ENVIS Monograph 1

Natural Resource Management and Development in Himalaya –

A Recourse to Issues and Strategies

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Environmental Information System on Himalayan Ecology

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Contents

Foreword

Two decades ago the National Committee on Environmental Planning and Coordination had organized a National Seminar on Resources Development and Environment in the Himalayan Region. The issues raised at that time indicated existence of policy gaps. The recommendations included a list of priorities and among them two important ones were; I) A high-level multidisciplinary group should be set up to identify gaps in the on-going research, design and development pertaining to the Himalayan region and also to identify appropriate financial arrangements for supporting further activities that need to be taken up, and ii) Initiating a programme on long-term research into the functioning and dynamics of the Himalayan Ecosystems. Some recommendations of this seminar were implemented and progress on sectors such as inventory of resources and development of suitable technologies was satisfactory. However, the pace of all such activities is not sufficient to meet the pace of population growth and their growing requirements which are intimately linked with the natural resources of the region. This could be seen from the problems the region is faced with.

G.B. Pant Institute of Himalayan Environment and Development, an autonomous organization of the Ministry of Environment and Forests, Government of India, was chosen to set up the Environmental Information System on Himalayan Ecology at the Institute. It has been collecting, compiling, processing and disseminating the available information on the region during the last few years of its existence. This document, first in a new series being published by the centre, discusses the data availability, accessibility and the views of various workers on development and natural resource management concerns in the Himalaya. The document owes a lot to the researchers, administrators and development planners who are trying to achieve the all important task of sustainable rural development based on natural resources in the Himalaya.

Date: 10th December, 1997
Kosi-katarmal

(L.M.S. Palni)
Director

Acknowledgement

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(K.S. Rao)

Introduction

Growing concerns for deteriorating environment by stakeholders and other over the last four decades seem to have linkage with gigantic cause-and-effect arguments on Himalaya and the northern plains being on the receiving end are also plunging fast towards environmental and socio-economic collapse. The processes - physical, human, socio-economic and political have contributed to such debates through visions of deforestation, landslides, large-scale downstream flooding, uncontrolled population growth, increasing poverty and the malnutrition. This pattern of thinking has been widely accepted as established fact by large number of people who often lend their support to perpetuate it as a truism. Ives & Messerli (1989) has referred it as the 'Theory of Himalaya Environmental Degradation'. Their conclusions indicated that: i) the population explosion was due to the introduction of modern health care and medicine and the reduction of diseases; ii) the increased population in subsistence mountain societies has led to a (a) reduced amount of land per family; (b) deepening poverty and (c) massive deforestation; iii) that such deforestation will result in total loss of all accessible forest cover in the countries existing in Himalaya in the near future. While there are uncertainties, the gaps or lack of accessibility to information is driving every researchers to different conclusions. The present effort is to analyze the existing information about problems and prospects in rural development and preservation of natural resources in Hiamalaya.

Himalaya - what, where, who and why?

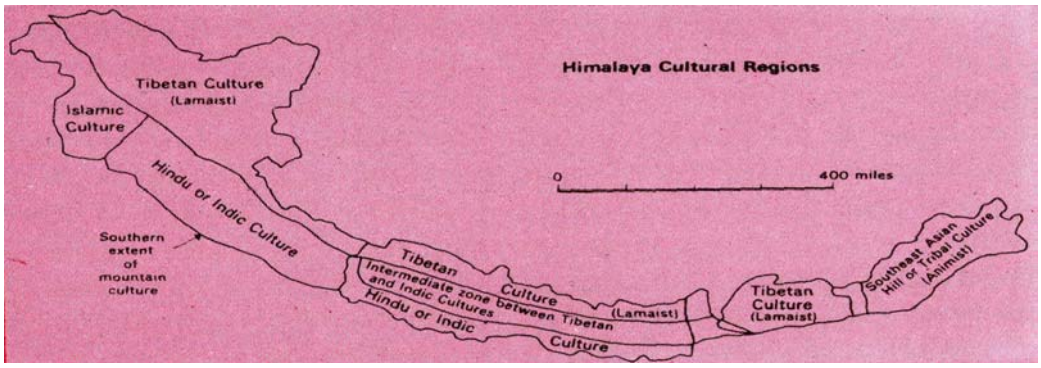
The traditional definition of the Himalaya, *sensu stricto*, is that great range of mountains that separates India, along its north-central and northeastern frontier, from China (Tibet), and extends between latitudes 26°20' and 35°40' North, and between longitudes 74°50' and 95°40' East. The region extends from the Indus Trench below Nanga Prabat (8,125 m) in the west to the Yarlungtsangpo-Brahmaputra gorge below Namche Barwa (7,756 m) in the east, a west-northwest to east-southeast distance of about 2,500 km covering the political administrative regions of Afghanistan, Pakistan, India, Nepal, Bhutan and China (Ives & Messerli, 1989). Complicated as the physical geography of the region, the knowledge about the patterns and extent of prehistoric settlements in Himalaya is also sparse. This caused the reconstruction difficult and what ever could be done is mainly based on Sanskit epic literature which has been derived from an oral tradition. Such literature is said to be modified several times before being actually committed to writing (O'Flaherty, 1975). The British writings describe three patterns of settlements in Indian Himalaya. The western Himalaya was widely settled from 1500 BC onward by a population of nomadic warriors called Khas who were part of succession of waves of Aryan migration into India from the northwest. The Khas are believed to subjugated the indigenous inhabitants relegating them to a rigidly inferior social status. The Khas gradually become acculturated to the predominant Hindu influences of the northern plains. In central and eastern Himalaya the settlers seem to be the migrants of Tibeto-Burman tribals from Southeast Asia some time in the early millenia BC. The sanskrit writing described them as Kirata and were said to be great hunters, skilled in arts of magic and also practiced cannibalism. In the higher reaches of Himalaya the settlements of Bhotias and related peoples dating from the early centuries AD are said to be the settlers from the successive waves of nomads transforming in the

process to the more settled life combining agriculture, pastoralism and trade. During the Muslim conquest of northern India some time in fourteenth century, the high caste refugees moved into the western Himalaya and slowly displaced the ruling Khas lineages. Stiller (1975) reports that during the Gorkhali conquest, late in the eighteenth century, there were about eighty separate principalities between Sutlej and present-day Sikkim. The study by Karan (1987) defined five mountain cultural regions in the Himalaya and between 1901 and 1981 the population of these regions has trebled from 11 million to over 33 million. The region, broadly defined, provides the life-support base for about 50 million mountain people and probably in excess of 450 million people of the plains - the very densely populated areas of the Indus, Ganges, Brahmaputra, and upper and middle Jiang (Sichuan Basin) which constitute a significant proportion of humankind. In terms of modern definitions of development paradigms the area also embraces one of the worlds' greatest accumulations of poverty, malnutrition, and accelerating population growth. Given the enormous range of altitude in a short north-south horizontal distance reduces the outbursts of cold air from Central Asia and ensures the northern peninsula of India has warmer winters than otherwise be the case. It also harbors a wide range of phytogeographic regions and floral/faunal assemblages. In addition Himalaya is crucial in regulating monsoonic climate and ensuring adequate water flow in major rivers in South Asia. Thus the influences of Himalaya are far reaching.

Indian Himalaya

The region

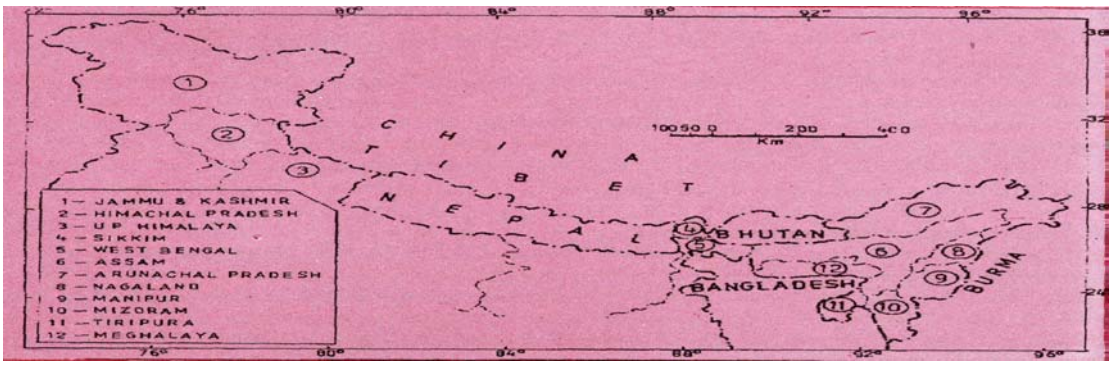
The Himalaya, lying in Indian territory, is spread over a length of about 2,500 km and a width of 220 to 300 km. It covers partially/fully twelve states/provinces of India viz., Jammu & Kashmir, Himachal Pradesh, Uttar pradesh, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoral, Tripura, Meghalaya, Assam and West Bengal. It has a total geographical area of approximately 591 thousand km^2 and is inhabited by about 51 million persons (Rao & Saxena, 1994). The region could be divided into two broad categories: (i) self-contained politico-administrative units co-terminating with the boundaries of the states/Union Territories which have their own Five Year Development Plans to take care of their development needs. These are referred as special category states and include Jammu & Kashmir, Himachal Pradesh and Sikkim; (ii) the hill areas forming parts of larger composite states confined to the states of Assam, Uttar Pradesh, West Bengal and are covered by Hill Area Development Programme, which forms a component of Five Year Plan formulated for the entire state. Physiographically the Himalayan region is grouped as the northern mountains and this group is further identified as (a) western Himalaya (Kashmir Himalaya and Himachal Himalaya); (b) central Himalaya (U.P. Himalaya) and (c) eastern Himalaya (Darjeeling-Assam Himalaya and Purvanchal) (Singh, 1971).



		Population		
Region	**Area (km^2)**	**1901**	**1951**	**1981**
Kashmir Himalaya	**222,797**	**2139362**	**3253852**	**5981600**
Himachal Himalaya	**55,500**	**1920294**	**2385981**	**4237569**
U.P. Himalaya	**51,100**	**1207030**	**3106356[a]**	**4815326**
Sikkim Himalaya	**7,100**	**30458[b]**	**137725**	**315682**
Darjeeling Himalaya	**3,200**	**249177**	**624879**	**1006434**
Arunachal Himalaya	**83,700**	**n.d.**	**336558[a]**	**628050**

Indian part of Himalaya *sensu stricto*: area and population of different sub-regions (based on Karan, 1987 and Census of India, 1901, 1951 and 1981)

a- data of 1961 census; b-data of 1981 and n.d.- no dat available



The people

Multiple ethnic composition is a striking feature of Himalayan realm. There are numerous tribal groups confined to the Himalayan region. Population size and distribution of different ethnic groups greatly varies. Among smaller groups, Raji tribe of Kumaon, is represented by only about 350 individuals. Ethnic spectra of central and western Himalaya differs conspicuously from that of the north-eastern region. Racially, a majority of tribal communities, particularly those in north-eastern region, exhibit 'mongoloid' affiliation as could be observed from the physical features of the people. In western and central Indian Himalaya, 'Khasa' ethnic characteristics are more conspicuous. Evolution, migration and acculturation process gave rise to a number of socio-cultural identities representing tribal/non-tribal continuum. It could be generalized that traditional tribal societies, in majority of cases, even at present level of development tend to prefer isolation and preserve their culture, a tendency very uncommon with the non-tribals. However, with the gradual improvement in communication and the expansion of market economy, the tribal cultures are getting more and more influenced by the values of modernization and westernization.

Area and population attributes of various Meso regions of Indian Himalaya

	Area	Population	Density	Population (%)	
Meso region	(Km^2)	(Millions)	(no./km^2)	Urban	Workers
Assam Valley	56597	9.18	162	7.4	43.3
Kashmir region	222800	4.40	20	16.7	n.d.
Himachal	56019	2.81	50	6.3	55.2
U.P. Himalaya	122802	1.80	14	4.5	n.d.
Purvanchal	94800	4.10	43	n.d.	n.d.

n.d. - no data.

Assam is the most thickly populated state of the Indian Himalaya followed by Tripura whereas Arunachal Pradesh is the most sparsely populated province. urban sprawl is exceedingly high in the state of Mizoram where about 46% of population is urban. Himachal Pradesh and Sikkim are the least urbanized states. Males outnumber females in all areas except for rural areas of Uttar Pradesh Hills and Himachal Pradesh. States in the north-eastern region have achieved a higher level of literacy as compared to those in the central and western Himalaya.

Agriculture is the focal activity of hill dweller all through the region. Excepting the state of Tripura, the proportion of women cultivators is more than that of men. In Tripura, more women are reported to be engaged as agriculture laborers and in other occupations.

The climate

Latitude, altitude and continentality are the most influencive factors regulating the climatic attributes over large areas in the mountains. Effectiveness of the regional determinants is moderated by the local topographical influences (Barry, 1992). Himalayan Mountain System, instead of running parallel to east-west direction, runs from north-west to south-east direction. The western ranges of Kashmir are located around 36°N while the eastern ranges of Arunachal Pradesh are located around 27°N. Thus, western region including the mountainous areas of Jammu & Kashmir, Himachal Pradesh and Uttar Pradesh have stronger temperate influences compared to eastern sector including Sikkim and Arunachal which for being closed to the equator exhibit more tropical influences. Because of proximity of the eastern Himalaya to sea (Bay of Bengal) and the unique directions of monsoon originating from the Bay of Bengal and Arabian Sea, eastern Himalaya receives more rainfall as compared to the central and western Himalaya. The topographical/geomorphological variations do not straightaway correlate with the latitudinal or continental trends. Indeterminate configurations of valleys and peaks with respect to their length, breadth and altitude result in immense variation in climatic attributes over short distances. Average annual rainfall was found to vary from 1800 mm to 2600 mm over an area of 30 km^2 in Sikkim Himalaya (Sharma et al., 1992). Since latitudinal, continental and orographical factors influence the climate in different ways, altitudinal gradient in climatic elements (Baumgartner, 1980) is not likely to be the same all across the Himalaya. While topography of the region has been mapped in detail, quantitative information on rate of air ascending over a mountain slope, water vapor supply, wind direction and wind speed which determine the precipitation regime (Browning, 1980), are lacking.

The available measurements in Garhwal/kumaon reveal that the high altitude areas (3000 m amsl) are characterized by pre-industrial levels of carbon dioxide concentration (270 ppm) whereas in valleys (500 m amsl) the concentration (330 ppm) is comparable to the present day global averages. The differences in other atmospheric parameters like air density across an altitudinal gradient resemble the generalised global trend. The influence of industrialization in terms of chloro-fluro carbon (CFC) emission is expected to be negligible as the difficult topography restricts industrial growth. Deforestation could be responsible for changes in the Himalayan climates but the state of knowledge on the rates of deforestation and reforestation is quite confusing (Saxena et al., 1993) so as to establish reliable forest - climate relationships. The analogy of spatial differences in climate due to altitude effects in the Himalaya with the global temporal trends provide an immense scope for creating a useful knowledge base for predicting the future climate changes.

i) Greater Himalaya (Himadri)

The northern most ranges of Himalaya separated by "Main Central Thrust" constitute Greater Himalaya (Himadri) zone. The feature is full of glaciers, snow clad peaks and large longitudinal valleys. This range has a granitic core flanked by metamorphosed sediments; the width and altitude varying between 40-60 km and 5000-7000 m amsl, respectively.

ii)Lesser Himalaya (himanchal)

This is a central chain of mountain ranges enclosed by the divides of "Main Central Thrust" in north and "Main Boundary Thrust" in south. The rocks are highly compressed and altered. The region consists of higher mountains cut into deep ravines. Altitude, in general ranges between 1000 to 5000 m amsl and width between 60-90 km.

iii) Sub-Himalayan Tract (Shiwaliks)

The foothill belt of the region is built entirely of shiwalik sediments. These newer and river borne deposits derived from the rising Himalaya represent the most recent phase of the Himalayan orogeny. These hills generally exhibit a hogback appearance where the southern slopes are steeper in comparison to the northern slopes. The wide longitudinal valleys in between the lesser Himalaya and the Shiwaliks are called 'Duns' in western and central Himalaya and 'Dwars' in eastern Himalaya. This region is characterized by fault scrap, anticlinal valleys and syncinal ranges; the width, varies between 5-30 km and elevation between 300-1000 m.

Problems and Issues of the Region

Trends reflecting exploitation of natural resources at rates much higher than those at which these resources get replenished, are presently evident all through the world. The reasons and consequences of these trends are also well known. While dramatic increase in per capita resource demand is identified to be the basic cause of widening the gap between resource exploitation and replenishment in the affluent regions, population explosion is argued to be the strongest determinant of such trends in the developing and underdeveloped regions. Consequence of these trends appear as deterioration in environmental quality in terms of deforestation, poor biological productivity and utility potential, soil erosion, hydrological imbalances, flood and other natural hazards and socio-economic disparity. With increasing elevation the systems are characterised by i) lower rates of abiotic, biotic and cultural exchanges, ii) slower rate of growth, iii) slower aging and late maturity, iv) poorer reproductive efficiency, and v) higher resistance. Such areas exhibit less visible impact of environmental problems at present. However, the impact of natural hazards increases with increasing elevation. Some important issues of regional relevance were reviewed by several authors in the recent past (Swaminathan, 1991; Anonymous, 1992c; Khoshoo, 1992; Dhar, 1993; Rajgopalan, 1993; Ramakrishnan et al., 1994 & 1996; Rao, 1994; Qasim, 1995; Joshi, 1996; Valdiya, 1997).

Deforestation and related issues

Degradation of natural forests is a global problem (Guppy, 1984; Sayer & Whitmore, 1991). Mankind has been destroying forest for millennia ever since agriculture was discovered (William, 1989). In the Himalaya too, deforestation is argued to be not a recent phenomenon. it has a long history, being well established in late eighteenth century at least (Mahat et al., 1986). In Himalaya, degradation of forest cover is a primary problem which gives way to a variety of problems. With deforestation of slopes many environmental degradation processes like soil erosion, slope failures, depletion of soil fertility, scarcity of fuelwood and fodder, increased overland flows, reduced ground water recharge, loss of biological diversity are accelerated. Siltation of river beds in lowlands are the repercussions of vegetal cover degradation in the Himalaya. However, extent of impairment of various processes attributed to vegetal degradation depends upon a range of other factors including past histories, intensity of removal of natural vegetation, patterns of natural regeneration and /or other human interferences (Valdiya & Bartarya, 1989 and 1991; Singh et al., 1984; Gilmour et al., 1989; Ramakrishnan et al., 1992; Alford, 1992). Since definition of 'forest degradation' (deforestation is the extreme stage of forest degradation causing removal of tree cover at any given point of time) and also lack of a temporal data base of land cover/use, projections on rate of deforestation may be misleading. Land cover classification schemes applied in Himalayan region illustrate the variability in perception about what forest or forest degradation is. Varying definitions and inconsistent methodologies adopted for assessing land use result in a wide range of variation in forest area estimates. How interpretations drawn from available data could be misleading, can be illustrated by data pertaining to central Himalayan region (U.P. Himalaya). Glancing at the data without going into methodological details, would lead one to draw a conclusion that forest cover increased by 1.4 fold during 1972-1982 (Saxena et al., 1993). Contrary to this, a concern for 'ongoing deforestation' has been expressed during the same period. The confusing state of data base thus leads to erroneous conclusions, particularly on the pace of deforestation or forest degradation.

Land cover classification schemes adopted by different workers

Anonymous (1983)	Anonymous (1989)	Kawosa (1988)	Singh et al., (1984)	Singh (1987)
Closed forest	Dense forest (crown cover >40%)	Forest (continuous canopy), (Crown cover >60%)	Good forest (crown cover >60%)	Closed forest (canopy cover >50%)
Open/degraded forest	Open forest (crown cover 10-40%)	Forest vegetation (crown cover 40-60%)	Medium forest (crown cover 30-60%)	Open forest (canopy cover 20-50%)
Non-forest (including agricultural land, grassland,	Scrub area (crown cover <10%)	Forest vegetation (crown cover <40%)	Poor forest (crown cover <30%)	Scrub

shrub land, non-forest plantation, barren land)				
Others (including snow, fog, cloud and shadow)	Non-forest plantation (barren land)	Glaciers or permanent snow	Snow	Shifting cultivation
	Uninterpreted area (clouds, fog and shadow)	Non-vegetation areas	Other non-forest	Regrowth (2 year old)
				Bare soil

Forest area estimates for Jammu & Kashmir State - variability in the reported data

Reporting agency	Forest area ('000 ha)
Anonymous (1976 a)	2761.00
Anonymous (1980a)	2104.00
Anonymous (1982)	2089.20
Anonymous (1983)	2235.50[a]
Gupta (1983)	2801.60
Kawosa (1988)	1317.60[b]
Prajapati (1989)	2088.00[c]

a - data for the year 1972-75
b - data for the year 1980-82
c - data for the year 1981-83

For understanding the role of forests in the life of the Himalayan mountain societies it is important to understand the interlinkages between agriculture, animal husbandry and forests. Over the centuries forests have been converted to agriculture fields, grazed by increasing animal populations. This close relationship between population growth, expanding area under subsistence crops, and increase in livestock numbers is closely related to intensifying demands on the forests. While there are serious problems in determining total available forest cover, biomass productivity, biomass demands and actual consumption, there are also conflicting estimates of the amount of forest/support land needed to support one unit of cultivated land. Ives & Messerli (1989) put such estimates for forest land to 4-5 times of cultivated land. But the quality of such support land is not defined. Rao & Saxena (1994) indicated that there was little conversion of forest to agriculture during the last sixty years in central Himalaya.

However, the quality of support land has decreased due to fragmentation and apathy towards commons. The other theory states that growing fuel wood demands are the cause of receding forest perimeters around the habitations in the mountains. Bajracharya (1983a; b) while studying Pangma Panchayat in eastern Nepal concluded that such forest reduction have more relation to increasing human subsistence needs than the fuel removals as the demand of fuel are mostly within limits of production. This leads us to believe the nibbling effects of subsistence demands on forests are main cause of degradation. As the demands are competitive for same resources, the lopping for fodder/fuel is said to create canopy openings resulting in increase in invasive plants. These plants are said to interfere with the tree saplings regeneration, and increase the chances of frequent fires through increase in easily combustible fuel loads. The additional problem is these situations creates scarcity of leaf litter which is needed for animal bedding and manure. Moench & Bandyopadhyay (1986) while studying the Mulgori village of Garhwal Himalaya has conclusively established this phenomenon.

Jackson (1983) while studying the natural resource use patterns in Dwarahat Block of Almora District in Kumaon Himalaya has concluded that most of the degradation of forest to unpalatable weeds stage is due to increased human and animal populations. According to him such scenarios are very common in central Himalaya. Even at this stage spontaneous regeneration is possible if the grazing pressures are reduced. One important suggestion by him is the introduction of energy efficient stove for reducing the fuel requirement alongwith off farm employment generation programmes. The analysis of facts available indicated that such programmes have been successful only in limited areas (Rao & Swarup, 1993). The main reasons are while the officials responsible to implement this programme are only enthusiastic about the numbers they distributed, the utilization efficiency is not considered. Ives & Messerli (1989) quoting a study by Messerschmidt in Nepal indicated the 'Chula' are not liked by the rural women as the instant heat requirements for short duration are not met by them while the tea shop owners preferred them as they found running of stove for entire day more efficient. This necessitates us to think about changes required in technology during introduction and need of administrators to understand such issues.

Differing climate regimes support differing vegetation types. In a given altitudinal zone, natural vegetation is more dense, diverse and stratified in the north-east than in the north-west. On account of being close to South-east Asia, South-east Asian tropical plant species are more abundant in the north-eastern Himalaya and gradually decline towards north-west. Temperate coniferous and tropical African elements decrease from the north-east to north-west. Cooler and drier climate of north-western Himalaya supports a rich germplasm of temperate fruits while hot and humid climate in the north-east supports a rich germplasm of tropical fruits like citrus. Himalaya, though occupies 15% geographical area of the country, nurtures 28.8% of the endemic dicot flora of the country (Chatterjee, 1939). Considering the status of survey and documentation of genetic wealth of the difficult mountainous areas, the biological richness (in terms of number of species) of the area is perhaps underestimated. Deforestation threatens irrecoverable losses to the biological diversity.

Declining yields and food insecurity

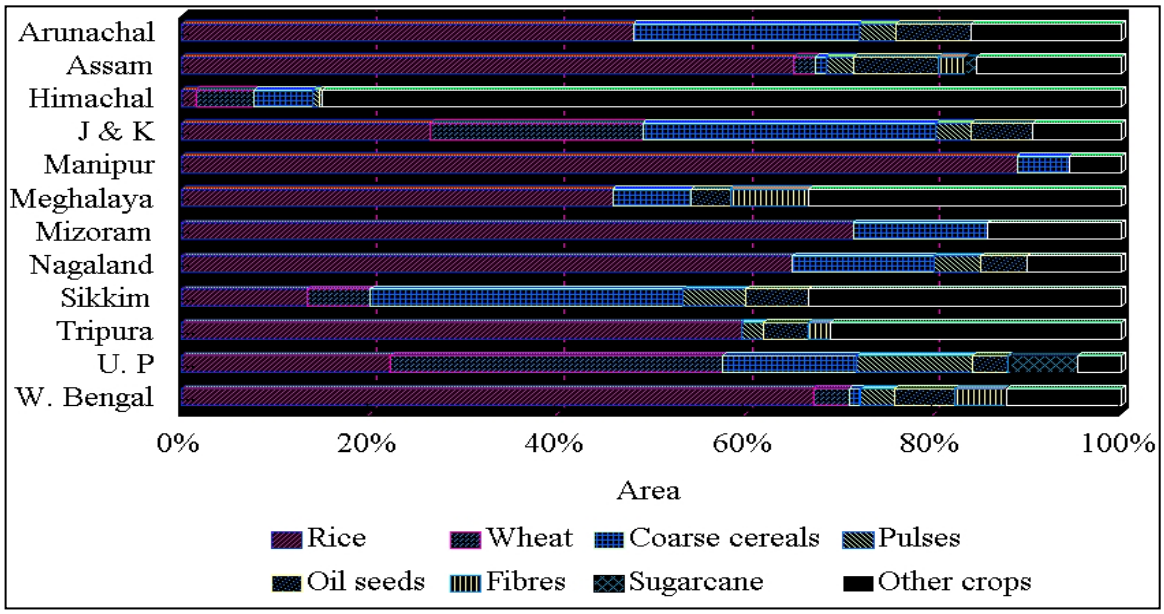
Expansion of agriculture on marginal land and declining crop yields are considered to be major unsustainable trends in the Himalaya (Eckholm, 1979; Ives & Messerli, 1989; Jodha, 1990). Similar to deforestation/forest degradation scenario, there is lack of adequate data base supporting these agricultural trends. Temporal trends can be established conclusively from reliable and comparable time sequence data which are altogether lacking. Consistent increase in cropland acreage in response to population expansion will hold true only when there is not change in the attitudes of the farmers and that of agricultural technology. An upward trend in preference for secondary and tertiary sector development activities might have deteriorated agricultural production in the region. The alternative explanation is that mountain people are forced to abandon the agricultural land and search for alternative modes of securing livelihood because mountain farming systems no longer provide food security. it is only in the last few decades that food grains have become a market commodity in the hills. This change commonly forms the basis of drawing a conclusion that food grains are marketed because of local food insufficiencies. Interpretations and generalizations based on indirect evidences together with visualizations are bound to lead to unrealistic impressions. It is difficult to resolve whether poor performance of agriculture is due to decline in acreage of productive land or due to decline in crop yield levels or if due to both, the relative contribution of the two factors.

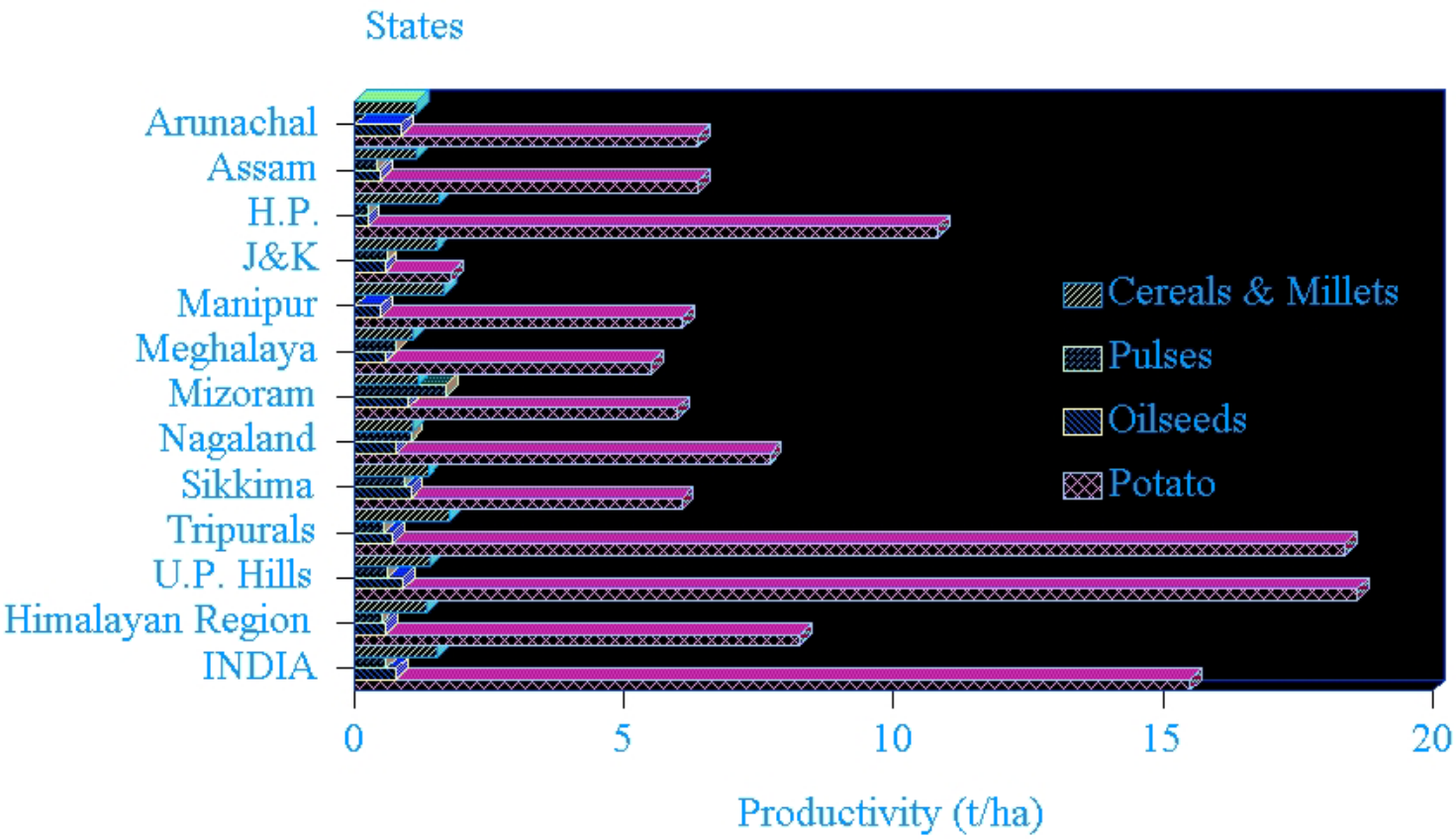
Erosion of genetic diversity of traditional crops and role of change in food habits in aggravating food insecurity problem in mountains are as yet not considered as important as expansion of cultivated cropland and low levels of crop yields. Crop yield data at two points of time in Uttar Pradesh Himalaya suggest that yields of traditional food crops like finger millet, paddy and *Echinocloa* have been more stable than wheat. Unfortunately, preferences for consumption of wheat and paddy, and more so for paddy, are the recent changes in food habits. Thus food insecurity problem realized at present is likely to be due to change in food habits and population growth rather than due to decline in yield levels (Rao & Saxena, 1994).

Estimated yields of agrarian crops in Kumaon (kg/ha) (after Whittler,1984)

Crop	1896	1979
Rice	1120	1133
Wheat	898	538
Barley	n.a.	362
Fingermillet	1120	924
Echinocloa	1100	924

n.a. - no data available


Arunachal
Assam
Himachal
J & K
Manipur
Meghalaya
Mizoram
Nagaland
Sikkim
Tripura
U. P
W. Bengal
0%
20%
40%
60%
80%
100%
Area
Rice
Wheat
Coarse cereals
Pulses
Oil seeds
Fibres
Sugarcane
Other crops


States
Arunachal
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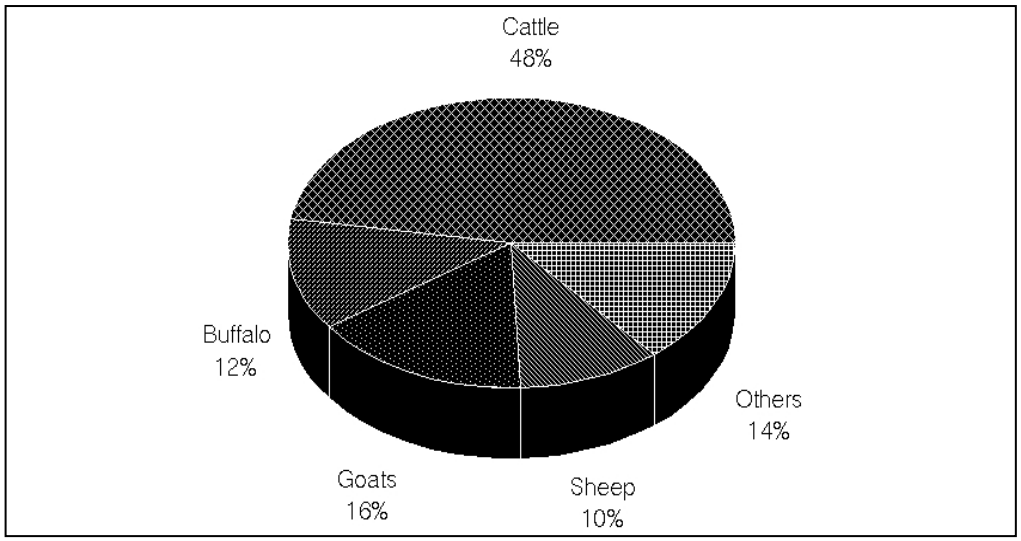
Mizoram
Nagaland
Sikkima
Tripurals
U.P. Hills
Himalayan Region
INDIA
Cereals & Millets
Pulses
Oilseeds
Potato
0
5
10
15
20
Productivity (t/ha)

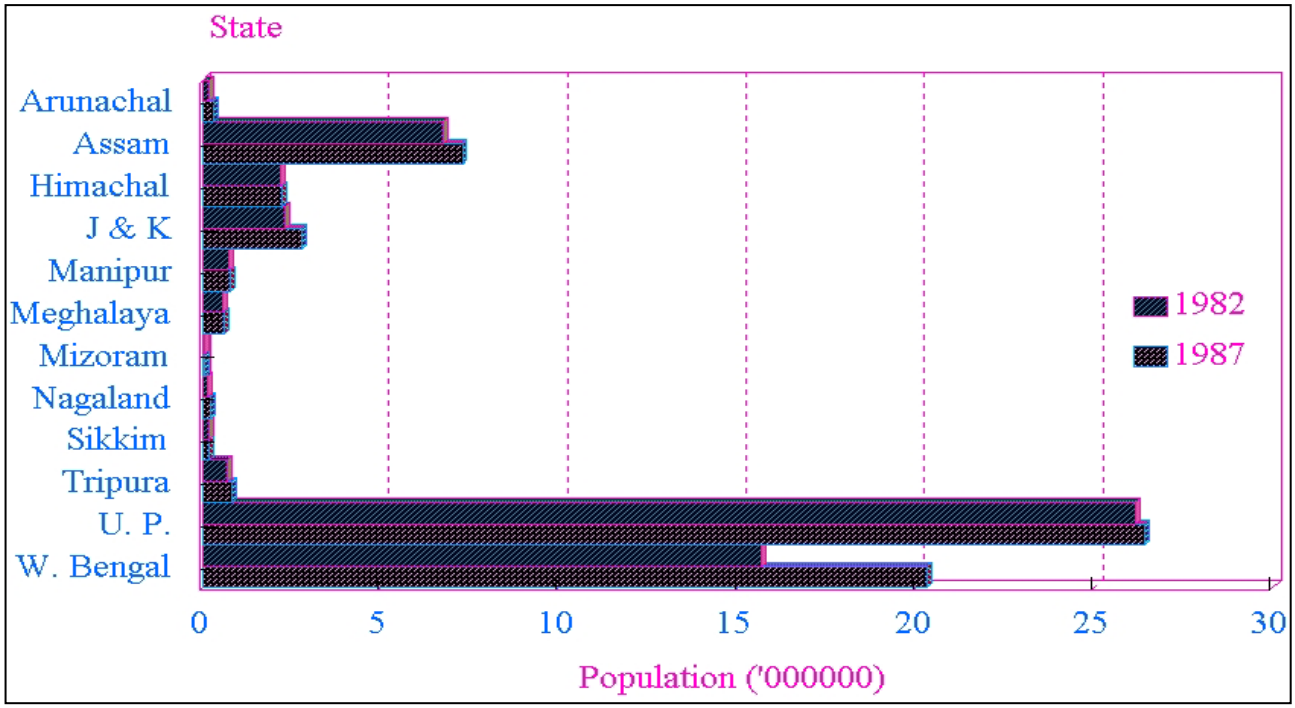
Emergence of land use changes is a continued evolutionary process set in from the beginning of advancement of human civilization. Remoteness, inaccessibility and frequent environmental risks in mountains fostered evolution of production systems sustained by locally available inputs or conversely least dependent on external inputs. In a historical perspective, hunting and gathering from the wild was the starting step for securing survival. This gave rise to shifting agriculture followed by settled agriculture. Shifting agriculture continues to be the major agricultural system on the forest slopes in north-eastern tribal belts, while its occurrence in the central and western Himalaya is rare at present. Settled agriculture on terraced slopes in mid elevations (upto 1800-2000 m amsl) or unterraced gentle slopes in high elevations (above 1800-2000 m amsl) is the major agricultural land use in the central and western Himalaya. Diversity of domesticated crops in the region is very high when compared with low land agricultural systems. Crop diversity is managed by mixed cropping and/ or with crop rotation. Valleys all through the Himalaya are much more intensively cropped than the slopes. Technological innovations such as chemical fertilizers, pesticides and high yield crop varieties which transformed low land agricultural areas, could not change the mountain farming system to the same extent, on account of mountain specific constraints. Dependence on forests for maintaining soil fertility in crop lands or expansion of agricultural land itself thus was not substituted by the new technologies. As forests and livestock provide material and energy inputs in traditional mountain farming systems, expansion of traditional agriculture runs the risk of forest degradation. In order to meet the present and future challenges meeting sustainability criteria, the traditional systems need to be adapted in ways which enhance crop yields but not at the environmental and social costs (Ramakrishnan et al., 1993).

Loss or soil fertility in agricultural systems of Himalaya do not have supporting research data (Bruijnzeel & Bremmer, 1989). It was concluded that while decline in agricultural production is realized and also attributed as a consequence of deforestation in many instances, the upper and lower limits of soil fertility in relation to crop yields for a given soil type have yet to be defined (Anonymous, 1992c). However, Maikhuri et al., (1996) while analysing data on crop yields per unit area in 11 watersheds of Garhwal Himalaya reported that the yields were found to decrease between 1970-74 and 1990-94.

Declining livestock productivity

Of the 449 million domestic animals in the country, nearly 50 million are in the Himalayan region. Cattle are most common (47.5%), followed by buffalo (12.3%), goats (15.8%) and sheep 10.4%). Generally, cattle, goats and sheep constitute an important livestock wealth in western and central Himalaya whereas pig and poultry in eastern Himalaya. yaks are reared in alpine areas. Equines are reared for transportation. Overgrazing and open grazing are often argued as a major causes of poor regeneration and degradation of forest areas. This view is substantiated by the fact that livestock density per unit of land area in Himalaya is much higher than in the lowlands and lack of exclusive fodder crops farming in the mountains. Positive values of traditional livestock


Cattle
48%
Buffalo
12%
Others
14%
Goats
16%
Sheep
10%

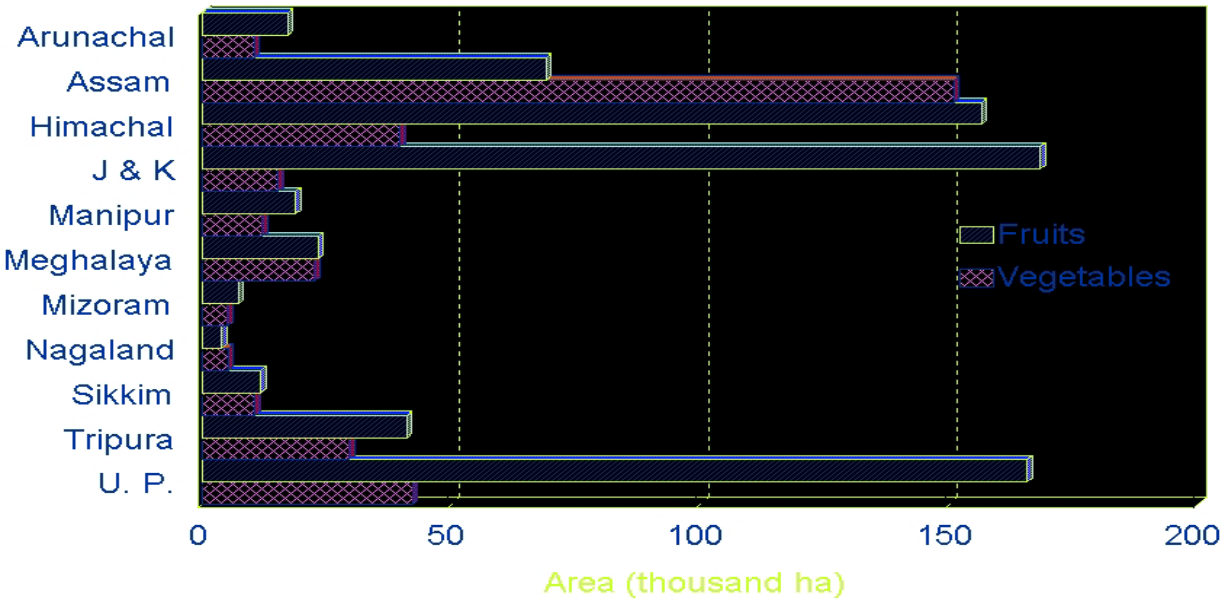

State
Arunachal
Assam
Himachal
J & K
Manipur
Meghalaya
Mizoram
Nagaland
Sikkim
Tripura
U. P.
W. Bengal
1982
1987
0
5
10
15
20
25
30
Population ('000000)

management systems have been given marginal importance. Efforts of diffusing grazing pressure on land in local animal husbandry systems do exist. Invariably, livestock are sent to high altitude pastures during summer/rainy season. A significant portion of animal feed is derived from crop wastes too. Thus hill folk is not unconscious of consequences of overgrazing. Neverthless, a trend of increasing pressure of livestock on forests cannot be denied. Comprehensive comparisons of the ecological economic costs /benefits of rearing livestock in the Himalaya with those in other environments are lacking.

The land holdings being very small, livestock supplement the income and are considered to constitute and important capital asset. Animal dung and bedding material are the only manure for the crops. Almost entire energy requirement of hill agriculture is met either from bullock power or human power. This scenario is not likely to change much in the future due to limitation of terrain structure and pattern.

Horticulture

Horticulture is a much recent land use change which has succeeded in selected sub-regions, particularly Himachal Pradesh and Kashmir in the west. A change from traditional food crop cultivation to agro-horticultural systems succeeded largely because of economic incentives and monetary profits to the farmers which were ensured through government subsidy and market demands. Horticultural development in central and north-eastern region is so far not as conspicuous as in the western Himalaya. Perennial cash crops other than fruit tree do play a vital role in economy of eastern and north-eastern Himalaya. Large cardamom grown as understory crop in forest areas is an important perennial cash crop in Sikkim while citrus, tea, rubber and pineapple are the major cash crops in the north-eastern Himalaya.



Environmental and social costs of horticultural development are now being increasingly realized. Horticultural land use expansion often involves encroachment on forest land. Demands for packing the marketable produce becomes a pressing factor for unsustainable harvests from the forest land. Market forces and institutional set-up created for gearing horticultural development led to economic growth but at the cost of equity. Prosperous farmers benefited more than small and marginal farmers (Swarup & Sikka, 1987). Analogous to negative impacts fruit crops in western Himalaya, tea, coffee and rubber did contribute substantially to economic development in north-eastern India, but also gave rise to social tensions. Social and environmental costs of these commercial production systems promoted directly or indirectly by the Government were perceived long after the progression of economic growth. There are a number of wild trees, shrubs and herbs which supplement the nourishment of people in the hills. The knowledge of their uses and productive potential is declining. Reasons for this decline are many including absence of market, lack of tested technology/methods for cultivation and value addition, and weak public policies promoting uses of wild edibles.

Hydrological imbalances and soil erosion

Water is the most underutilized, at the same time most abundant resource of Himalaya. it is estimated that about 11,00,000 million cubic meter mater flows every year down the Himalaya offering a potentiality of generating electricity to the tune of 28,000 MW and making as much as 247,000 million cubic meters water available for irrigation in the Indo-gangetic plains (Valdiya, 1985a). Uneven distributions of water both in space and time comes in way of harnessing the potential for development. Flow of water as a result of gravitational force provides immense scope for power generation and improving upon the efficiency of agricultural systems in the region. At the same time, a short sighted approach of harnessing this renewable resource may accompany social problems, waste of financial resources and hazards engulfing the plains too. These are subsurface and surface flows which largely meet the demands of hill. Ground water used are confined to large low land valley areas only. Despite of a surplus of water resource and hydropower, scarcity of this resource in the form of short supply of drinking water, predominance of rainfed farming and low level of electrification are common in many areas. The nature and magnitude of the problem, however, is not uniform all through the region. To illustrate, 100% village level electrification has been achieved in Himachal Pradesh. Hydroelectric potential in this segment has been exploited to such an extent that the state of Himachal Pradesh produces enormous surplus which has to be sold outside the state at nominal cost; thus the potential benefits are not being realized. Other problems, include management of power production and transmission. In many remote rural areas, power supply is extremely erratic and there is much variation in voltage that the rural poor find the new source in now way better and suitable than the conventional energy sources. Contrary to the situation in Himachal Pradesh, hydroelectricity production in other states lags far behind their own requirements.

Status of other essential uses (like drinking water, sanitation) and productive uses (like irrigated farming) is grim. About 84% of the net sown area in Himalaya is rainfed.

Though water stress limiting productivity may not be true for the high altitude areas, unstable and low levels of crop yields on slopes in mid and low altitudes (upto 1500 m amsl) are partly due to water stress. Incidences of reduced discharges and drying up of springs (the traditional sources of drinking water supply) have been found increased during the past few decades (Valdiya & Bartarya, 1991). Though there are no controversies on such trends, effectiveness of natural and human factors contributing to hydrological imbalances has emerged as contentious issues in the recent years (Gilmour et al., 1989; Valdiya, 1985b; Alford, 1992; Smadja, 1992). Corrective measures have been taken but seem to suffer from several drawbacks. Development interventions introduced by the Government since 1950s failed in resolving drinking and irrigation water supply problems partly because of technological drawbacks and partly because of weak institutional arrangements made for transfer and management of the introduced technology (Kothyari et al., 1991).

Hydrological imbalances currently observed in the Himalaya are considered to be linked to the loss of vegetation cover. Further these two factors under the influence of the geomorphological forces in geologically active belts exacerbate the process of landslides and erosion. These phenomena apart from directly deteriorating the local environment, have significant implications for the adjoining regions too. However, Hamilton (1987) while summarizing the information available indicated that - "At a local level, sediment load is strongly influenced by human activity, stream discharge characteristics. At the medium level downstream of the catchment being impacted, it is still uncertain what the quantitative effects of human activity could contribute, but the high variability of natural factors dominates both stream discharge and sediment load. At the macro level in large basins, human impacts in the upper watershed are insignificant on lowland floods, low flows, and sediment but these effects can be significantly influenced by human activity in the lower reaches of the river".

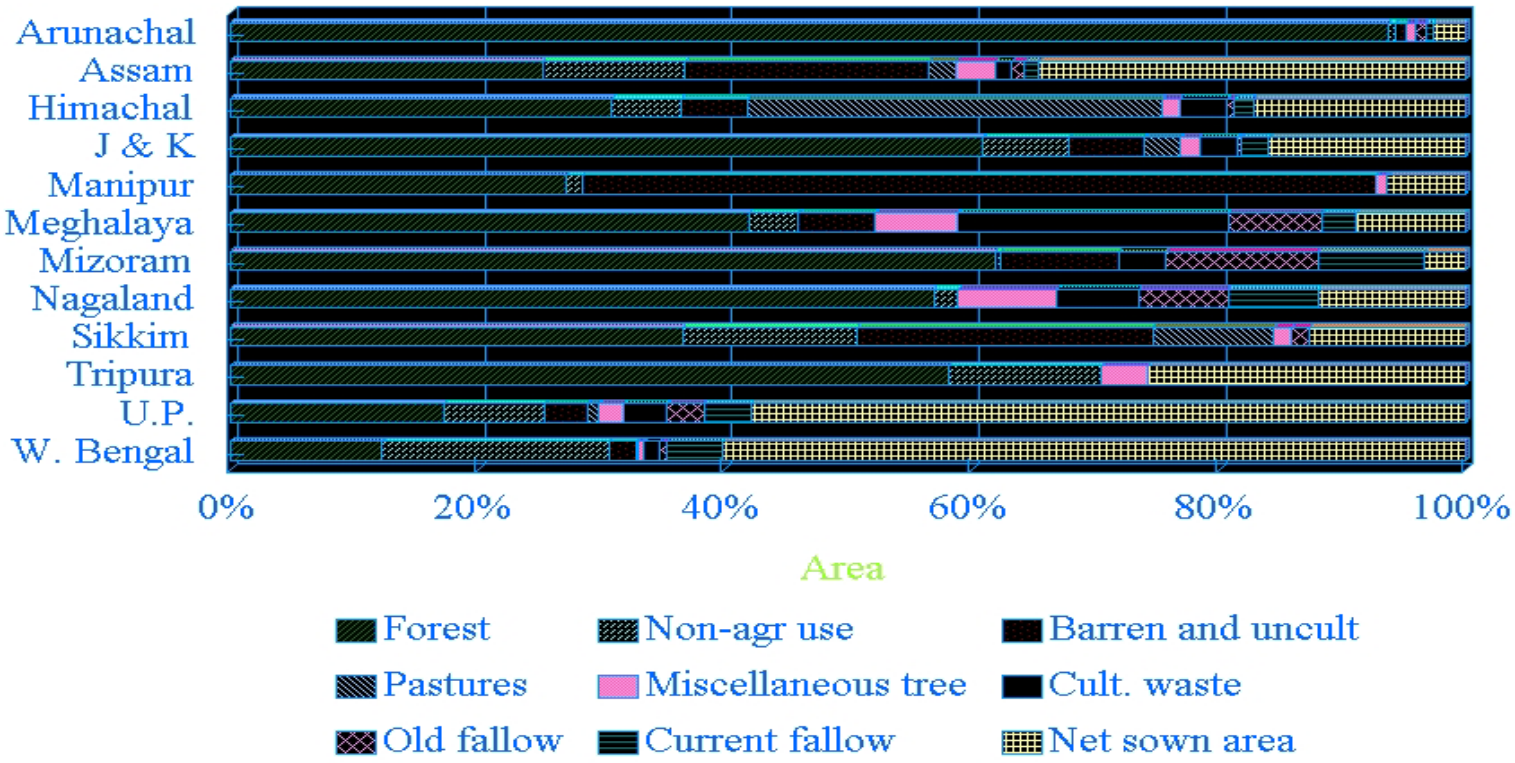
Burijnzeel & Bremmer (1989) while reviewing the published information on hydrological imbalance in Himalayan systems concluded that the land use manipulation effects tend to be diluted as the area under consideration increases. Their observations also include: i) conversion of forest land to agricultural uses will lead to increased total water yields as a result of a reduction in evapotranspirational demand of the new vegetation; dry-season flows may increase or decrease following the conversion, depending on the maintenance of infiltration characteristics of the soil; where the latter deteriorate as a result of poor soil management, more or less severs reductions in low flows can be expected, and *vice versa*; ii) reforesting degraded grass or croplands with fast growing trees will generally lead to reduced total and dry season flows as the associated increase in water consumption will override the effect of improved rainfall infiltration under situation existing in Himalaya; and iii) though the physical aspects of soil conservation in the Himalaya are well understood, the application of certain conservation measures such as closure to grazing, construction of inward sloping bench terraces, mulching of the surface, may meet with problems of acceptance. Given the loss of soil productivity associated with surface erosion on the upper parts of hill slopes, conservation is a must, however, reforestation for erosion combatment should only be promoted if all other measures could be expected to fail.

Sustainability of mega-level water resource development projects addressing triple objectives of drinking water supply, irrigation and hydroelectricity generation involve heavy investments, extensive environmental changes and require long gestation periods before the real benefits could start accruing. Economic cost : benefit ratio and rate of financial returns of these projects is questioned on account of poor precision of parameters used for deriving economic indices. To illustrate the case of one multipurpose river valley project in central Himalaya, variation in data on sedimentation rates was found to vary from 8.1 ha m/100km^2/year to 16.5 ha m/100 km^2/year. This led to over two fold variation in estimated values of life span of the reservoir (62-160 years) and consequently benefit/cost (1.28-3.96) ratio of the project, respectively. Sustainability of the mega level dam based projects is also questioned on accounts of geological and geomorphological features of the Himalaya. To what extent a given location would offer sustainable development opportunities or render unsustainability becomes an issue of debate (Valdiya, 1985b; Chandra, 1992). Other concerns attracting more and more attention with increasing emphasis on environmental and social goals of development address questions of benefit sharing between the mountain and lowland people and capacity/risk to recover environmental and social costs (Saxena & Rao, 1994).

Variability in data on sedimentation

Data source	Estimated sedimentation (ha m/100 km^2/yr)
Project authorities	8.10
Central Water Commission	12.50
Ganga Discharge Organization	16.33
Central Water Commission	14.86
Project Authorities	14.50

Development interventions at micro-level considering drinking water, irrigation, hydroelectricity generation in an integrated manner have yet to be properly designed and tested. Decentralized and small scale management systems involving active people's participation, and adapted to mountain constraints appeal more sustainable, particularly for meeting the minimum needs of the marginal areas. Traditional management of irrigation and potable water did not involve any advance technology. Its values and efficiency rest in low levels of financial investments, local controls, and quick responses in taking corrective actions in the event of damages. Disregard of these traditional management considerations adapted to mountain circumstances over ages in Government control management, limits the operational success of advanced technologies at present.


Arunachal
Assam
Himachal
J & K
Manipur
Meghalaya
Mizoram
Nagaland
Sikkim
Tripura
U.P.
W. Bengal
0%
20%
40%
60%
80%
100%
Area
Forest
Non-agr use
Barren and uncult
Pastures
Miscellaneous tree
Cult. waste
Old fallow
Current fallow
Net sown area

As a consequence of the uneconomic production from inconveniently located agricultural plots and growing alternative off-farm opportunities for securing livelihood, a significant portion of farm land gets abandoned. Such a situation also reflects out-migration from the rural areas in hills and, at the same time, unwillingness of the absentee owners (non-resident) to part away with the land. Land abandonment under these conditions accompanies perpetual loss in the productive potential of land. Adaptive responses to stress factors by farmers (Scott & Walter, 1993) played a significant role in evolution of traditional agriculture in the past when farming was the only option for securing livelihood. In the present circumstances, it often becomes more cost effective for the farmers to find employment than to spend his costly and scarce resources for rehabilitating the land of low productivity (Turner, 1982). As at present 30% of the total reported area of the Indian Himalaya is classified as fallow, non-cultivable and unculturable land. Besides, a Significant acreage of land classified as forest land lacks tree cover. Since natural regeneration in these areas is extremely slow, for all practical purposes, the acreage devoid of tree cover or poor grazing value could be considered as abandoned land.

Cropping intensity in Indian Himalaya

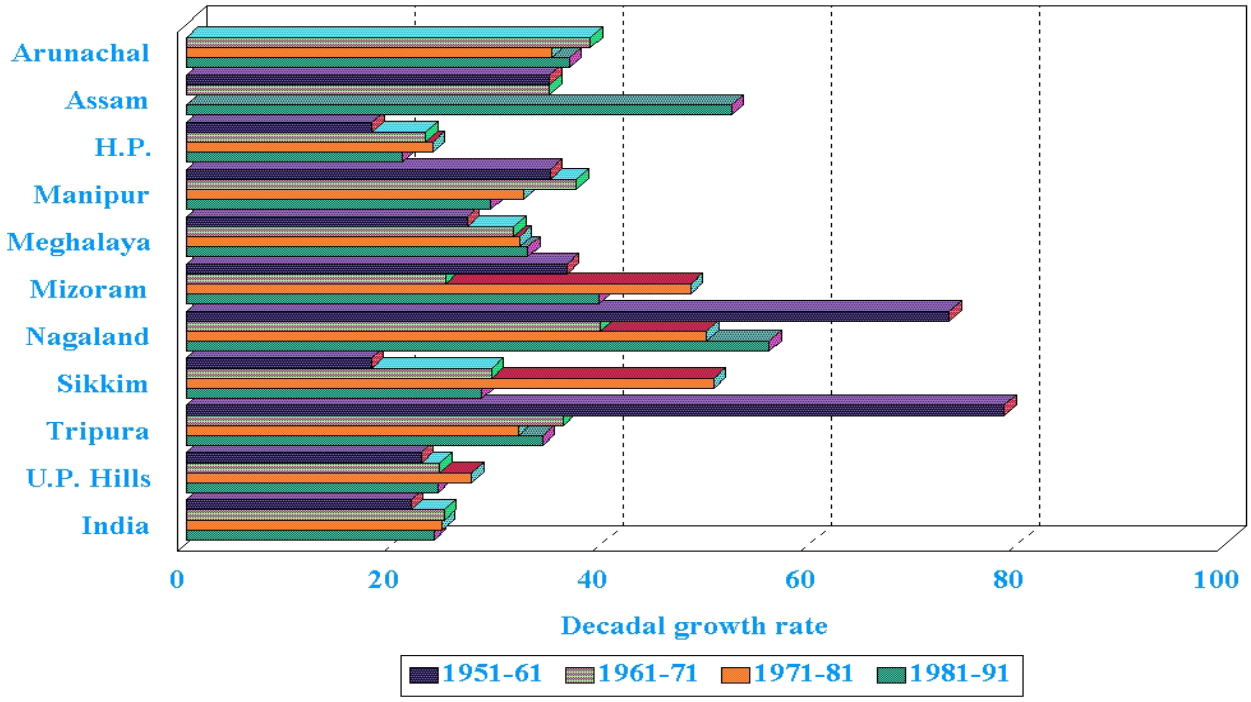
State	Gross cropped area (lakh ha)	Gross irrigated area (lakh ha)	Cropping intensity (%)
Arunachal Pradesh	2.5	0.3	166.7
Assam	37.5	5.7	138.4
Himachal Pradesh	9.7	1.7	167.2
Jammu & Kashmir	10.6	4.3	147.2
Manipur	1.8	0.8	128.6
Meghalaya	2.4	0.4	120.0
Mizoram	0.7	0.1	100.0
Nagaland	2.0	0.6	111.1
Sikkim	1.5	0.2	166.7
Tripura	4.2	0.4	155.6
Uttar Pradesh	253.5	143.8	147.1
West Bengal	83.5	19.1	156.7

Acreage of areas classified as fallows and uncultivable in the available statistics at regional level are indicative of the magnitude of land abandonment problems. In states like Himachal Pradesh in the west and Meghalaya in the east, more than 30% of the reported area is classified as uncultivable land. Fallows mean land abandoned for a period of a few months for restoring soil fertility through natural processes. Utility of these areas could be enhanced by raising the cropping intensity. Uncultivable land category covers the land suffering severe physical constraints. Under extreme situations of food scarcity farmers are likely to extend cultivation in these areas but the cost of their

rehabilitation is very high. Primary motive behind extension of agriculture in these marginal areas relates to a tendency of increasing the land holding size and not that relating to food security.

Population Growth

Decadel population growth rates calculated for each of the Himalayan states for the period 1951-1991 indicate that the growth rate has slowed down, though marginally in most of the cases. However, it is still above the national average in all states except for Himachal Pradesh and Uttar Pradesh Himalaya. Size of land holdings in Himalaya is about 1/8th of the average for the country. However, smaller size of land holding is not solely due to population growth. A large chunk of land is either seized for non-agricultural use (e.g., forest) or is not suitable for agriculture (e.g., rock out-crops, perpetual snow areas). The proportion of land that is not available for cultivation because of physical and legal constraints in the Himalaya is of much higher order than in the plains. Population pressure, beyond the carrying capacity or population support capacity of the region, can disrupt the balance of utilization-regeneration but this may not



necessarily hold true. As a result of scarcity of a given resource or set of resources due to increase in demands, it is also possible that innovative technologies and/or human/institutional mechanisms rendering enhancement in the rates of regeneration or curtailment in the level of consumption of the scarce resources or emergence of substitutes of the scarce resources, have come into being (Fleuret & Fleuret, 1978; Fox, 1993). However, lack of evidences in support of positive changes in response to population growth in the Himalaya support the widespread views on population pressure leading to unsustainable trends in the region.

Forest area and human population data of states in the Himalayan region indicate an increasing trend of population growth and decreasing trend of forest area. However, there seems no statistically significant relationship between the two parameters. Nagaland, a state where the rate of population increase is observed to be the highest, shows the lowest extent of deforestation. Manipur, Meghalaya and Tripura exhibit more or less similar rates of population growth but differ considerably with respect to the loss of forest cover during the same period. Data on forest cover and population merely at two points of time are indeed inadequate for drawing any precise trends or relationships. Further, demands on forest by the increasing population may not necessarily get expressed as deforestation in a true sense. While there are deficiencies in the methodology adopted for deducing these statistics, the observations do provide substance indicating that (a) population explosion alone is not responsible for the current scenario of forest degradation, (b) unrealistic picture may emerge if attempts are made to predict the future scenario based upon the available data. Overpopulation, a major factor contributing to environmental degradation and poverty in many developing countries and also implied for Himalayan region (Martins & Nautiyal, 1988; Ives & Messerli, 1989) need to be looked into from multiple considerations. Concepts of population support capacity or carrying capacity are not clearly established in quantitative terms. Carrying capacity statistics projected in terms of sustainable limits of population density or livestock density arrived at are based on several assumption and so are likely to be far away from the realities.

Forest area ('00 ha) and human population ('000) in some states in the Himalayan region

State	Forest area[a]		Population[b]	
	1972-75	1980-82	1971	1981
Assam	21055	19796	14625	19896
Himachal Pradesh	15075	9130	3460	4280
Jammu & Kashmir	22335	14361	4616	5987
Manipur	15090	13572	1072	1420
Meghalaya	14390	12458	1011	1335
Nagaland	8154	8095	516	775
Tripura	6330	5183	1556	2053

a- after Anonymous (1983)
b- after Anonymous (1971 & 1981)

Alienation and desperation

Land tenure/ownership laws and regulations usually are considered to be biased state enforcement restricting or denying the age old customary rights and privileges of people pertaining to the resources uses in vast forest land owned by the Government. Such thinking infuses a feeling of alienation and leads to people-government conflicts.

Because of this perpetual conflict, unsustainable resource uses or patterns emerge as infrequent retaliatory or opportunistic instances and succeed in pockets where Governmental checks are weak.

Poor infrastructure and difficult terrain impede industrial development of the area and thereby low employment potential for the local people. Though the region is naturally endowed with enormous potential or raw material, concentration of processing of the produce elsewhere debars the Himalayan dweller in getting a significant share in the accrued benefits. Mass migration, is manifestation of desperation and alienated feelings in many areas. There are instances in Garhwal Himalaya where about 3/4th of the total families in a village migrated out during the period 1972-88 (Maikhuri et al., 1995).

Development Concerns in Himalaya

Development denotes position of a region or country in comparison to others. In this sense, the hill area of our country are the least developed and considerable efforts have certainly been made to elevate them to the national average. Though the desired target or goal has generally not been achieved the plan programmes during various Five Year Plans did have their impacts. The important ones are:

- A realization of special consideration of the peculiarities of hilly terrain and hill societies in development policy formulation and planning process
- An appreciation of the values of hills in the maintenance of ecological balance, along with their long term economic values
- Preference to development programmes relying more on indigenous/local rather than external resources
- Emphasis on the area specific development programmes compatible to ecological and social specificities of an area, rather than a blanket plan for all hills
- A need for hastening the process of technology transfer
- Importance of long term studies for ecological and economic changes in time and interactions in space for a realistic understanding of the hill ecosystems
- Relevance of integrated management of natural resources and programme implementation in ecological units instead of administrative units
- Over and above, all feel that drastic changes in the strategies so far adopted for development of Himalaya, are needed urgently.

At this juncture it is worth to implore ourselves at to why in-spite of considerable know-how and repeated recommendations of the Planning Commission, gaps in development planning exist and still worse is that instead of narrowing, the gaps are perhaps widening. Action Plan for Himalaya (Anonymous, 1992c) has identified the following reasons:

- Low investment per unit of area (one km2 on orthogonal projection in map may be twice or more depending upon the slope of land in mountain systems), though due to sparseness of population, the per capita figures appear impressive

- Introduction of technology without assessing the needs and priorities of the people having diverse socio-economic, cultural and ecological settings as well as problems
- Developmental efforts put in a particular direction in isolation and with no consideration to its effect in other related fields
- Technology developed for plains pushed into the hills without necessary and appropriate modifications
- Predetermined norms of development based on experience in the plains applied to the mountains as well
- Lack of extension education programmes appropriate to the needs of women and manifold in the mountains
- Small, isolated and fragmented holdings
- Principle of 'more incompetent' persons to 'more difficult and underdeveloped areas' restricting the hills from getting benefited from efficient public servants
- Allurement towards comforts and glare of urban centers among the local elite and qualified youth in hill areas
- Political priorities for tertiary activities manifesting in 'abrupt changes' over the primary and secondary activities
- Absence of effective government mechanisms to ensure contingencies in the even of natural risks and uncertainties for primary activities, and thereby attraction for salaried jobs rather than self-employment

Development concerns in the Himalaya revolve around how could resources of the region be managed for conserving/improving the environmental values of the region together with socio-economic development of mountain people. The strength of ecological and socio-economic concern depends upon the specificities of the target area and background of people involved in thinking. While conservation of natural resources figures as top priority on the agenda or environmentalists thinking about the development of mankind in a wider perspective, ways of building upon the economic potential linked to infrastructural development, introduction of advanced technology and increased cash flows through market economy are the primary concerns of deprived and desperate rural hill dweller. Sustainable management of natural resources is possible neither by asserting power by enforcing laws by the state in the name of wider public interest nor by giving free hand to the people to decide the balance between use of natural resources for the present and future and amongst themselves. Reverting back to the historical times by entrusting management machinery in the hands of people in the present circumstances, involves a risk of exploitation of natural resources to build financial resources. Though incompatibility between local immediate economic development priorities and regional environmental conservation priorities exists, there is also scope for narrowing down this conflict. The objective of preservation/conservation of Himalayan environment can be achieved provided the actions adopted to serve the long term interests of a wide group (people living in the Himalaya as well as those outside the region) appreciate and address the immediate needs of the people of the region.

The difficult terrain, environmental hazards, poor communication and low level of scientific/technological progress rendered marginalization of hill areas from getting developed through administered development. People of the region feel and think more about the disparity in the pace of development between hills and plains, between urban and rural areas within the mountains, and more and less developed hill villages than about the scope of improving the quality of their life by themselves. The question that why the development advanced at a faster pace elsewhere has acquired more importance than how the less developed people could become more developed. The issue of disparity on one hand weakens the indigenous potential to advance on development track and on the other, magnifies the dependence of people on government for their development.

Isolation and natural impediments in mobility favoured enormous diversity in socio-cultural systems adapted to local conditions and evolution or rich traditional knowledge on resource dynamics, uses and management. Hill societies in historical times have laid emphasis on self-reliance to secure their perpetual existence in isolated and inaccessible areas. The element of self-reliance is likely to be of more adaptive significance in more remote and inaccessible areas. An appropriate mix of self-reliance and dependence on external inputs is a prerequisite for accelerating the pace of development meeting the sustainability criteria. Bringing improvement in life quality of people with external inputs may earn credibility of those faced to difficult ways of life, but is not likely to be sustained in a long term perspective. Development interventions must capitalise upon and add to the indigenous development capacities. Present levels of appropriate technological knowledge as well as capacity to put the existing knowledge in to practice in the Himalaya need dramatic improvements from the point of the interests of the people settled in the region and many more settled in the adjoining low lands.

Regional development perspective of Himalaya seem to be clouded with environmental and economic issues; social issues being usually given a peripheral or secondary importance. Environmental degradation is more a problem of relationships among people competing for productive resources than of relationships between people and habitats (Horowitz, 1988). Development priorities for the mountains are justified for improving upon the life quality of mountain people and also to persuade the people of the plains that the future of the mountains cannot be isolated from their own (Eckholm, 1975). However, to what extent a more marginal area like Himalaya gets priority over a less marginal area like the Indo-Gangetic plains will continue to be a question resolved by political decision making process. Protection of interests of indigenous population, therefore, must assume the focus as well as priority for interventions aimed for sustainable development in the Himalayan region. Unfortunately, human dimensions of environmental and developmental changes remain poorly understood (Fisher, 1990).

Development strategy is basically a set of actions identified by choices and compromises in decision making process. The logical unifying principles of inducing sustainable rural development in the Himalaya could be:

- Realize the opportunities and constraints for development in mountain perspective

- Divert attention of people from 'what they do not have' to 'what they have' for overcoming the present state of desperation
- Build on the local knowledge, natural resources, skill and human capacities
- Provide people with technology and materials altogether new to them or beyond their reaches but meeting sustainability criteria
- Make people to realize the real costs of given intervention by way of promoting their active participation in development interventions
- Design people-government participatory action frameworks clarifying responsibilities, accountability and profit/loss sharing

While it is true that Himalayan environment has already deteriorated to an alarming extent and there are many gaps in our knowledge to design appropriate solutions. It is also true that ecologically rich areas and low input production systems (though they are not conceived to be developed on economic criteria), are surviving in the Himalaya to a much greater extent than elsewhere in the country. This appreciation for the environmental values blended with the essentiality of purposeful alterations in the natural resources as well as processes, an integral component of culture and social system of Himalayan man, has been suppressed by the documented knowledge on the 'miracles' of modern science and technology. Strategic approaches of developing new technologies or thrusting those which have proved successful elsewhere, must be replaced by looking into the indigenous repository of knowledge and technology followed by necessary refinements therein. Such initiatives should contain:

- Preparation of resource inventories and studies on levels of living of the people highlighting their needs in the context of their habits, traditions, experience and resources
- Identification of improved technologies that are simple in adoption, proven efficient under the socio-economic and physical conditions, specific to the problem or to the area
- Imparting extension education to the women folk along with the men in the target area
- Incentives for primary production activities and interventions for economic benefits or primary production directly to the rural poor
- Creating awareness towards the elements of sustainability in conjunction with the present trends of development so as to contain the unrealistic aspirations of the common mass and, as aspiration for development of society and not of the individuals
- Impact studies focusing on the acceptance or otherwise of the newly introduced technology and further needs in that direction. This would lead to a two-way traffic between the people and the technologists
- Political willingness, free from interference, and dedication of public servants without which nothing would succeed in our system

Institutional capabilities, in terms of numbers, for generating and transferring the scientific information and technology have been developed to a considerable extent. The Defense Research Development Organization, Snow and Avalanche Study Establishment, Botanical Survey of India, Zoological Survey of India, Geological Survey of India, Forest Survey of India, Indian Council of Forestry Research and Education, Survey of India, Indian Council of Agricultural Research, Universities and other Research and Development establishments of Department of Science and Technology, Department of Biotechnology, Council for Scientific and Industrial Research, Ministry of Environment and Forests (Wildlife Institute of India and G.B. Pant Institute of Himalayan Environment and Development) have generated enormous information on the region. Off late non-governmental organizations have also started sharing the task along with some of the existing governmental departments in the region.

The environment and development related issues are mainly due to increasing conflicts of interests over resources. This is further excentuated due to lack of partnership among various organizations working to achieve the ultimate goal. Every partner is acting as creator of technology and a critic of the government infrastructure and none seems to be interested in spreading the technology available.

Sustainability of any development intervention would depend upon a logical consideration of these opportunities and constraints. Huge variation in physical, biological and human system in the region demand careful consideration of locational specificities while designing and implementing any development intervention. Further, since scientific knowledge base of the region is limited, efficacy of any intervention must be thoroughly tested before it is spread on a large scale.

Strategy for Environmentally Sustainable Rural Development

In view of the decline in per capita food availability and the rapid increase in food requirements in the developing countries, food production in these countries need to exceed the growth rates achieved at present. Natural resources are being placed under such strain that the objective of ensuring food production is at least adequate in terms of quantity and quality. It is, therefore, not sufficient merely to review natural conditions and submit strategies for increasing production since they are already in line with the state of the art in production technology. An appraisal of information available for the Himalayan region suggests that management consideration argued to have emanated from scientific studies are inherent in the traditional systems. Thus what is needed is to appreciate the positive points of traditional resource production and use systems and strengthen them through science and technology inputs for further improvement in their values and efficiency instead of advocating, abrupt changes involving replacement of traditional systems by the new ones found suitable elsewhere and carrying a big question mark in the context of mountain systems such as Himalaya. What is required is that these strategies be anchored in the economic, social and political circumstances which determine the development of the environment, production and living conditions in these areas (Dhar, 1993; Anonymous, 1996). The most important development objectives in this context are: (i) improving food and energy supplies by increasing in agricultural and forestry products, and adjustment of the production structures; (ii) securing the greatest

possible employment and income effects for the broad mass of the population; and (iii) long-term protection of natural resources. One could observe that these objectives are quite interdependent in the long term and overly pronounced emphasis on any one of them would not provide self-dependencies between natural, technical and social factors in their significance with respect to goal attainment are needed. Since ecosystems are the natural basis for all development processes and their maintenance is of predominant importance in the longer term, planning process, therefore, should take this into consideration (Rao & Saxena, 1994).

Focus on natural resource management

Production, consumption, preservation and distribution are the key processes characterizing resource dynamics. They are also used as social, environmental and economic indicators of development for a given region. In conventional economic perspective, production is looked as a process operating at two levels: primary level - dealing with raw material available from biological (farms, forests and livestock) or non-biological systems (minerals), and - secondary level - dealing with value addition to raw material using labor, capital and technology inputs. Industrialization thus addresses production process at a secondary level. Several factors like communication, transportation and marketing, commonly referred to as infrastructural facilities, influence both primary as well as secondary level production processes which must be considered along with tertiary sector of development in conventional economic approaches. Production was viewed merely as a means of securing livelihood by the mountain societies and obtaining monetary profits, the core of economic growth, from the production process is recent concern. Surplus of primary produce such as food grains used to be appropriated as contingencies in the even of natural catastrophe or to secure commodities that are not available locally (e.g., farmers settled in high altitudes exchanging surplus potatoes, amaranths and buckwheat with paddy from farmers in low altitudes). Mountain people values need based exchanges more than opportunities for monetary profits through cash driven market. Present marginal status of the Himalaya is thus partly due to lack of economic concerns in the traditional socio-cultural systems of mountain people and partly due to slow pace of industrialization because of physical constraints and preexisting low level of infrastructural facilities. Realizing the monetary benefits from production processes by the local populace is a recent consciousness in response to growing markets for resources of the region together with emerging technologies of value addition to locally produced raw material at distant places in the lowlands. A critical issue in the present scenario is the growing incompatibility of regional and local development priorities - local populace pressing for improvement in infrastructural facilities, industrial growth and cash crops in order to realize economic benefits and regional imperatives for avoiding the risks of environmental degradation and regenerating the environment degraded in the past (particularly reforestation/afforestation activities). Government set up does realize the local priorities but it also carries the responsibility of implementing actions escaping regional or global criticism.

Preservation/conservation owes importance because of fragility of the Himalayan environment and considerable damages, whatever be the causal factors, to the Himalayan landscape in the past. Values for conservation/preservation of resources are deeply

embedded in the religion and culture of traditional societies. With advancement of administered development, the state came forward with legislative/administrative mechanism ensuring environmental preservation/conservation. However, the governmental mechanism of environmental conservation/preservation of Himalayan environment also provided checks and restrictions on age old traditional usufruct rights infusing an element of alienation toward governmental policies among the local populace. Issues related to uses of natural resources were delinked from the issue of proprietary rights or land ownership rights in the hills in historical times. Agricultural land was the only land use where land ownership rights and use rights of individuals were recognized. Under difficult Himalayan terrain restricting mobility, mountain societies evolved as small cohesive set-ups where decision making process operated locally. Centers of decision making got gradually distanced from the mountains and mountain people started getting ruled by those who were far away from the realities. Decision making process started getting influenced more by values of Himalayan resources as perceived by aliens than by the local population. Focus of state intervention shifted from resource use rights to resource/land ownership rights. State interventions thus proved counter productive to the preexisting socio-cultural values for conservation. Rejuvenation of the age old cultural values together with reorientation of state interventions therefore deserves attention in designing and implementing approaches for the goals of environmental development of the area.

Consumption and distribution of the produce are the processes addressing social goal of development - the equity. Because of physical stress, isolation, environmental uncertainties, marginal cultural values of monetary profits, rationality in resource use evolved over ages among the indigenous societies. Consumerism could not proliferate partly because technologies of value addition could advance and partly because exchanges pertained only to minimum needs for securing livelihood in the region. Low levels of advanced technologies and capital forced mountain societies to emphasize on primary level production processes (such as agriculture) or to move to centers of industrial growth located in low lands (male out migration). This also facilitated increasing unequal terms for trading raw material from mountains to the lowlands. With increasing exposure, local population started realizing the exploitative market and industrialization processes. State did institute checks on open trade of raw material for protecting the interests of the marginal area. However, these checks at times and places prove non-existent. Though drawbacks in government programmes and policies are not ruled out, there are also serious drawbacks on the part of the people. People's demands are guided by their aspirations and not by the realities of constraints the Government is faced with. People - Government partnership rather than conflicts could only mitigate the multitude of problems (Rao & Saxena, 1994).

Development programmes in the past, due to economic, social and political constraints, have affected the food-fodder-energy links. Despite the ambiguity and inconsistency of land use data, reduction in forest cover cannot be denied. Since subsistence systems are dependent upon forest based inputs, yields are likely to be lowered, if not so far, then definitely in the future. As an ameliorative measure,

promotion of agroforestry is often advocated to achieve the duel objective of promoting cash economy and environmental conservation. The former objective, in the present scenario, is as important as the latter, but is hard to achieve on account of long gestation periods before the planted trees yield marketable goods. Further, there are strong reservations of the people towards planting trees because of tiny and fragmented crop fields. The knowledge of tree culture ensuring the existing levels of crop production or possible improvements therein with such management itself is quite inadequate in the hill areas. The ineffectiveness of the afforestation/reforestation programmes is clearly felt, though not quantified precisely. However, the fact that mountain trees are more productive than others, the existence of rich tree germplasm useful to man for his present needs and the capability of many indigenous trees to improve rather than exhaust the soil fertility must be recognised and realized for future research and development in the Himalaya. Cultivation of medicinal plants has the possibility of getting ready acceptance by the people as it would help in strengthening the economy over short periods (Maikhuri et al., 1998). This is an area which should be given priority in the development planning of the region. There is immense scope for making use of existing production systems to improve the well-being of the people inhabiting harsh hill environments. In the present circumstances when ecology and economy of the region have deteriorated to serious levels, development programmes ought to be framed for both short term and long term gains.

Reconciling conflicts through integration

A shift in emphasis from addressing ecological and socio-economic problems separately to an integrated cross-sectoral view of multiple and diverse problems is visible in the policy documents of the Government, particularly during the past few years (Anonymous, 1992a & b). Yet, advocacy and willingness for integrated approaches paving way for sustainable development is yet to be accompanied by development, demonstration, and replication of effective integrated development strategies serving ecological, economic and social development imperatives together. Programmes translating the new paradigm have been instituted but were found in no way more effective than sector focused development programmes instituted in the past. The lacunae are apparent both in programme design and implementation. Himalayan watershed management project funded by the World Bank was conceived as a development programme with a focus on integration of five sectors, viz., forests, agriculture, livestock, horticulture and minor/micro level irrigation. However diversion of as much as 63% of financial investment on he forestry sector led peripheral importance to other sectors. Further, in the absence of a strong data base (even the basic data on rainfall, temperature and water yield are not available and there are methodological problems in extrapolating the data from a few stations to unsampled places), effectiveness of the management interventions envisaged was not achieved (Kireet Kumar & Rawat, 1996). Emphasis was on introduction of interventions new to the people (chemical fertilizers, check dams, lined canals, storage tanks) by ways of providing subsidy. Such interventions do become visible but are not likely to persist after the project support is withdrawn/terminated. Marginal importance to people's participation invokes a feeling in the local populace that interventions are to serve more

to national/global interests (e.g., increasing the tree cover) than the local ones (e.g., socio-economic development). People's participation would not only bring down the programme cost (about 22% of project cost was incurred towards project staff and infrastructure in World Bank sponsored watershed programme) but would also remove many misconceptions and conflicts pertaining to people - government relationships. Interventions supplementary/complementary to the indigenous resource use practices and capable of improving upon the efficiency of indigenous systems are likely to succeed more than altogether new interventions in risk prone mountain environments. Advancement in science and technology together with restructuring of institutional mechanisms of implementation of development activities is needed for enhancing the element of sustainability in Himalayan scenario. Multiple facets of problems and potentials in Himalaya demand integrated approaches. However, integrated approaches have yet to advance from merely bringing different development sectors under a common programme as at present to a framework where interventions improving the state of one sector complement to the development objectives of the other sector.

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G. B. Pant Institute of Himalayan Environment and Development was established during *Bharat Ratna* Pandit Govind Ballabh Pant Birth centenary year in August 1988 as an autonomous Institute of the Ministry of Environment and Forests, Government of India. The Institute is identified as a focal agency to advance scientific knowledge, to evolve integrated management strategies and demonstrate their efficacy for conservation of natural resources, and to ensure environmentally sound development in the entire Indian Himalayan region in harmony with the local perceptions.

Apart from undertaking research and technology development and/or demonstration on its own, the Institute has established linkages with various national and international organizations committed to environment and development issues in the mountains. The Institute's objectives also include identification and strengthening of the local knowledge of the environment and contribution towards strengthening research of regional relevance in the scientific Institutions/Universities/NGOs/Voluntary agencies working in the Indian Himalayan region.

The Institute functions under a Society, guided by the Government Body and a Science Advisory Committee and has a decentralized set-up, with its headquarters at Kosi-Katarmal, Almora, Uttaranchal and Units at Sikkim (Pangthang, East Sikkim), Himachal (Mohal, Kullu), Garhwal (Srinagar-Garhwal, Uttaranchal) and North-East (Itanagar, Arunachal Pradesh), and core scientists specialized in diverse disciplines, technicians, administrative and supporting staff, and a number of project fellows and research associates spread over various units.

All research and developmental activities of the Institute are multidisciplinary in nature and revolve around seven core programme *viz.,* Land and Water Resource Management (LWRM), Sustainable Development of Rural Ecosystems (SDRE), Conservation of Biological Diversity (CBD), Ecological Economics and Environmental Impact Analysis (EIA), Environmental Physiology and Biotechnology (EPB), Institutional Networking and Human Investment (INHI), and Indigenous Knowledge Systems (IKS). The thrust of research and development efforts is to provide solution to location-specific problems through time bound projects. The research is essentially need based and the field activities are well supported by laboratory based basic efforts whenever required. Rigorous data collection and demonstrations of science and technology inputs, including packages developed by the Institute, *e.g.* Sloping Watershed Environmental Engineering Technology (SWEET), are underlying activities of all the projects. The Institute is now moving from descriptions to prescriptions and demonstrations and also attempting to influence, through understanding of ground realities, the decision making process at all levels for the overall well being of the Indian Himalaya and its people. Apart from research and development activities, the Institute has a number of support facilities and services such as library, arboretum, videography, nursery, instrumentation centre, consultancy, project formulation, soil, water analysis, tissue culture, data processing and information systems, training programmes, workshop and seminars. The Institute receives its core fund from the Ministry of Environment and Forests, Govt. of India. In addition to the above, currently support from various national (DBT, CSIR, UGC, DST, INSA, NEC, ICSSR, MoWR, MoRD, ICAR, WWF-India, State Governments, etc.) and international (ICIMOD, UNESCO, NORAD, TSBF, Shastri Indo-Canadian Foundation, CIDA-SICI, BCN, McArthur Foundation, UNDP/FAO/UNIDO, UNICEF, etc.) agencies are also available. In addition to the execution of various in-house and externally funded R&D activities in the Indian Himalayan region, the Institute also sponsors projects, through Integrated Eco-development Research Programme (IERP), to various Universities/Institutes/Govt. Institutions and NGOs for the support of location-specific action-oriented R&D activities.

Besides research publications in the form of scientific papers, the Institute also publishes *Hima Paryavaran* Newsletter, ENVIS Bulletin, ENVIS Newsletter, Himalayan Biosphere Reserves Bulletin, Pt. Govind Ballabh Pant Memorial Lectures, Training Modules, Technical Reports and Annual Reports, etc. The research output and subject compilations are brought as Himavikas Publications or Himavikas Occasional Publications and are published by the reputed publishing houses. The Institute also provides consultancy services to various users/stakeholders within the mandate and jurisdiction of the Institute.

ENVIS Centre on Himalayan Ecology

The Environmental Information System (ENVIS) Centre on Himalayan ecology was established at the headquarters of G.B. Pant Institute of Himalayan Environment and Development (GBPIHED) in the financial year 1992-93 with the fiscal support from the Ministry of Environment and Forests (MoEF), Government of India. ENVIS Centre on Himalayan ecology is a part of ENVIS network centres in India coordinated by the MoEF; the national focal point in the country for collating information from various ENVIS centres and providing national scenarios to the international programme INFOTERRA of the UNEP (United Nations Environment Programme). ENVIS Centres essentially help in handling of huge and varied information relevant to environmental management and development.

The ENVIS Centre of the Institute (GBPIHED) has the responsibility of collecting, collating, compiling and building qualitative and quantitative databases of information related to various aspects of Himalayan ecology. The centre is also integrating the available information in ready-to-use form for the users of the remote regions of the Indian Himalaya in particular and for regional development planning in broader perspectives. Through print/electronic media, the Centre is regularly disseminating all available information, free of cost, to various stakeholders/users that include all District Information Centres (operating in the Himalayan states of the country), ENVIS Centres elsewhere in the country, Universities and their Campuses, other educational and research institutions, policy makers and planners, Government and Non-Government organizations, and general public, etc., working on various aspects of Himalayan ecology. For further details, Dr. P.P. Dhyani, Scientist-in-charge of the ENVIS Centre of the Institute, may be contacted.