57.13 %. Potato (*Solanum tuberosum*) is cultivated at both altitudes. The acceptance of high yielding varieties of crops in the villages Harkot, Dhanyad and Kanoli is almost nil, and minimal at the other two introducing agencies.

8. Many a varieties of traditional crops have almost disappeared or are fast disappearing. The varieties facing such threat include 11 varieties of paddy, 3 varieties each of wheat and ragi. Owa, a wheat like crop has totally disappeared. The traditional varieties are being re-placed by other traditional varieties with more yield or a high yielding varieties.

9. The absolute numbers of domesticated animals has increased, during the period 1977-1992, though the number of heavy animals has decreased and small animals have increased. In per capita holding, sheep dominate (0.88), followed by goats (0.40), oxen (0.21), and cows (0.20).

10. Though, no restriction is communally sanctioned for size of livestock holding, the animal population is being controlled by availability of fodder grass at Pindari grasslands (bugiyals). Alpine grasslands at Pindari is allotted among various shepherds, where they traditionally graze their sheep and goats every year from April-May to October-November. The sheep and goats prefer particular grasses like masuria

(*Trachydium roylei*) at Pindari grassland. A shepherd can take the sheep or goat of other households of his village at a charge. For example, in Harkot a shepherd charges Rs 10.0 per sheep or goat, if he takes it for grazing at Pindari. The Bhotia shepherd of Harkot pays either an amount of Rs. 50.00 per 'toli' (consisting around 300 sheep and goats) or in kind in terms of one or two sheep or goat to the villagers of Khati when he passes the forest land of Khati while taking his flock herd to Pindari. The unyielding cows and non ploughing oxen, are considered as burdens both by the Bhotias and Hindu communities.

11. Both the categories of Bhotias could be termed "Hinduised tribes" since both have undergone marked changes in socio-cultural milieu through acculturation and have almost lost their unique tribal characteristics being assimilated to Hindu culture.

12. One aspect of cultural life, which has undergone marked change relates to the marriage pattern of the Bhotia tribe. The unique marriage practices like rang bang, child marriage, marriage by capture, cross cousin marriage, levirate etc. are being replaced by Hindu marriage patterns, i.e., Kharchadan and Kanyadan. Teenage marriage is prevalent among all the communities, being comparatively lesser among the Brahmins. Parallel existence of patriliny and matriliny among the Bhotias has strengthened the social status of women.

3.3 CONSERVATION OF BIOLOGICAL DIVERSITY

3.3.1 Mechanisms of the maintenance of biological diversity and their role in ecosystem organization & functions in conservation areas (1989-90)

Background

The biological mechanisms maintaining a diverse community are not as clearly known as the variation in diversity in space and time. The disturbances caused by fire play a key role in the various ecosystem processes. The present study was initiated to learn about the causes and consequences of variability in fire regimes and to understand the variation in spatial and temporal terms following fire events and their mechanism(s).

Objectives

1. To analyse the damage caused by fire.
2. To study the regeneration through seed, coppicing and sprouting.
3. To understand the characteristics of shoots and leaves of sprouts; and
4. Determination of total dry matter (leaf and shoot), and nitrogen production.

Results and Achievements

1. After forest fire behaviour of three species viz., *Quercus leucotrichophora*, an evergreen canopy forming species; *Rhododendron arboreum*, an evergreen undercanopy species; *Lyonia ovalifolia*, a deciduous undercanopy species of mixed broadleaf forest was analysed. Damage in terms of bark depth was highest for *L. ovalifolia* and lowest in *Q. leucotrichophora*.
2. All the species showed their regeneration through coppicing, except for *Q. floribunda* which regenerated through seed. Number of sprouts per tree on main stem and lateral branches was highest for *R. arboreum* and lowest for *Q. leucotrichophora*. Sprouting upto 40 cm diameter of trees for *Q. leucotrichophora* was not observed.
3. Shoot length, diameter, and buds per shoot were highest for *L. ovalifolia* whereas leaf/shoot and shoot mass was highest for *R. arboreum*, followed by *L. ovalifolia*. Leaf area, leaf mass, moisture and specific leaf area were

highest for *L. ovalifolia*, followed by *R. arboreum* with few exceptions.

4. Nitrogen concentration in leaves was higher for *L. ovalifolia* and *Q. leucotrichophora*. Comparison of leaves of unburnt and burnt trees of *Q. leucotrichophora* and *R. arboreum* showed that the nitrogen concentration was higher for leaves of burnt trees and, the reverse was observed for shoot nitrogen concentration. Total leaf and shoot production was 2653.52 g/ha, of which about half was produced by *L. ovalifolia*. Total nitrogen production was 27.13 g/ha, of which about 46 % was contributed by *R. arboreum* alone.

3.3.2 Exploration of Lesser-Known Crops of Garhwal Himalaya as Food Source (1990-91)

Background

Garhwal Himalaya serves as a reservoir for a large number of traditional, under- utilized crop species. With ever increasing population pressure and fast depletion of natural resources, it is of utmost importance that the possibilities of using little known crops should be explored in order to meet the growing demand of food. In the present project, an attempt has been made to work out the eco-energetic analysis and caloric content of some of these crops across an altitudinal gradient, and to survey the area under cultivation of these crops (presently and in the past) and to find out the reasons for decrease in the cultivation of these traditional land races from the region.

Objectives

1. To survey plant species of potential food value which have been domesticated by the traditional societies.

2. To study the contribution of "lesser-known" crops in meeting the food requirements of traditional societies.

3. To compare the nutritional attributes of the "lesser-known" crops with those of common food crops.

4. To analyse the land management, cultural practices and ecophysiological requirements of lesser-known crops and their comparison with common crop agroecosystems.

5. To identify strategies for conservation of the lesser-known crops.

Results and Achievements

1. Survey of Bangar valley (Khaliyan- Bangar) in Tehri Garhwal, revealed that the area planted by *Setaria italica* and *Echinocloa frumentacea* has declined by upto 80-85% in the last two decades. The area under *Perilla frutescens* and *Macrotyloma uniflorum* has been almost replaced by improved varieties of *Glycine max* (Soybean Brass) and *Oryza sativa* (Govinda H.Y.V.). There are several interacting factors that are directly and indirectly responsible for this genetic erosion and for creating an imbalance in traditional agroecosystem.

2. The caloric content of the edible portion of some important under-utilized crops cultivated across an altitudinal gradient of Garhwal Himalaya was analysed. In majority of the crops it was found that the caloric content increased with increasing altitude. The differences observed in the caloric content of same crop at different altitudes may be influenced by climatic variations.

3. *Perilla frutescens* locally known as "Bhangjeera" is an important oil yielding, under-utilised lesser-known crop of Garhwal Himalaya and is mostly cultivated between 1000-1800 m. The oil of this crop is used in medicines. But, recently due to introduction of high yielding oil varieties of mustard, the cultivation of this crop has declined drastically. This crop is strictly grown in rain-fed condition and takes almost a year to ripe. Unlike mustard, *Perilla* is not seriously attacked by plant diseases, insect and pests. By the time *Perilla* plants are 2-3 inches high, they are already quite

resistant to drought. Because of its low growth form in the initial phase, it is also resistant to unusually low temperature and can withstand frost. Important information regarding plant density, grain and by-product yield of this under utilised oil crop is given in Table 4.

Table 4. Plant density, grain and by-product yield of an important under-utilised oil crop (*Perilla frutescens*) grown in pure and mixed stands at middle and higher altitude of Garhwal Himalaya

Crop species	Density (/ha)	Yield (kg/ha)	By-product (kg/ha)
Middle altitude (1000-1200m)			
Pure stand			
Perilla frutescens	266000	612	1357
Mixed stand			
Perilla frutescens	184000	294	699
+			
Vigna mungo	159000	668	509
Higher altitude (1500-1800m)			
Pure stand			
Perilla frutescens	296000	444	1214
Mixed stand			
Perilla frutescens	112000	157	347
+			
Eleusine coracana	493000	542	1331
+			
Amaranthus viridis	81000	235	308

4. *Panicum milliaceum* (Hog millet) locally called as "Chenna" is cultivated exclusively on irrigated land. Among all the under-utilized crops, this is the only crop which takes least time (55-60 days) to ripen. It is a kharif season crop and cultivated between May to June. Due to poor food quality of *Panicum* and introduction of H.Y.V. of rice and wheat, cultivation of this crop has been reduced sharply in most of the villages in the region during the last two decades. However, between 1970 to 1980 or even before the irrigated land in the region was utilized properly by taking three crops in a year from same piece of land like wheat+mustard between Oct.-April (Rabi crop), *Panicum milliaceum* during May-June and paddy between July to October (Kharif crop). Now only two crops are harvested annually (wheat + mustard during Rabi season) and rice during Kharif season.

5. The eco-energetic analysis of *Panicum milliaceum* cultivated in lower (550 m) and higher altitude (1600 m) has been worked out. The total energy input was found maximum for this crop when cultivated at higher altitude whereas, the total energy yield through grain and crop by-product, and output/input ratio was highest for the same crop cultivated at lower altitude. This crop required minimal inputs as compared to other under-utilized crops and was found energetically highly efficient with output/input ratio of upto 35.5 (grain) and 116.2 (grain + crop by-product), respectively. The monetary output/input analysis showed similar pattern like energy, with maximum net return and efficiency ratio at lower altitudes.

3.3.3 Studies on Diversity, Fragmentation and Conservation of Ecologically Sensitive Habitats of the Himalaya (1991-92)

Background

One of the major priorities in conservation biology involves the studies of habitat diversity and the consequences and future trends of habitat fragmentation. In the Himalayan context, the scenario of habitat heterogeneity is changing at a fast pace, largely due to social and environmental factors. The identification and characteri-zation of the habitats in 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; important ones, however, are (i) reduction in total habitat area, (ii) redistribution of the remaining area, (iii) development of disjunct fragments and (iv) disruptions in important interactions. 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 Kumaon Himalaya. The studies confine to Askot Wildlife Sanctuary during the reporting period.

Objectives

1. Habitat classification, mapping and identification fragmented habitats.

2. Identifying natural and anthropogenic pressures causing fragmentation.

3. Identifying fragile habitats/communities/species

Results and Achievements

1. Epiphytic orchids studied so far indicated their decrease with increasing elevation.

2. Among identified orchids *Eria spicata* (27 host), *Pholidota articulata* (23), *Coelogyne ovalis* (14), *Luisia trichorhiza* (13), *Aerides multiflora* (12) etc. are the common epiphytes with broad habitat (host) range. Both the indices, i.e., RI and PUI were taken in consideration for the prioritization of the hosts (habitats). Out of various critical hosts identified *Acer oblongum, Ougeinia oojeinensis, Emblica officinalis* and *Glochidion velutinum* need attention due to their poor presence/ availability in the area. Similarly others (*Quercus leucotrichphora*) deserve special mention on account of increasing pressure on these hosts due to their multipurpose utility (Table 5).

3. Manifestations of commonness and rarity of 172 ethnobotanically important taxa of the sanctuary was analysed which revealed that 33.7% taxa are in endangered category.

4. The total potential number of wild useful plants increases with increasing elevation. Anthropogenic and physiological factors are responsible for higher percentage of endangered taxa in lower and higher elevational ranges, respectively.

5. The richness of plant resources was higher along the vertical gradient as compared to horizontal.

Table 5. Major hosts of Askot Wildlife Sanctuary supporting richness of orchids (host) ranking according to their index of sensitivity

Hosts	Orchids (No)	Index of sensitivity (hosts)		Total
		Rarity	Pressure	
Acer oblongum	8	5	2	7
Ougeinia oojeinensis	7	3	4	7
Castanopsis tribuloides	12	2	4	6
Emblica officinalis	11	3	3	6
Glochidion velutinum	8	3	2	5
Engelhardtia spicata	19	1	3	4
Casearia glomerata	9	2	2	4
Macaranga postulata	9	1	3	4
Quercus leucotrichophora	14	1	3	4
Sapium insigne	24	1	1	2

3.3.4 Establishment and Maintenance of a Functional Arboretum (Surya Kunj) at Kosi-Katarmal (1991-92)

Background

Preservation of woody genetic resources through introduction in the arboretum is the primary objective of the project. While selecting species for plantation, emphasis is being given to indigenous species with economic potential. It is also envisaged to identify different specific combinations for viable stratification for maintaining the continuum.

Objectives

1. Quantitative analysis of existing flora and biomass.

2. Plantations and nursery development.

3. Survey of soil and water analysis characteristics.

Results and Achievements

1. Quantitative analysis of the vegetation at different sites revealed the dominance of *Chrysopogon serrulatus, Cyperus compressus* and *Pogonatherum paniceum* in the existing vegetation.

2. Above ground and below ground biomass revealed the habitat preference of species in different sites (Table 6).

3. Seeds of 64 species collected from different area of Kumaon were sown and their germination and inter-cultural inputs monitored.

4. Mixed plantations of about 1295 saplings was undertaken which showed a survival percentage of 52.36.

5. Soil and water analysis of the arboretum indicated a soil pH range between 5.5 to 6.6 with a moisture content varying from 2.5% in dry flat land to 31.2% in marshy land. Sulphate and chlorides are present up to desirable level(Table 7). The water quality data is presented in Table 8.

Table 6. Above and below ground biomass ($g\ m^{-2}$) in site A and B

Species	Sites	
	A	B
Chrysopogon serrulatus	64	-
Arthraxon nudus	27	-
Heteropogon controtus	-	65
Pogonatherum paniceum	-	8
Miscellaneous	66	49
Total above ground biomass	157	122
Total below ground biomass	313	483
Total biomass	470	605
Root/shoot ratio	1.99	3.69

Table 7. Soil Characteristics

Sampling site	% Moisture Content	% Organic Carbon	% N	pH	Sulphate (mg/g)	Chlorides (mg/g)
A	3.5	0.65	0.114	6.4	0.30	0.86
B	31.2	1.15	0.174	5.5	0.32	0.26
C	9.3	1.04	0.470	6.1	0.17	1.28
D	2.5	0.88	0.121	6.6	0.17	1.32
E	15.4	1.00	0.239	6.0	0.18	1.28
F	5.5	0.73	0.320	6.2	0.16	1.99

Table 8. Chemical Characteristics of Upreti Dhara

pH	Specific conductivity in ls/cm	Flow lit/min	Nitrates mg/l	Dissolved Oxygen mg/l	Chlorides mg/l
7.1	78	5.00	BDL	12.00	29.20

BDL - Below Detection Limits

3.3.5 Development of a Nursery and Rhododendron Arboretum at Pangthang (1991-92)

Site development of the Sikkim Unit Complex at Pangthang (1970 m above msl) has been initiated this year. Out of the 7 acres of land, about 2 acres have been delineated for nursery and rhododendron arboretum development. The total area is fenced. The site of the Institute is about 12 km on the north-west side by road from Gangtok.

Nursery Development

All bushy weedy species were removed from the entire site. Not a single tree was disturbed and all the standing individuals have been retained in the plan of site development. Thus, some of the species of the area are already in the collection at Pangthang site. The steep areas of the site have now been terraced for preparation of nursery beds. A total of 22 terraces with an average dimension of 29 x 2.1 x 2.2 m were constructed without much disturbance on the landscape. With a view of soil preparation, seedlings of a number of vegetables have been raised and planted in the first year. Growth of the vegetables is satisfactory. Seedlings of cabbage and cauliflower have been distributed free to the inhabitants of surrounding areas. Seeds of tree species were collected and seedlings are being raised. Experiments on seed

germination, seedling survival with or without shade, etc., are being carried out as the site receives snowfall and frost in the winter. As a trial in the first year seedlings of *Michelia excelsa* (Rani chanp), *Michelia cathcartii* (Tite chanp), *Prunus nepalensis* (Arupate), *Hovenia dulcis* (Bangi kath), *Bassia butyracea* (Chiuri) and *Erythrina arborescens* (Phaledo) have been raised.

Seedlings of *Michelia excelsa* (Lali kawla), *Quercus lamellosa* (Buk), *Machilus villosa* (Ghew kawla), *Engelhardtia spicata* (Manuwa), *Michelia lanuginosa* (Phusre chanp), *Symingtonia populnea* (Pipli), *Rhododendron arboreum* (Lali gurans), *Nyssa sessiliflora* (Lek chilaune), *Machilus* spp. (Kawla), *Elaeocarpus sikkimensis* (Bhadrase), *Cedrela toona* (Tun) were planted on the sides of the foot-paths of the nursery and 97% seedling survival was recorded. A number of bamboo species are being planted on the sides of a drain in the nursery.

Rhododendron arboretum

Plants (*Rhododendrons*) collected from different locations in Sikkim and Darjeeling were planted at the site demarcated for arboretum at Pangthang. Planting procedure was designed so as to simulate natural conditions as far as possible. Plants were brought alongwith intact root-system contained inside the soil monoliths. Seeds of various rhododendrons were also collected for germination studies. So far 15 rhododendron species have been collected and planted. Experimental trials of planting such as (i) planting at about 1m distance on terraces, (ii) planting on undisturbed ground, and (iii) epiphytic species on tree stumps are in progress. The collected and planted species are: *Rhododendron anthopogon, R. arboreum, R. arboreum* var *cinnamomeum, R. barbatum, R. campylocarpum, R. ciliatum, R. cinnabarinum, R. dalhausiae, R. grandiflorum, R. lepidotum, R. niveum, R. pumilum, R. thomsonii, R. triflorum, R. virgatum,* and *R. wightii.* Germination of rhododendron seeds met with only limited success. This will be further tried with various treatments in the future.

Field observations revealed that some rhododendrons are in a bad shape, in terms of survival conditions, particularly in the Singalila range. This condition has been brought about by extensive fuel foraging. In less than five years of time the area is expected to be devoid of rhododendrons. *Rhododendron niveum* is now quite scarce in the North Sikkim. Only 7 individuals were found growing and 3 seedlings were observed (average height 40 cm). *R. camelliieflorum, R. nivale, R. leptocarpum, R. vaccinioides, R. lindleyi, R. setosum, R. sikkimense* etc. were quite scarce and not a single one could be collected so far.

3.3.6 Conservation of Biological Diversity of Ecologically and Economically important Plants of Central Himalaya (1992-93)

Background

Amongst the economically viable food plants, wild edible species constitute an important source as a supplement and substitute especially in times of scarcity. The Himalayan people hold limited cultivable land and can not afford optimum agricultural inputs. Therefore they largely rely on a number of unconventional crop plants such as Chenopodium, Buckwheat etc. Since there is a great scope for enhancing the acceptability of lesser known economically important plants i) as income generating resource for the mountain inhabitants, and ii) promoting diversity of plant resources for human consumption, it is envisaged to initially inventorize such resource and also identify the occurrence and availability of the resource so that conservation strategies are developed for such germplasm on priority.

Objectives

1. Inventory and identification of economically viable species.

2. Categorization and classification of wild edible species with regard to rarity, endemism and other attributes.

Results and Achievements

1. Out of 800 species reported from India 334 wild edible plants were identified in Indian Central Himalaya. It was noticed that wild edibles mostly occur between 1000-2000 m perhaps due to mild climatic conditions. Interestingly, only 5.39% of wild edible taxa are present between 4000-5000 m. This could be due to inadequate plant exploration in that area.

2. The identified taxa were subjected to test of rarity following Rabinowitz *et al.* (1986). The analysis revealed that 28 taxa (8.68%) exhibited narrow geographical distribution, restricted habitat specificity and small population size (Table 9). On the other hand commonness was more prevalent, representing 157 taxa (47.01%). Analysis of the life forms revealed the representation of 121 herbs, 96 shrubs and 103 tree species. *Aconitum heterophyllum, Corylus jacquemontii* and *Juglans regia* top in the trade value.

Table 9. Different forms of rarity alongwith commonness exhibited by wild edibles of Indian Central Himalaya based on three traits i.e. geographical distribution, habitat specificity & local population size

Rarity	Geographical distribution	Habitat specificity	Local pop. size	Total no. of spp	%
1	Narrow	Restricted	Ev small	28	8.68
2	Narrow	Restricted	Sm large	31	9.28
3	Narrow	Broad	Ev small	11	3.29
4	Narrow	Broad	Sm large	13	3.89
5	Wide	Restricted	Ev small	28	8.38
6	Wide	Restricted	Sm large	48	14.37
7	Wide	Broad	Ev small	17	5.09
Commonness					
8	Wide	Broad	Sm large	157	47.01

Ev= everywhere, Sm= Somewhere

3.3.7 Timber Line and Snow Line Vegetation of Kumaon in Central Himalaya: Aspects of Composition, Diversity and Conservation (1992-93)

Background

The timber line and snow line vegetation in the Himalaya is least investigated, but this should not be taken to mean that it is less interesting than those occurring in lower elevations. The remoteness, difficult terrain and almost non-existent logistic facilities make the area least inviting for undertaking researches of any kind. The present study, therefore, will be a pioneering attempt in Himalayan timber line and snow line.

Objectives

The major objective is to generate base line information on floristics, phytosociology and phenology of plants occurring at timber line and snow line areas in Pindari region of Kumaon Himalaya. The study intends to collect data on -

1. Species composition and diversity

2. Phenology of important species

3. Regeneration status and population structure of tree species at timber line

4. Other aspects of study include identification of endangered/threatened species and habitats supporting such ecologically sensitive taxa, prioritization of species and micro habitat to be conserved in future, and survey of ethnobotanically important species and their habitats.

Results and Achievements

1. Based on published records and previous observation of the investigator, an extensive inventory of existing plant species, their altitudinal range, habitat preference and status has been prepared for timber line. Nearly 400 species belonging to 54 families have been recorded. The dominating families at timber line are: *Asteraceae* (31 species), *Rosaceae* (31), *Poaceae* (29), *Brassicaceae* (25), and *Ranunculaceae* (22), etc.

2. Preliminary information on distribution of various dominant (Physiognomic) types has been collected. In general, three distinct

physiognomic types, i.e., broad- leaved, deciduous; broad leaved, evergreen; and needle leaved, evergreen were identified.

3. Sites for intensive study have been selected in Pinder micro-catchment area for preparing data base on timber line vegetation in the Himalaya.

4. Species representing different dominant types have been identified as *Quercus semecarpifolia, Rhododendron campanulatum* (broad leaved evergreen), *Betula utilis* (broad leaved deciduous), and *Abies pindrow* (needle leaved evergreen), for detailed phenological observations.

5. Following work has been planned for the coming year: a) Collection of data on composition and diversity of communities at timber line. b) Monthly/seasonal observation on phenophases of identified taxa. c) Collection of data on natural regeneration of tree species at timber line. d) Preliminary survey of snow line vegetation.

3.4 ECOLOGICAL ECONOMICS & ENVIRONMENTAL IMPACT ANALYSIS

3.4.1 Transhumance in Central Himalaya and its Impacts on the Himalayan Environment (1990-91)

Background

Transhumance is a historical phenomenon evolved as an adaptation to extremities of physical environment in remote and high Himalayan mountains. Transhumance encompasses essentially varying degrees of dependence on agriculture and pastoralism to secure human beings. The very existence of this life support system and preservation of cultural values by the societies practising them for centuries offer a scope for deeper understanding of sustainability and for getting an integrated view of the social, cultural, economic and environmental facets of development.

The Bhotiyas of Dharchula (District Pithoragarh) practising transhumance in two valleys of Darma and Byans constitute the focus of this study. The target group consists of tribals settled in 13 villages of Darma valley and 7 villages of Byans valley scattered across an altitudinal range of 2300 m to 4100 m above sea level. The extreme cold in higher reaches imposes constraints on intensive agriculture and people depend more on trade as a profession to support their livelihood. The termination of trade with China in 1962 necessitated diversion of attention from trade to agriculture. Palthi or ogal (*Fagopyrum esculentum*) and potato (*Solanum tuberosum*) are the major crops grown in the area. Phapher (*Fagopyrum tataricum*) is grown on a small scale. Vegetables grown for domestic consumption include cabbage, turnip, peas and radish. Animal husbandry and valuable collection of plant products from the wild are other occupations linked to crop husbandry. Collection of data and analysis initiated earlier were carried forward.

Objectives

1. To compile and analyse the historical accounts of social, cultural, religious, political and economic setup of these transhumanic people.

2. To analyse the spatial patterns and temporal trends of the fundamental requirements of these people.

3. To estimate the efficiency of resource use in terms of both economic and ecological costs, and to analyse the question of their sustainability.

Results and Achievements

1. These people have a rich knowledge of cattle breeding to rear livestock resistant to the extreme of climate. The genetic variability in the livestock appears to be a selective adaptation to climatic variability in the region.

2. Goats and sheep were found to be kept for three distinct purposes. The ones used for procreation got the most attention followed by those used for wool production and for transportation.

3. The average annual wool production was found to be highest for male Tibetan Goat (14 kg), followed by the female Tibetan Goat and male Sheep (0.8-1.0kg), and the female Sheep (0.5-0.75 kg).

4. People generate some income through informal trade in Nepal, where they sell their agricultural produce at a rate higher than that in India.

5. Use of roots and stems of shrubs, as fuel wood was common in villages above timber line. *Juniperus, Caragana, Cotoneaster, Berberis, Salix* and *Rosa macrophyla* are being consumed at an average rate of 30 kg per day, per household.

6. Data on medicinal herbs being collected from the wild and their market values have been compiled.

7. Data/information collected are being analysed to identify appropriate openings for development of people inhabiting a difficult and neglected region.

3.4.2 Environmental Impact Analysis of Multipurpose River Valley Projects - Tehri Dam (1991-92)

Background

Sustainable utilization of natural resources for socio-economic development of the people of Himalaya by ways which also complement the development needs of the country has emerged as a prime concern of decision makers and a challenging issue for the academicians. Time and again, attention is drawn towards past errors in the development planning. A more crucial issue is to formulate strategies for rectifying the past mistakes, if any, and for removing the uncertainties of their likely recurrence in the future. Rationality in decision making, apart from many other factors, is strongly influenced by the quality and quantity of information on multiple facets of environment, technology and socio-economics, enabling one to envisage the likely consequences induced by a given development activity. Recent advancements in remote sensing technology complemented with automated data processing offer immense scope for enhancing the element of objectivity in development project appraisals. This project initiated in collaboration with Space Application Centre, Ahmedabad examines the applicability/ utility of thematic information derived from earth resources satellite data, integrated with other information for environmental appraisal of multipurpose river valley projects, selecting Tehri Dam as a test case. Interpretation of satellite data and collection and analysis of ground based information initiated in the previous year were carried forward during this year.

Objectives

1. To review the present mechanisms of preparing environmental impact assessment document and management plan in the context of multipurpose river valley projects.

2. To carry out a time sequence resource analysis in Tehri Dam catchment area.

3. To undertake socio-economic analysis in the catchment area and to integrate non-spatial and spatial information for inferring the ecological and economic trends.

4. To identify specifications of methodology to be adopted for impact analysis, preparation of environmental manage-ment plans and their monitoring.

Results and Achievements

1. Visual interpretation of false colour composite (FCC) of IRS data (scale 1:50,000) to map land cover/use in 1989-90 was completed.

2. Key geomorphological and geological attributes were mapped using satellite data supplemented with information available in topographical sheets and field surveys.

3. Maps depicting population growth, sex ratio, literacy, land holdings, agriculture in the affected area were prepared taking village as a mapping unit at different points of time.

4. Socio-economic-geological conditions of the affected area were studied in fifteen selected villages, following a stratified sampling design. The changes induced by the development activities are being inferred.

5. Integration of spatial and non-spatial information through computer based techniques is being looked into.

3.4.3 Impact of Domestic Sewage Disposal on Natural Water Springs of Almora (1991-92)

Background

Adequate quantity of potable water is not available to large populace of several hilly areas of Kumaon Himalaya due to a number of environmental factors. Hilly areas are characterized by shallow depth of subsoil water which enhances the possibility of recharging through the top soil. This state of affairs leads to water pollution especially in large townships through unmanaged open drains and cesspools. The project aims to collect and analyse data on the impact of sewage disposal on natural springs of Almora town.

Objectives

1. To map the spring lines and their recharge areas in and around Almora town and to infer their dynamics in the recent times.

2. To monitor quantity and quality of water and impact assessment of present system of sewage disposal on subsurface water flows currently in use.

3. To suggest appropriate mitigation measures in order to contain qualitative and quantitative problems pertaining to domestic water in the town.

Results and Achievements

1. Water chemistry of samples taken from 12 springs of Almora (Fig. 2) town was analysed in three different seasons.

Fig. 2. LOCATION OF NATURAL SPRING IN ALMORA TOWN

2. Marginal seasonal variations in the water quality was noticed.

3. Springs near heavily populated areas showed higher concentration of nitrates (60 to 68.4 mg/l) as compared to the ones at higher altitudes (scattered population) indicating possible leaching of sewage from the town which consequently affects ground water quality.

4. Preliminary data is also being generated to assess the relationship between different rock compositions and the proximity of spring lines.

3.4.4 Development of Roads and its Environmental and Socio-economic Impact in Kapkot Block, Almora District in Kumaon Himalaya (1992-93)

Background

Transportation is a focal index of development of any region, since it plays a vital role in economic and infrastructural growth. In this context, roads are a major means for transportation, and provide specialised services and facilities. However, several negative aspects are associated with road construction, particularly acceleration of deforestation, landslides and soil erosion. Kapkot block of Almora district in Kumaon Himalaya, is known for its remoteness and underdevelopment. Road constructions were initiated in this block in 1960. An attempt has been made in this study to identify the influence of road building on economic and infrastructural development of the block, nature of utilization of road transportation by different segments of rural society and the consequential changes in the socio- cultural milieu. The diversity in landscapes, geological conditions and road types influence the scope and objectives of the study.

Objectives

1. To find out the nature and degree of socio-economic impact of roads on hill people.

2. To give a true picture of the transport system, i.e., accessibility, connectivity, length and density, traffic flow, etc.

3. To highlight the role of road network in changing the land use, occupation, expansion of human settlement, building material and shape and size of houses.

4. To quantify the degree of enhanced socio-economic services and infrastructural growth articulated through the woods in different areas, i.e., near and far from roads.

5. To analyse the human ecology and habitat transformation.

Results and Achievements

1. Data was collected both from secondary sources, and primary surveys, on physical setting, i.e., drainage, geology, physiography of slopes, landuse, settlement pattern and road networks, socio-economy and infrastructural attributes. Base maps had been prepared for the block and sample villages by using survey of India topo sheets by supplementing it with inputs from field survey.

2. Geologically, the block could be divided into two major units i.e. the lesser Himalaya (around 65%) and the greater Himalaya. The drainage pattern is generally dendritic type and the block could be categorized into 5 major drainage systems - the Pinder system with only 9 villages, the Saryu system with 104 villages, the Eastern Ganga system with 13 village, the Mehergad system with 20 villages and the Pangar system with 68 villages.

3. The average slope ranges from less than 10° to 39°. Altitudinally, the area ranges between 1000 to 7000 m. However, the maximum concentration of the settlements and road network was found in the altitudinal zone of 1200 to 2000 m.

Table 10. Concentration of Settlements and Road Networks

Sl.	Altitudinal range(m)	Percentage Concentration of	
		Settlements	Roads
1.	Less than 1200	5.61	86.14
2.	1200 - 1600	50.00	34.45
3.	1600 - 2000	34.11	19.33
4.	More than 2000	10.28	10.08

Source: Survey of India toposheets and Primary Survey.

4. Drainage pattern had a significant role in the development of road network as it was observed that most of the roads were constructed along the river or channel.

5. Road development was found to be linked with growth of basic infra-structural facilities, i.e. health, secondary education, banking, communication and electricity. However, the distribution of primary schools, post offices and livestock development centres were not dependent on road networks, though it was observed that basic facilities particularly man power resources, were found to be more in road side schools, post offices and livestock centres than the ones at a distance from the road.

6. Development of growth centres and service sectors were found to be positively linked with the development of road network. Marked changes in landuse and cropping pattern were associated with construction of road networks. Potato as a commercial crop, had replaced many a traditional crops particularly at road head villages. Besides soybean, pea and vegetables, recently introduced commercial crops, have increased in the average income.

4. INFORMATION SYSTEMS, PUBLICATIONS AND NETWORKING

4.1 Environmental Management Information System on Himalayan Ecology (1992-93)

Enormous data and information have been generated to serve the needs of environmental management, planning and policy formulation. This vast literature, diverse in subject content, varied in form, multilingual in nature, uneven in quality, and often difficult to access in terms of both time and cost needs to be compiled, stored, updated and disseminated for their use. Environmental Information System (ENVIS) Centre on Himalayan Ecology has been established at the Institute as a central facility to serve information needs of all those concerned with environment and development of the region. The Computer System with peripherals has been procured. The Centre is equipped with facilities of Color Dot Matrix Printing and Scanning. A biannual periodical "Himalyan Environment & Development Bulletin" has been planned.

4.2 Integrated Eco-development Research Programme for Himalayan Region

In March 1982 the Planning Commission had finalised guidelines/format for Coordinated Action Research Projects in the Himalaya, Western Ghats and the Ganges Region. The Himalayan projects, also called the Integrated Eco-development Research Programme for Himalayan Region, has four clusters, i.e., (1) North-Eastern Region, (2) Eastern Himalaya, (3) Central Himalaya, (4) Western Himalaya. From 1st April, 1992 the Ministry of Environment and Forests has entrusted the responsibility of execution of this programme to the Institute.

4.3 Institutional Networking

Scientists of the Institute at the Sikkim Unit have been actively establishing linkages with other relevant organizations. The Institute has been contributing to the activities of the Sikkim Science Society. In the absence of any Science and Technology Council and an established Department of Science and Technology of State, the Government of Sikkim has entrusted the Sikkim Science Society with the responsibility to function as the State Science and Technology Council and to carry out science and technology promotion activities in the State. Out of a variety of programmes of the Society, the publication division is coming out with SSS-Newsletter (quarterly) and the Journal of Hill Research (biannually) for the last several years. Recently scientists of the Institute in the capacity of the Chief Editor/Editors at the Sikkim Unit have taken over the responsibilities of publication of above periodicals of the Society.

Two postgraduate students from School of Environmental Sciences, Jawaharlal Nehru University, New Delhi carried out their dissertation work at Kosi, Almora on forestry and agroforestry related problems in Kumaon.

4.4 Institute Publications

4.4a Action Plan for Himalaya

"Action Plan for the Himalaya" is a comprehensive documentation of the problem complex-ecological, social, economic and the actions/needed for resolving the problems, published by the Institute.

The issues related to environment and development have been considered under ten broad heads: (i) Water Management and Soil Conservation (ii) Forests and Forestry (iii) Energy (iv) Farming Systems (V) Bio-diversity and Conservation (vi) Transport and Communication (vii) Industrialization (viii) Tourism (ix) Health and Nutrition (x) Management of Natural Hazards. Irrespective of the diversity from various considerations, some points ought to be addressed on priority all through the region - water harvesting and decentralized supply systems, people's participation in management of forests, mini and micro hydel projects, consolidation of land, public purchase system on lines of public distribution system, micro industrial units enabling value addition close to the source of production of raw material, conservation of wild as well as cultivated plants, active involvement of educational institutions in environmental management and maint-enance of biodiversity, appreciation of geotechnical considerations in road alignments and more emphasis of technology like ropeways and cable transport in order to improve transport and communication, expansion of tourism industry in ways which directly involve and benefit to the rural people, research, development and extension on wild fruits and oil plants.

The document brings out that the G.B. Pant Society of Himalayan Environment and Development consisting of representatives from Central and State Governments, Scientists, Technologists and people's representatives could serve the purpose of an apex body carrying the responsibility of taking decisions on integrated management of natural resources for sustainable development in the Himalaya.

4.4b Himalayan Biodiversity: Conservation Strategies

The proceedings of the workshop organised by the Institute in Oct. 1992 at Srinagar (Garhwal) incorporates the findings of eminent scientists on the status of biodiversity in the Himalayan region. The publication identifies and analyses diverse perceptions on the focal issues related to the major themes of the subject matter. The objective of putting the ideas together in the printed form is not only to provide an adequate database on Himalayan biodiversity but also to draw useful, effective and practically feasible conservation strategies (expected time of publication : July, 1993).

4.4c Fodder trees of Kumaon Himalaya

This illustrated publication offers a comprehensive account of the fodder trees of the area with notes on systematics, distribution and utility. Nutritional aspects of the fodder are also reviewed (expected time of publication: October, 1993).

4.4d Agricultural Economy of Garhwal Himalaya

This publication has been planned broadly on the lines of 'Agricultural Economy of Himalayan Region: with special reference to Kumaon' published in September 1991. The study is planned to contain 12 chapters namely, Introduction, Human Resources, Livestock Resources, Land Resources, Land Holdings, Farm Machinery & Implements, Irrigation, Cropping Pattern, Horticulture, Tourism, and finally an overview. First draft of four chapters is ready, information on another two has been analysed and is being interpreted and drafted, while the information already collected for five chapters, is

being updated. All efforts are being made to hand over the final draft of the report to the press by July 1993.

4.4e Integrated Watershed Management : A Case Study in Sikkim Himalaya. Gyanodaya Prakashan, Nainital

In order to work out the integrated approach of development a five year study on Integrated Watershed Management initiated by the Institute in Sikkim area. The data generated on physical background, demography, land use, water resource, forest, livestock, agriculture, settlement, and infrastructure of a micro watershed in south Sikkim are described and analysed in the book.

4.5 Laboratory and Library

The major equipment procured for Laboratory analysis is Nitrogen Auto Analyzer. For field data collection/analysis the equipment procured are Data Sonde Multi Parameter Water Quality Datalogger, Paqualab Water Testing Kit, Plant Canopy Analyser, Soil Moisture Trase System and Campbell Weather Station field units.

A total of 357 books were added to the library this year which brings the total to 3524 as on 30.03.1993. The library subscribed 54 periodicals including 32 from overseas. A number of newsletters and annual reports from Indian and foreign organisations are being received in the library. An addition of 15 periodicals has been made this year. Databases related to library have been updated. Current Awareness services are being provided by the library. Library is also subscribing the periodical "Current Contents (Diskettes with Abstracts) : Agriculture, Biology & Environmental Sciences" which is a very useful source for literature updating.

5. MISCELLANEOUS ITEMS

5.1 Prominent Visitors

a. Shri K.C. Pant, Chairman, Tenth Finance Commission, visited the Institute. After discussions with the staff members of the Institute and visit to the laboratories and library, Shri Pant planted a sapling in the Institute Campus (Oct. 11, 1992).

b. Dr. Joseph L. Fox, Associate Professor, University of Tromso, Norway visited the Institute in Nov. 1992. He was here to explore possibilities of collaborating in Biodiversity programmes of this Institute. Besides interacting with the scientists, he delivered a talk on 'Wildlife and grazing system in high Himalaya' (Nov. 5, 1992).

c. Dr. Calle Hedberg, a GIS specialist of the Norwegian Forestry Society visited in connection with the collaborative project of this Institute with NORAGRIC. For about a week he was here and held detailed discussions with the scientists of this Institute. He also delivered a lecture on 'The applications of GIS in environmental sciences' (Nov. 20, 1992).

5.2 Workshops/Seminars

5.2a Tropical Soil Biology and Fertility (TSBF) programme - Inaugural Workshop : Indian Region, April 6-10, 1992, Kausani, U.P.

This workshop sponsored by TSBF Headquarters (Nairobi, Kenya), Indian National Science Academy and Department of Science & Technology, Government of India was organized by the Institute. The core objective of the workshop was to review the on-going and potential areas of research on soil biology and fertility in India/South Asia. Seven overseas scientists and twenty scientists from different parts of the country participated. The proceedings were finalized for publication.

5.2b Workshop on Approaches to Sustainable Development, August 1-4, 1992, Manali, H.P.

This workshop opened dialogue for identifying potential issues concerning sustainable development which could be looked

into by the Institute and International Centre for Integrated Mountain Development (ICIMOD), Kathmandu through collaborative programmes. Apart from the faculty of the two organizations, a number of government officials, academicians and people's representatives participated in the workshop.

5.2c Workshop cum Seminar on Himalayan Biodiversity: Conservation Strategies, October 14-17, 1992, Srinagar, Garhwal

The workshop was inaugurated by Dr. Rajendra Prasad, Vice-Chancellor, H.N.B. Garhwal University, Srinagar. 45 Scientists, academics and environmental experts presented their findings and participated in 5 Technical Sessions and 3 Working Group Meetings. Among others, the participants included eminent Scientists both from within the country and abroad, such as, Dr. T.N. Khoshoo, Prof. Kamaljit S. Bawa (U.S.A.), Dr. Sharon Kinsman (U.S.A.), Dr. Pei Shengji (ICIMOD, Nepal), and Prof. S.S. Bir.

5.3 Awards and Honours

Prof. A.N. Purohit was honoured with the "Seth Memorial Award" by the Society of Tree Scientists, India (January, 1993).

Prof. A.N. Purohit was elected the Fellow of National Academy of Agricultural Sciences. (Dec. 1992).

Dr. L.M.S. Palni and, associates from Palampur, were presented "C. Ventakata Ram Memorial Award" for work on tea tissue culture (December, 1992).

5.4 Membership of Specialised Committees

Prof. A.N. Purohit served as a member of the Expert Group of Planning Commission to formulate a National Policy on the Himalaya for Integrated Development.

Dr. E. Sharma was granted *engratis* membership (from January, 1993) of the Ecological Society of America for a period of three years.

5.5 Publications of the Faculty

Maikhauri, R.K. (1992). Devastating Earthquake, October 1992, in Garhwal Himalaya U.P., India. *Ambio* 21: 486-487.

Maikhauri, R.K. (1992). Eco-energetic analysis of animal husbandry in Traditional societies of India. *Energy the International Journal* 17: 959-967.

Maikhauri, R.K. (1992). Ecological analysis of a cluster of villages emphasising animal husbandry of different tribes in Meghalaya in north-east India. *Energy Environmet Monitor* 8: 79-88.

Samal, Prasanna K. (1993). The status of women in Central Himalayan region of India: a cultural interpretation. *Man In India* 73(1): 87-95.

Samal, Prasanna K. and Subrat Sharma (1992). Institution building at community level: understanding the constraints in it from a micro analysis. *In: Proceedings of the Interaction Seminar on Sustainable and* Replicable Eco-development in Uttranchal. Vol. II, pp 1-17.

Singh, A.K. and **D.S. Rawat** (1992). A Functional Profile of Women and Work in Rural Kumaun. *In: C.M. Agrawal (Ed.). Dimensions of Indian Womenhood.* Vol. III. pp. 175-182.

Sundriyal, R.C. (1992). Structure, productivity and energy flow in an alpine grassland in Garhwal Himalaya. *Journal of Vegetation Science* 3: 15-20.

Sundriyal, R.C. and A.P. Joshi (1992). Annual nutrient budget for an alpine grassland in Garhwal Himalaya. *Journal of Vegetation Science* 3: 21-26.

Sundriyal, R.C. and A.P. Joshi (1992). Inter-specific relationship among plant species in an alpine grassland of the Garhwal Himalaya, India. *Bangladesh Journal of Botany* 21: 81-91.

Swarup, R. (1992). The Women in India. *In: C.M. Agrawal (Ed.). Dimensions of Indian Womenhood,* Vol. II. pp 11-30. Shree Almora Book Depot.

5.6 Participation of Scientists in Symposia/Workshop/Conferences /Training Courses

Scientists of the Institute participated in the following:

Planning workshop for Regional Cooperative Programme on Ecosystem Rehabilitation in South and Central Asia, Bangalore, November 9-13, 1992 organised by United Nations Educational Scientific and Cultural Organisation, Regional Office, New Delhi (K.G. Saxena).

Tropical Soil Biology and Fertility (TSBF) Programme Workshop, July 1992, Watamu, Kenya (K.G. Saxena).

International Symposium on Mountain Hydrology, Shimla, May 28-30, 1992 (R. Joshi).

Invited lecture for the Officers of Agriculture /Forest/Irrigation Departments on "Soil and Water Conservation" on 10th June 1992 at SIRD Complex, Karfectar, South Sikkim (R.C. Sundriyal).

Workshop on "Approaches to the Sustainable Development of the Indian Himalaya" (Institutional collaboration between ICIMOD, Nepal and GBPIHED, India) during 1-4 August 1992 at Manali, HP (All scientists of the Institute).

Invited lecture on "Global Warming" at Sikkim Science Society lecture series, Krishi Bhawan, Gangtok in July 1992 (E. Sharma).

Workshop on "Himalayan Biodiversity: Conservation Strategies, during 14-17 October 1992 at Srinagar, Garhwal (All scientists of the Institute).

Interaction Seminar on Sustainable and Replicable Eco-development in Uttaranchal, Shitalakhet, Almora. April 25-26, 1992 (P.K. Samal).

Tropical Soil Biology and Fertility Programme Inaugural workshop: Indian Region, Kausani, Almora. April 6-10, 1992 (P.K. Samal).

Workshop on Parvatiya Kshetra Me Paryavaran Prabandh Prashikhyan, Hawal Bag, Almora. June 30, 1992 (P.K. Samal).

Indian Science Congress Association (80th Session), Goa. January 3-8, 1993 (P.K. Samal).

International Symposium on Tiger, New Delhi, Feb. 21-24, 1993 (S.S. Samant).

National Symposium on Physiological and Biochemical Aspects of Crop Improvement, NBRI, Lucknow, March 23-25, 1993 (A.N. Purohit & L.M.S. Palni).

6. GOVIND BALLABH PANT SOCIETY OF HIMALAYAN ENVIRONMENT AND DEVELOPMENT

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

Two Members of Parliament Nominated by Government of India	Member
Minister-in-charge Environment, Government of Jammu & Kashmir	Member
Minister-in-charge Environment, Government of Sikkim	Member
Minister-in-charge Environment Government of Himachal Pradesh	Member
Minister-in-charge Environment Government of Uttar Pradesh	Member
Minister-in-charge Environment Government of West Bengal	Member
Minister-in-charge Environment Government of Assam	Member
Minister-in-charge Environment Government of Arunachal Pradesh	Member
Minister-in-charge Environment Government of Mizoram	Member
Minister-in-charge Environment Government of Manipur	Member
Minister-in-charge Environment Government of Meghalaya	Member
Minister-in-charge Environment Government of Nagaland	Member
Minister-in-charge Environment Government of Tripura	Member
Two Members of Legislature Assembly Uttar Pradesh Nominated by Government of India	Member
Prof. S.P. Nautiyal 376 Phase II, Vasant Vihar, Dehra Dun	Member
Prof. Mahatim Singh Director Potash Research Institute of India, Gurgaon	Member
Prof. Mirinal Miri North-Eastern Hill University, Shillong	Member
Shri Chandi Prasad Bhatt Desholigram Swarajya Mandal, Gopeshwar, Chamoli	Member
Shri Natwar Thakkar Nagaland Gandhi Ashram P.O. Chuchuyimlang District Mokokchung, Nagaland	Member
A representative from Indian Institute of Forest Management Bhopal	Member
Secretary Ministry of Environment & Forests, New Delhi	Member
Secretary Department of Science & Technology, New Delhi	Member
Secretary Department of Scientific & Industrial Research, New Delhi	Member
Secretary Ministry of Human Resource Development, Department of Education, New Delhi	Member
Secretary Ministry of Rural Development, New Delhi	Member
Secretary Department of Urban Development, New Delhi	Member
Secretary Expenditure, Ministry of Finance, New Delhi	Member
Secretary Department of Non-Conventional Energy Sources, New Delhi	Member
Secretary Department of Steel & Mines, New Delhi	Member
Secretary Department of Water Resources, New Delhi	Member

Secretary Department of Agricultural Research & Education, New Delhi	Member
Secretary Planning Commission, New Delhi	Member
Chief Secretary Government of Uttar Pradesh, Lucknow	Member
Director General Indian Council of Forestry Research & Education, Dehra Dun	Member
Inspector General of Forests, New Delhi	Member
Director Botanical Survey of India, Calcutta	Member
Chairman Indian Council of Social Science Research, New Delhi	Member
Director Wildlife Institute of India, Dehra Dun	Member
Director Govind Ballabh Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora	Member-Secretary

7. GOVERNING BODY

Secretary Ministry of Environment & Forests, Paryavaran Bhawan, CGO Complex, Lodi Road, New Delhi-110 003	Chairman
Secretary Department of Biotechnology CGO Complex, Lodi Road New Delhi-110 003	Member
Chief Secretary Government of Uttar Pradesh, State Secretariat Lucknow	Member
Inspector General (Forests) Ministry of Environment & Forests, Paryavaran Bhawan, CGO Complex, Lodi Road, New Delhi-110 003	Member
Joint Secretary & Financial Adviser Ministry of Environment & Forests, Paryavaran Bhawan, CGO Complex, Lodi Road, New Delhi-110 003	Member
Prof. A.K. Sharma Department of Botany, University of Calcutta. 35 Ballygunge Circular Road, Calcutta-700 019	Member
Dr. T.N. Khoshoo, FNA Tata Energy Research Institute 9 Jorbagh, New Delhi-110 003	Member
Prof. S.K. Sinha, FNA Director Indian Agricultural Research Institute, New Delhi-110 012	Member
Prof. K.S. Valdiya, FNA Department of Geology Kumaun University Nainital, U.P.	Member (Resignation accepted w.e.f. 24.11.92)
Director G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora	Member-Secretary

8. SCIENCE ADVISORY COMMITTEE

Prof. S.K. Sinha Director Indian Agricultural Research Institute New Delhi	Chairman

Prof. K.S. Valdiya Department of Geology Kumaun University Nanital, U.P.	Member (Resignation accepted w.e.f. 24.11.92)
Dr. C.L. Acharya Department of Soil Sciences, Himachal Pradesh Agriculture University, Palampur, Himachal Pradesh	Member
Prof. J.S. Singh Department of Botany, Banaras Hindu University, Varanasi-221 005	Member
Dr. P.V. Sane Director National Botanical Research Institute, Rana Pratap Marg, Lucknow	Member
Dr. R.C. Guha Institute of Economic Growth, University of Delhi, Delhi-110 007	Member
Dr. Baldev Sahai Group Director Remote Sensing Area, Space Application Centre, Ahmedabad	Member
Dr. (Mrs) Manju Sharma Adviser Department of Biotechnology B-Block, CGO Complex, Lodi Road New Delhi-110 003	Member
Dr. P.G. Lavakare Adviser Department of Science & Technology, Technology Bhawan, New Mehrauli Road, New Delhi	Member
Dr. G.D. Sootha Adviser Department of Non-Conventional Energy Sources, Paryavaran Bhawan, CGO Complex Lodi Road, New Delhi-110 003	Member
Director G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora	Convenor

9. PROGRAMME EVALUATION COMMITTEE (ECO-DEVELOPMENT PROGRAMME)

1. Prof. R.S. Ambasht Department of Botany Banaras Hindu University Varanasi	Chairman
2. Nominee of Director General ICFRE, Dehra Dun	Member
3. Nominee of Wild Life Institute Dehra Dun	Member
4. Nominee of Director Wadia Institute of Himalayan Geology, Dehra Dun	Member
5. Nominee of Director School of Hydrology, National Institute of Hydrology, Roorkee University, Roorkee	Member
6. Nominee of Director Central Soil & Water Conservation Research Institute Kaulagarh Road, Dehra Dun	Member
7. Nominee of Vice-Chancellor G.B.Pant University of Agriculture & Technology, Pant Nagar, U.P.	Member
8. Nominee of Vice-Chancellor Y.S.Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh	Member
9. Nominee of Secretary Ministry of Environment & Forests New Delhi	Member
10. Dr. Shekhar Pathak Kumaun University Nainital	Member
11. Mrs. Ratana M. Sundarshan International Development Research Council, Jor Bagh, New Delhi	Member
12. Nominee of Director G.B. Pant Institute of Himalayan Environment and Development Kosi-Katarmal, Almora	Member-Secretary

10. STATEMENT OF ACCOUNTS

Income & Expenditure Account for the year ended 31st March 1993

Expenditure	Rupees	Income	Rupees
Pay & allowances to Staff	22,59,471	Interest received from banks	9,32,982
Institute's cont. to CPF	98,329	Miscellaneous receipts	57,979
Travelling expenses (official)	1,97,690	Excess of expenditure over	69,00,746
" (non official)	56,746	income	
Postage expenses	26,527		
Stationery expenses	92,930		
Petrol/Fuel expenses	2,39,981		
Telephone expenses	56,374		
Water & Electricity charges	59,021		
R & M vehicle	1,94,914		
R & M Building	22,912		
Hospitality charges	11,278		
Research & Development expenses	8,49,649		
Printing charges	1,47,694		
Wages	23,223		
Rent	66,500		
R & M Office/Scientific equip.	33,900		
Other contingencies	2,26,624		
News paper and Periodicals	7,436		
Audit fee paid	12,000		
Bank charges	282		
Liveries expenses	9,264		
Expenses - Action Plan	97,714		
DST (RWH)	21,232		
DST (SF)	65,205		
DST (SF/ES)	12,000		
DST (RSR)	19,577		
CSIR (HCR/GCSN)	28,365		
TSBF Workshop	94,860		
ENVIS	2,23,613		
IERP	24,99,868		
NORAD	1,36,528		
Total	78,91,707		78,91,707

For Rattan Lal & Associates, Chartered Accountants
Sd/-
(N.K. Jain, Partner)

Sd/-	Sd/-	Sd/-
(Harish Chandra)	(K.G. Saxena)	(A.N. Purohit)
Drawing & Disbursing Officer	Scientist & Officer Incharge	Director

Note: 1. All items of receipts and payments are accounted for on cash basis.
2. Figures have been regrouped and rearranged wherever felt necessary.
3. Amount has been rounded off to the nearest rupee.

* These all notes are also applicable for all other tables mentioned in the Statement of Accoun

Receipts and Payments Accounts for the year ending 31st March 1993

Receipts	Rs.		Payments	Rupees
Opening Balance			Pay & Allowances to staff	22,59,471
(A) Cash and Bank Balances			Institute's Cont. to CPF	98,329
(i) Cash in hand	13,685		Travelling Expenses (Officials)	1,97,690
			Travelling expenses (non-official)	56,746
(ii) SBI, Almora (including Rs. 29,72,623 for construction and Rs. 15,15,000 for LCs and margin money	45,32,016		Postage expenses	26,527
			Stationery expenses	92,930
(iii) Central Bank of India, Kosi (including Rs. 40,562 for DST (RW) and Rs. 28,744 for DST (SF)	79,138		Petrol/fuel expenses	2,39,981
			Telephone expenses	56,374
(iv) State Bank of India, Tadong	11,421		Water & Electricity charges	59,021
(v) State Bank of India Chuchuyimlang	501	46,36,761	Repair & maintenance vehicle	1,94,914

			Repair & maintenance building	22,912
(B) Advances			Hospitality charges	11,278
(i) M/s Swaraj Mazda Ltd.	4,51,516		Laboratory & Scientific Equip.-Institute's	60,75,121
(ii) Staff & Units of the Institute	19,686		-NORAD	34,755
			Research and Development Expenses	8,49,649
(iii) DST (RW)	1,604		Laboratory Expenses	6,72,989
(iv) DST (SF)	48,500	5,21,306	Printing charges	1,47,694

Grant-in-aid received			Furniture & Fixtures	2,19,834
(i) From ME&F - for R&D and other exp.	1,15,00,000		Wages	23,223
-For construction work	2,06,01,000		Rent & taxes	66,500
-For integrated eco-research programme	25,00,000		Office equipments	4,89,391
			Refund/Adjustment of EMD	59,325
-ENVIS Centre	3,35,000	3,49,36,000	Work in progress(Glass house/Net house)	6,02,017
	--------		Repair & mant. office/Scientific equipment	33,900
(ii) From DST (RSR)		1,15,000	Other contingencies	2,26,624
(iii) CSIR (HCR/GCSN)		32,530	New Paper & Periodicals	7,436
(iv) From TSBF		95,286	Deposit with-CCU for construction of Institute's Complex	2,01,89,000
(v) From Norwegian Embassy (NORAGRIC)		42,93,333	-U.P. Rajkiya Nirman Nigam	5,00,000
			Vehicle 'C' -Institute's	4,96,378
			-NORAD Project	2,57,077
Interest received from Bank on				
- Institute's grant	8,73,668			
- NORAD grant	59,314	9,32,982	Expenses - Action Plan	97,714
Earnest money received	--------	13,500	DST (RWH)	21,232
Security deposit received		30,251	DST (SF)	65,205
Contribution to CPF payable		1,885	DST (SF/ES)	12,000
			DST (RSR)	19,577
			CSIR (HCR/GCSN)	28,365

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Miscellaneous receipts on account of			TSBF (Workshop)	94,860	
- License fee for residential accommodation	6,560		ENVIS Centre		2,23,613
- Sale of nursery items	16,543		Funds transferred & expenses on Integrated Eco development research programme		24,99,868
- Personal use of staff car	1,045				
- Sale of tender forms	700		NORAD Project		1,36,528
- Lodging charges of transit hostel	1,848		Security deposit		5,000
- Sale of books	1,640		Audit fee paid		12,000
- Sale of Scrap	12,203		Bank charges		282
- Royalty on books	3,690		Leveries expenses		9,264
- Other receipts	13,750	57,979	Cash and Bank balances		
			(a) - Cash in hand -Institute	39,741	
			-NORAD	2,764	
			- State Bank of India, Almora A/c 22752 (including funds for construction Rs.		
		23,29,482	and margin money against		
			import of equip. Rs. 6,17,000	30,22,101	
			- Central Bank of India, Kosi		
			(including funds for other projects)	2,46,322	
			- TDR with SBI, Almora	7,87,825	
			CBI, Kosi	85,843	
			- State Bank of India, Tadong	426	
			- State Bank of India, Kullu	250	
			- State Bank of India, Srinagar	3,384	
			- State Bank of India, Chuchuyimlang	10,494	
			- State Bank of India, Almora A/c 20910	39,18,524	81,17,674
			(B) Advances -		
			House building advance	38,500	
			Postage advance	2,240	
			Staff, units of Institute & others	10,477	
			DST (RWH)	298	
			CSIR (GCSN)	2,000	
			DST (SF-ES)	30	
			NORAD Project	3,000	56,545
Total		4,56,66,813	Total		4,56,66,813

For Rattan Lal & Associates
Chartered Accountants
(Partner)

Sd/-	Sd/-	Sd/-
(Harish Chandra)	(K.G. Saxena)	(A.N. Purohit)
Drawing and Disbursing Officer	Scientist & Officer Incharge	Director

Balance Sheet as on 31st March 1993

Liabilities	As on 31.3.92 Rs.	Received during 1992-93	As on 31.3.93 Rs.	Assets	As on 31.3.92 Rs.	Additions during 1992-93	As on 31.3.93 Rs.
Balance as per last Balance Sheet (excludes Rs. 48,700 for EMD)	2,71,77,995	-	2,71,77,995	Office Equipments	6,35,578	4,89,391	11,24,969
				Furniture & Fixture	10,30,233	2,19,834	12,50,067
				Vehicle-Institute's	8,13,315	4,96,378	13,09,693
				-NORAD project	-	2,57,077	2,57,077
Received during the year							
- From ME & F. - for				Library	26,00,507	6,72,989	32,73,496
(i) R & D and other expenses		1,15,00,000		Building	27,13,848	-	27,13,848
(ii) Construction work		2,06,01,000		Laboratory and Scientific Equip.	69,58,050	60,75,121	1,30,33,171
(iii) Integrated Eco Research Programme		25,00,000		- do - NORAD		34,755	34,755
(iv) ENVIS project		3,35,000	3,49,36,000	Deposit with CCU/UPRNN for Construction work	72,15,377	2,06,89,000	2,79,04,377
- From DST (RSR)			1,15,000	Deposit with Sp. LAO for Land Acquisition	80,000	-	80,000
- From CSIR (HCR/GCSN)			32,530				
- From TSBF			95,286	Work in progress	-	6,02,017	6,02,017
- From Norwegian Embassy (NORAGRIC)			42,93,333				
Earnest money received during 1991-92 48,700							
- do - 1992-93 13,500	62,200						
(Less refund/adjustment during 1992-93	59,325		2,875	Security deposit	21,720	5,000	26,720
Liabilities payable			32,136	Advances		56,545	56,545
				Cash at banks			80,75,169
				Cash in hand			42,505
(-) Excess of expenditure over income			69,00,746				
	Total	5,97,84,409			Total		5,97,84,409

For Rattan Lal & Associates
Chartered Accountants
Sd/-(N.K. Jain, Partner)

Sd/-
(Harish Chandra)
Drawing and Disbursing Officer

Sd/-
(K.G. Saxena)
Scientist & Officer Incharge

Sd/-
(A.N. Purohit)
Director

RATTAN LAL & ASSOCIATES
Chartered Accountants
Stand

3626, PRAKASH BHAWAN
Near Golcha Cinema Cycle

Darya Ganj, New Delhi-110 002
Ph.: Off.: 3273350 Res.: 7241273

Ref. No.....

Date.....

AUDIT CERTIFICATE

We have examined the Accounts and Balance Sheet of G.B. PANT INSTITUTE OF HIMALAYAN ENVIRONMENT & DEVELOPMENT KOSI ALMORA (U.P.) for the year ending 31st March, 1993. We have obtained all the necessry information and explainations which were required and certify that as a result of our audit, in our opinion, these Accounts and Balance Sheet are properly drawn up so as to exhibit a true and fair view of the state of affairs of the Institute according to the best of our information and explanations given to us and as appeared in the books maintained by the Institute. The Fixed Assets have been taken at purchase price in the absence of any physical verification done by the Management.

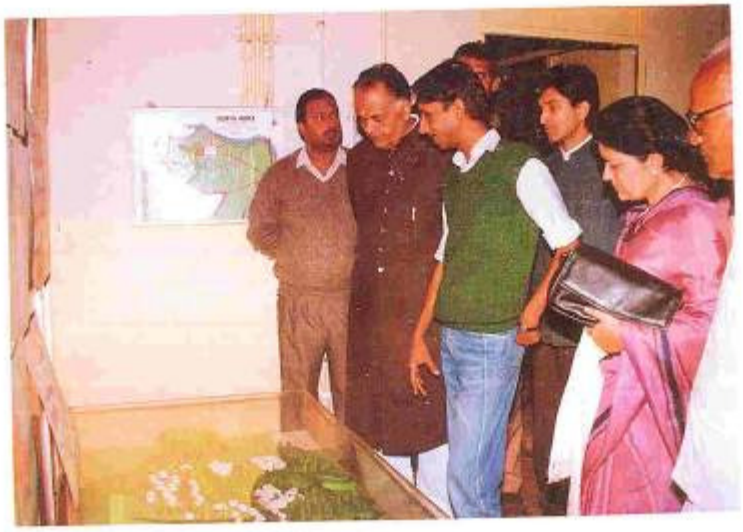
For RATTAN LAL & ASSOCIATES
CHARTERED ACCOUNTANTS

Sd/-
(N.K. JAIN)
Partner

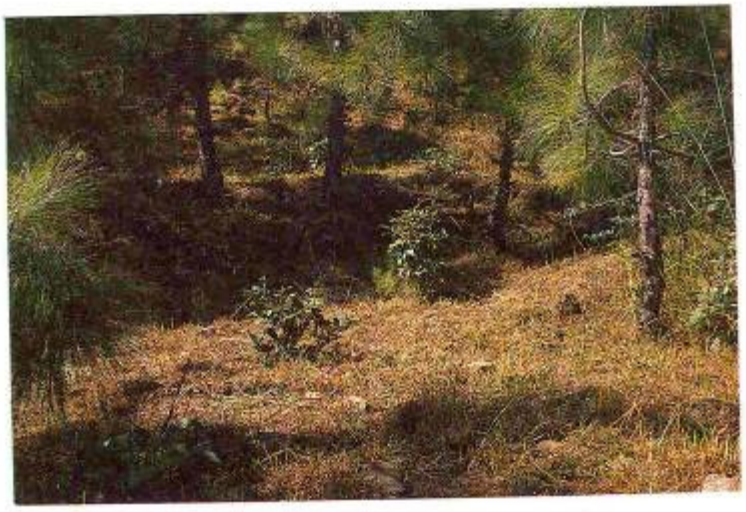
Place : NEW DELHI
Dated : 8.7.1993

Prof. Stein W. Bie, Director, Norwegian Centre for International Agricultural Development
and Prof. A. N. Purohit, Director of the Institute
entering an Agreement for Institutional Cooperation (August 20, 1992).

Meeting of 10th Governing Body at Tadong, Gangtok (Sikkim).



Honourable Chairman, 10th Finance Commission, Shri K.C. Pant
Visits the Institute at Kosi-Katarmal, Almora.



Oak regeneration under Pine Trees - a neglected research theme.

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