

A Study on Limitations and Potentialities of People, Forests and Agriculture in the Eco-Development of Sikkim Himalayas, India

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ABSTRACT The present study deals with analyses of Sikkim Himalayas with respect to population groups, forests and agriculture. The population groups include Lepchas, Bhutias and Nepalese, the later being divided into a number of castes. With uneven topography, the state presents four distinct ecological zones—Lower hills, Mid hills, High hills and Very high hills. Tree composition of forests at various altitudes differ significantly. Thus, lower hill forests are composed of *Shorea robusta*, *Terminalia crenulata*, *Terminalia chebula* and *Schima wallichii*. Middle hill forests harbour *Castanopsis tribuloides*, *C. indica* and *Engelhardtia* sp. At upper hills *Michelia excelsa* and *M. cathcartii* occur. At still higher elevations, Conifers, Rhododendrons and alpine pastures occur. Human activities, with regard to their dependence on forests and also agricultural practices are detailed for few crops. This paper presents the inherent problems and potentialities associated with agriculture. Some specific problems associated with various crops are also highlighted. As the area is divided into distinct ecological zones comprising different population groups with related economic activities, it is viewed, that solutions are to be traced zone wise to achieve sustainable development in the region.

Man's increasing manipulations of his environment often generate conflicts between human goals and natural processes. In order to achieve maximum benefits, man deflects the natural flow, of energy, disturbs natural processes, food chains and simplifies the ecosystem. The ecosystem concept can be used to study the interrelationships between living organisms and the physical environment. Nevertheless, this concept must be used with caution in studying human societies, as they are, given their distinct cultural character, partially independent of the natural environment. Thus, the interaction between the natural environment and human societies is not always governed by the same rational and objective principles which apply to the interrelationships between the components of the natural system itself. This relative independence of man with respect to the natural environment is a cru-

cial factor and operated through socio-economic and cultural environments of the human component. Thus it stresses the importance for specific studies for different areas inhabited by various ethnic groups in spite of their similarity with respect to other elements of the ecosystem. The present study deals with analyses of Sikkim Himalayas with respect to population groups and their relationships with forest resources. Human activities with regard to agricultural practices and subsidiary economic activities depending on the surrounding forests are also presented at micro level. This paper discusses the changes that are brought about in the ecosystem as a consequence of these actions and proposes some solutions in the sustainable development of the region.

STUDY AREA AND ADMINISTRATIVE DIVISIONS

Sikkim, the smallest hill state of the Indian

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Union lies in the Eastern Himalayas between 27° and 28° N latitude and 88° and 89° E longitude. It is bounded by Tibetan plateau in the north, the kingdom of Nepal in the west, the kingdom of Bhutan and the Chumbi valley of Tibet in the east and the Darjeeling district of West Bengal in the south.

The mountainous terrain of Sikkim consists of a tangled series of interlacing ridges rising range above range with the elevation of hill ranges varying from 300 m to 8400 m. The State is almost rectangular, 113 km long 64 km wide and with an area of 7299 sq. km. Sikkim has been divided into 4 districts for administrative purpose. District East with headquarter at Gangtok, District West at Gyalshing, District North at Mangan and District South at Namchi (Fig. 1). The ruggedness of the terrain leads to hamleting of communities. Thus, the concept of village is different in Sikkim. These small clusters of houses, often dotted along the hill slopes, are called *Bustis* (Hamlets) and, few *Bustis* collectively constitute a revenue block. Another significant feature with regard to settlement pattern is that the lower hills of the state are thickly populated with diverse economic activities while the high hills are inhabited by transhumant population or Lepchas in lower densities with self contained economies. This uneven distribution has resulted in more concentration of population in the East and South districts and lower concentration in the North district of the State.

CLIMATE AND ECOLOGICAL ZONES

Sikkim exhibits climate ranging from subtropical to alpine at various altitudes. In the foot hills and in the lower valleys up to 700 m almost subtropical conditions prevail. As the altitude rises, temperature decreases. A difference in the rainfall exists even in different areas of same altitude depending on the nearby forest wealth and its composition. Near Gangtok, the annual rainfall is between 375 and 500 cm while at Namchi located at the same altitude, the rainfall is about

200 cm. In higher elevations the climate is temperate and moist. The rainy season starts from May and continues till October. Showers and hail storms occur in later part of May. Though the permanent snowline is above 5000 m, often glaciers descend to 4000 m effecting the overall climate of Sikkim by lowering down the temperature considerably. With uneven topography, as one moves along in the area, from valleys to mountain peaks, the vegetation changes from sal forests to Rhododendrons, Conifers and finally to alpine pastures. Because of the congenial climate, a variety of plants grow wild.

In the light of varied climate exhibited by the State, the region could be broadly divided into four ecological zones namely, lower hills, mid hills, high hills and very high hills (Table 1). This division of the area is just arbitrary and explains the predominant climatic conditions enjoyed by the State. A perusal of the table indicates that wet and dry agriculture is restricted to lower and mid hills. Dzongu zone of north Sikkim which falls under mid hills is seen with slash and burn agriculture. At high hills, the main emphasis was given to pastoral economy supplemented with dry agriculture. Yak, mule and sheep are the common animals reared. There is also difference with regard to crops grown. Thus, at lower and mid hills, rice, wheat and millet are grown while at high hills, maize, barley and seed potato are the main crops. Among the horticultural crops, guava, lime, lemon, ginger and oranges are restricted to lower and mid hills, while high hills are with apple, plum, peach etc.

COMPOSITION OF POPULATION

Within its habitable portions, different social, religious, linguistic and ethnic groups coexist practising different types of agriculture and pastoral activities. The population of Sikkim is 3,16,385 out of which 2,65,301 (84%) are rural and 51,084 (16%) are urban (Census of India, 1981). Lepchas are the aboriginal tribes of the state practising Buddhism and constituting 13% of the total population.

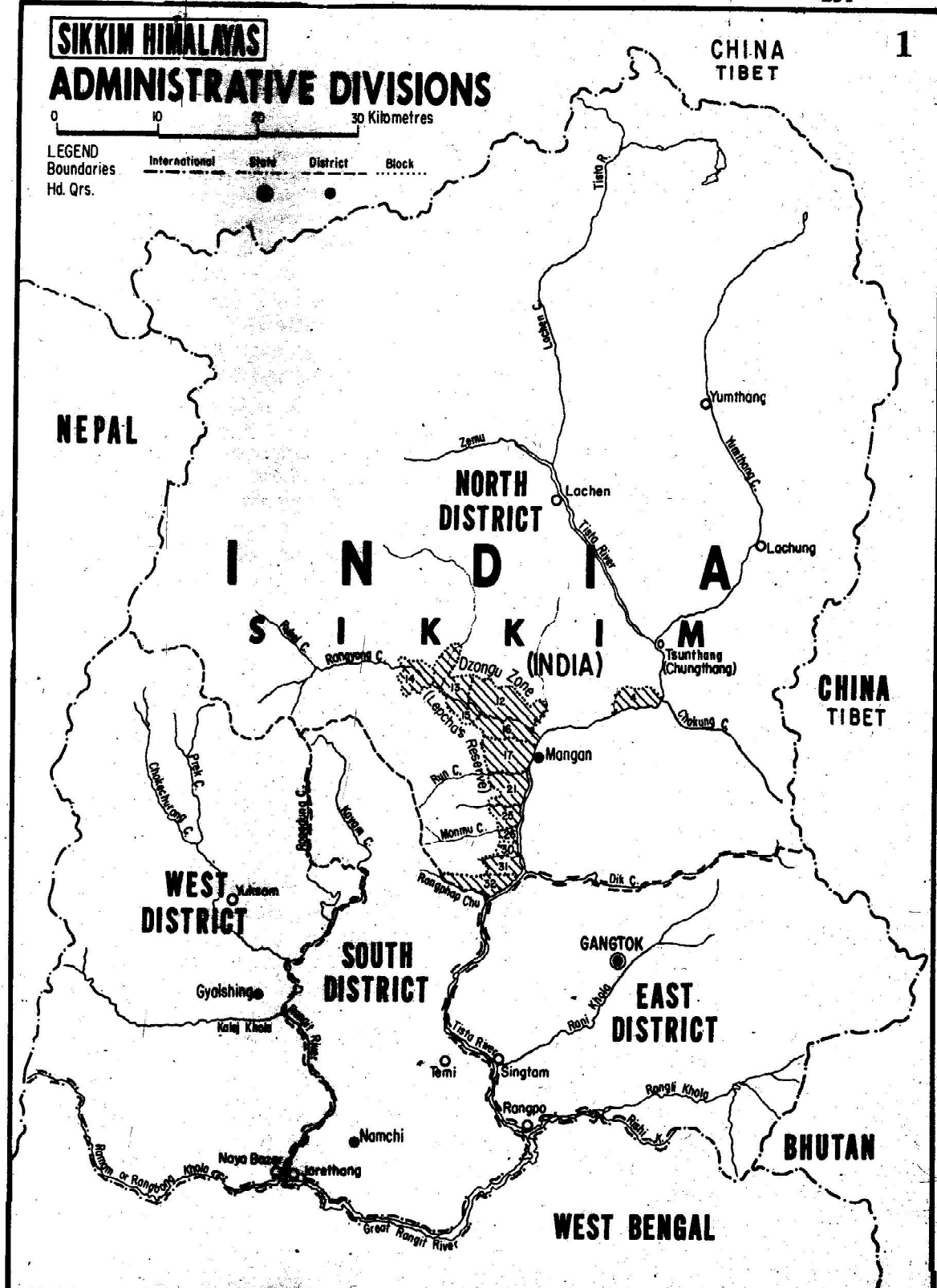


Table 1: Ecological zones in Sikkim State environment and ecological adaptation

Area	Climate	Altitude(m)	Ecological Adaptation	Crops	
				Agricultural	Horticultural
Lower Hills	Tropical	300- 500	Wet and dry agriculture Sedentary farming, live-stock, horticulture	Rice, maize, millet, wheat and mustard, pulses, soyabean, vegetables, potato	Guava, Lime, lemon, ginger, orange
Mid Hills	Sub-tropical Temperate	500-1500 1500-2000	Wet and dry agriculture, Slash and burn agriculture or rotational dry cultivation, hunting and collection of minor forest produce, horticulture	Paddy, maize, millet, wheat, soyabean, potato, vegetables, ginger	Oranges, large cardamum, plum, peach, pear
High Hills	Temperate Sub-Alpine Alpine	2000-2700 2700-4000 4000-5000	Dry agriculture, Bhutias Transhumance, Yak herding, horticulture, pastoral economy, wool, cheese, butter, hides, apple and potato are commercial commodities.	Maize, barley, vegetable, seed potato	Apple, plum, peach, peas
Very High Hills	Alpine	Above 5000	Lachenpa and Lachungpa Transhumant groups visit the area, Lachenpa grow vegetable and potato at higher elevation.	Mainly used for seed potato, vegetables	Pasturage

The Lepchas

The Lepchas are regarded as one of the most primitive tribes than the other ethnic groups of Sikkim. They are hunters and food gatherers besides having traditional agriculture. Majority of the Lepcha population remains in dense forests and remote mountains. The Dzongu area of the North Sikkim was declared as a Lepcha reserve and has remained isolated from other parts of Sikkim. Further, lack of transport facilities and strict restrictions imposed on outsiders helped to maintain the virginity of the area as a Lepcha reserve. A good number of Lepchas practise slash and burn agriculture and grow dry rice, buck-wheat and millet following seven year rotation cycle. Shifting cultivation or primitive sedentary agriculture combined with hunting, fishing and food gathering all characterise Lepcha agricultural complex.

The Bhutias

Bhutias are distributed throughout the State and practise Buddhism. A minor percentage of Bhutias settled in East and South districts do some agriculture. But the Bhutias settled in urban areas have business, particularly liquor shops, in various parts of the State. Bhutias settled in Lachen and Lachung of North Sikkim differ in many ways from the Bhutias living in other parts of the State. They are called Lachenpa and Lachungpa Bhutias. The adaptation of these Bhutias to these high altitude regions is linked to their different life style with regard to cultivation and animal husbandry. The main crops grown in the region include maize, wheat, potatoes while animals like yak, sheep and mules are reared. Bhutias of these regions practise transhumance. It is important to mention at this juncture, that this transhumance phenomenon is restricted to

Bhutias living in this region only while all other Bhutias of the state are sedentary.

Lepchas and Bhutias are Buddhists and are generally devout, though some of them even worship the spirits of the mountains, rivers and forests.

The Nepalese

Presently, 70 per cent of the State population is constituted by Nepalese. They are industrious, thrifty people and excellent settlers. They rose to important positions in business and administration. With the exception of Sherpas and Tamangs, who are Buddhists, the Nepalese are Hindu by religion and have the usual division into castes. Brahmans rank highest in the caste hierarchy and their main occupation is farming and government service. The Chhetris form a majority amongst the influential and wealthy people of Sikkim. Tamangs are very skilled at a number of crafts while Pradhans are shopkeepers, big business men and farmers. Sherpas are small land owners and also rear animals like sheep and mules. They are concentrated exclusively in few pockets of West Sikkim. The Gurungs, Mangar and Kirantis are essentially agriculturists and live evenly in all parts of Sikkim. Five castes namely Kami, Damai, Lohar Sarki and Maji were classified as Scheduled Castes. Bhutias, Lepchas and Sherpas are notified as Scheduled Tribes. Scheduled Castes constitute 6 per cent of the total population while Scheduled Tribes are about 31 per cent (Table 2). The three main languages of the State are Nepali, Bhutia and Lepcha. Hindi is understood by majority of people.

FOREST RESOURCES

The state of Sikkim is rich in forest wealth. Out of a total area of 7299 sq. km. the forests cover 2546 sq. km. i.e., 36 per cent (Fig. 2). The state is endowed with luxuriant vegetation of different types. Forest resources include timber, bamboos, fuel wood, fodder, minor forest pro-

Table 2: Distribution of ethnic groups by religion and language

S. Ethnic Groups No.	Religion	Language	Per cent
1. Lepchas*	Buddhism/ Christianity	Lepcha (Tibeto-Burman)	12.8
2. Bhutias	Buddhism	Bhutia (Tibeto-Burman)	14.1
3. Sherpas	Buddhism	Sherpa (Tibeto-Burman)	3.7
4. Tamangs	Buddhism	Tamang (Tibeto-Burman)	5.0
5. Brahmans	Hinduism	Nepali (Indo-Aryan)	8.4
6. Chhetris	Hinduism	Nepali (Indo-Aryan)	11.6
7. Pradhans (Newar)	Hinduism	Nepali/Newari	3.5
8. Rais	Hinduism	Nepali/Rai	14.5
9. Limboos (Subba)	Hinduism	Nepali/Limbu	9.4
10. Mangars	Hinduism	Nepali/Mangar	2.6
11. Gurungs	Hinduism	Nepali/Gurung	6.1
12. Scheduled castes	Hinduism	Nepali (Indo-Aryan)	5.9
13. Trading communities			2.2

* A few follow Christianity

duce, and other resources like orchids and wildlife. These forests generate good quantities of forest produce which could be utilised optimally for the forest based industries.

FOREST TYPES

Forest vegetation consists of mixed evergreen trees, grasses and bushes. Elevation, geology, rainfall and human activities are important factors that have influenced the characteristics and distribution of natural vegetation. The entire forest area has been divided into six zones (Table 3).

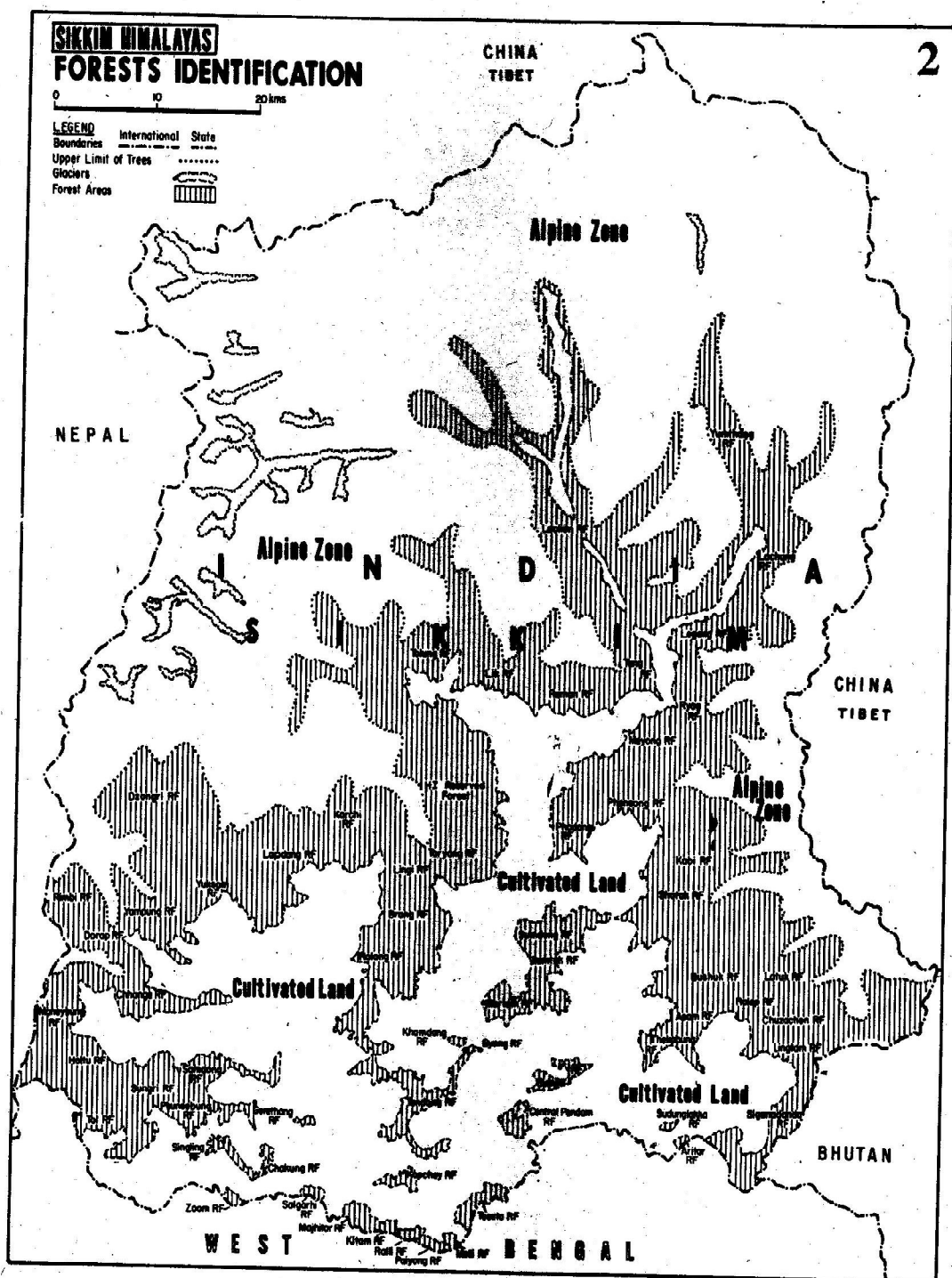


Table 3: The division of forest area

S.No. Forest zone	Elevation (in meters)
1. Lower Hill Forest	-90-1000
2. Middle Hill Forest	-760-1680
3. Upper Hill Forest	-1680-2450
4. Conifer Forest	-2600-2900
5. Rhododendron Forest	-2750-3660
6. Alpine Pastures	above 3660

1. **Lower Hill Forest (90-1000 m)**: This consists of three main types viz., sal forest, dry mixed forest and wet mixed forest.

Sal Forest: These are confined to Tista and Rangit river valleys. Principal trees of these forests are Sal (*Shorea robusta*) Dabdaba (*Garuga pinnata*), Pakasaj (*Terminalia crenulata*) Burra (*Terminalis chebula*) and Chilouni (*Schima wallichii*). In Rangit valley Chirpine (*Pinus longifolia*) also occur along with *Shorea robusta*.

Dry Mixed Forest: This type is mainly deciduous and occurs on ridges and drier slopes. Sal occurs as isolated species. Common species are 'Chilouni', 'Dabdabe' and 'Gomari' (*Gmelina arborea*).

Wet Mixed Forest: These are evergreen valley forests and prevail on damper soils on the north and north eastern parts of the state between Dikchu and Singhik and subsidiary valleys of Talung, Rangrang and Dikchu. The common species in this zone is Jamun (*Eugenia operculata*). Undergrowth consists of evergreen herbs and shrubs among which members of *Rubiaceae* predominate. Tamabans (*Dendrocalamus hamiltonii*) and Pheling (*Pseudostachyum polymorphum*) are of economic value and occur in extensive areas.

2. **Middle Hill Forest (760-1680 m)**: Principal species of this type of forest are Musre katus (*Castanopsis tribuloides*), Dalma katus (*C. indica*), Mewa (*Engelhardtia sp.*) are common.

In the undergrowth, Jhingni (*Eurya japonica*), Kharane (*Symplocos theaeifolia*) occur.

3. **Upper Hill Forest (1680-2450 m)**: This type occupies between 1520 and 1830 m. Species like Mewa, Rani Champ (*Michelia excelsa*). Between 1830 and 2130 m, species like Champ (*M. cathartii*), Musre katus and *Quercus* spp. occur.

4. **Conifer Forest (2600-2900 m)**: The presence of conifer forests depend upon the incidence of the precipitation. The plants in this zone include *Tsuga brunoniana*, *Podocarpus nerifolia*, *Larix griffithii* and *Pinus longifolia*, *Picea morindoides*, *Juniperus recurva*, *Abies densa* and *Taxus buccata*.

5. **Rhododendron Forest (2750-3600 m)**: These are dominated by various species of Rhododendrons. The oak species occur include *Quercus lamellosa*, *Q. pachyphylla* and *Acer campbelli*.

6. **Alpine Pastures (Above 3660 m)**: Alpine pastures consist of dwarf Juniperus and Rhododendrons and extensive meadows with *Deschampsia caespitosa*, *Salix* spp. etc.

FARM PRACTICES AND CLIMATE OF THE STATE

Agriculture is the mainstay of people. About 90 per cent of the total population depend on it. The total cultivated area is 79062 ha. Though total cultivated area is small, the agroclimatic situation vary greatly due to variation in elevation, topography and climate. The agricultural lands are situated at altitudes ranging from 300 m to as high as 3300 m. But majority of the land holdings are located below 2000 m altitude. The rainfall varies from 150 cm to 350 cm per annum and confined to six months. May to October could be considered rainy season. Farming in hills is in many ways different from that on the plains. The existing land use pattern in Sikkim

has been result of mixture of traditional evolution and adaptation of new methods gained through developmental agencies. Different agro climatic zones of the state are given in Fig. 3.

Land Use

Topographical features of the state restrict the maximum land use. The rugged harsh climate limits agriculture. The existing land use pattern for various altitudes are already detailed in Table 1. A perusal of the land use data indicates that only 880 sq. km. of the area is under cultivation compared to the total area of 7299 sq. km.

Data relating to land use in agriculture is given in comparison to the other uses such as settlements, forests etc. (Table 4; Fig. 5).

Table 4: Land use details of Sikkim Himalayas

S.No.	Type of Land	Area (in sq.km.)
1.	Total area of Sikkim	7299
2.	Area under forest	2650
3.	Area under snow and alpine pasture	2856
4.	Area under cultivation	880
5.	Area under terrains and others	999

Further break-up of the total agricultural land could be classified as given in Table 5.

Table 5: Land under agriculture use

S.No.	Type of Land	000 (hectares)	Per cent
1.	Net area sown	64.93	82.12
2.	Area under current fallow	0.50	0.63
3.	Total uncultivated land	7.02	8.89
4.	Land not available for cultivation within operational holdings	6.61	8.36
Total		79.06	100.00

Agricultural Holdings

There are about 31,061 agricultural holdings in Sikkim. Nearly 60 per cent of the holdings are small, having less than 2 ha. The average size of an agricultural holding is 2.35 ha. It includes residential construction, piggery enclosure, cattle-shed etc. Crescent shaped narrow terraces of 2.5 to 3.5 m wide 4.5 to 7.5 m long across the steep mountain slopes constitute the agricultural land holdings. A portion of land with gradient less than 15 to 20 per cent of total area is left untterraced. The terraces are levelled having 2 to 3 per cent gradient from end to end length-wise and are put up with small bunds of 15 to 20 cm high and about 30 cm wide all along the outer margins. Irrigation cum drainage channels run across the terraces at 30 to 60 m interval and the channel embankments often serve as farm boundary.

Cropping Practices

Monocropping and double cropping are the cropping practices. The altitude as well as the temperature very much influence the crop season. This is indicated by the fact that crop season is confined to summer months only at higher elevations while extended to *Kharif* and *Rabi* in low hills. Each holding has a minimum of one pair of bullocks and the fields are ploughed with country plough. All the other preparatory and intercultural operations are carried out manually with spades and hand forks. Each holding depends mostly on family labour and hence the intensity of cropping and the yield level of holdings depend mainly on the man power potential of respective holdings.

Crops and The Cropping System

Various crops grown in different seasons as *Kharif* and *Rabi* are given in Table 6.

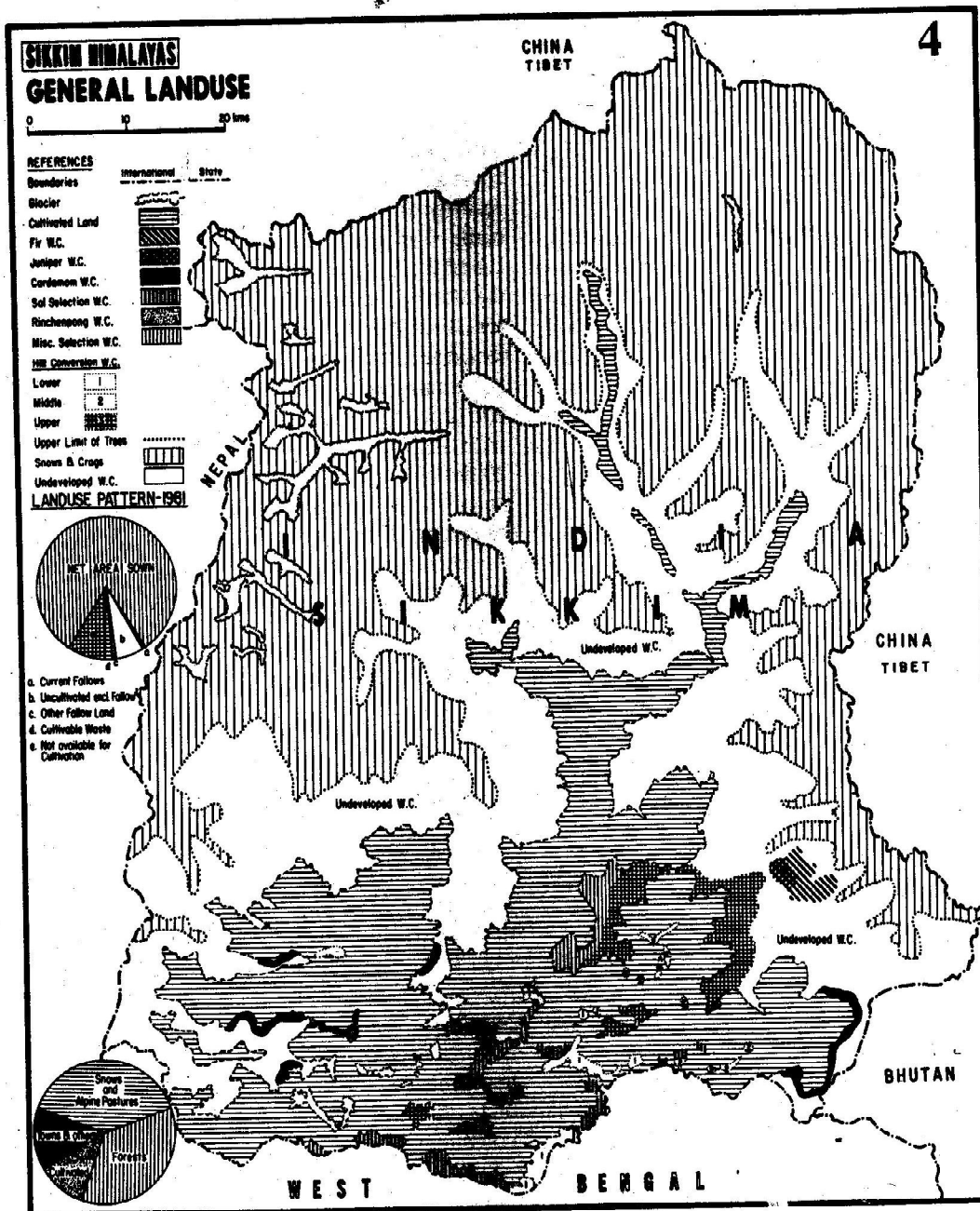


Table 6: Various crops grown in Sikkim Himalayas

<i>S. Kharif Season</i> No.	<i>Rabi Season</i>
1. Maize + Pulse Crops	Finger millet/mustard
2. Rice	Wheat/fodder oats
3. Vegetable plots <i>Bhindi (Lady finger),</i> <i>Brinjal, Raddish</i>	<i>Peas, Beans, Rai</i> <i>(Green leaves)</i>
<i>Cucurbits and Gourds</i>	<i>Potato, Cabbage etc.</i>
4. Fodder Plots <i>Maize+Cowpea Maize+</i> <i>Soya bean</i>	Fodder Oats

Inception of Agriculture Department

The Department of Agriculture and Animal Husbandry came into existence in the year 1954, with the initiation of Sikkim's seven year plan. The first five years provided the department with opportunities to lay foundation and to shape up the future. In the later years, the Department has striven its obligation to encounter the State's most serious problem of food crisis. Since late sixties, the department initiated distribution of seeds, seedlings and improved local breeds of livestock among farmers. Establishment of many nurseries, orchards and livestock farms has also taken place. Because of the variety of agroclimatic situation in Sikkim, the Department of Agriculture has divided the State into nine regions with five sub-regions. Each region has a regional centre with farm area varying from 8 to 20 ha. These centres form focal point for undertaking adaptive trials. Seed multiplication and extension works were taken care of by these centers.

Rice: Rice is the principal crop grown extensively from altitude ranging from 300 to 1700 m. State has a total area of about 12,500 ha under rice cultivation and an annual total production of about 0.20 lakh (10 lakhs equal to 1 million) tonnes. Most of the varieties grown are low yielding, late in maturity, very tall and susceptible to lodging and responsive to fertilisers. Out of these

'Bhuindhan', 'Thapachini', and 'Lana' are the important directly sown varieties. 'Atley', 'Chirakey', 'Basmithi', 'Krishna', 'Thulasi', 'Poudyal' are transplanted varieties adapted to areas below 1200 m elevation and 'Phodongey', 'Tapray' and 'Darmali' are transplanted varieties adopted to the area between 1200 and 1700m.

The present efforts of these center include:

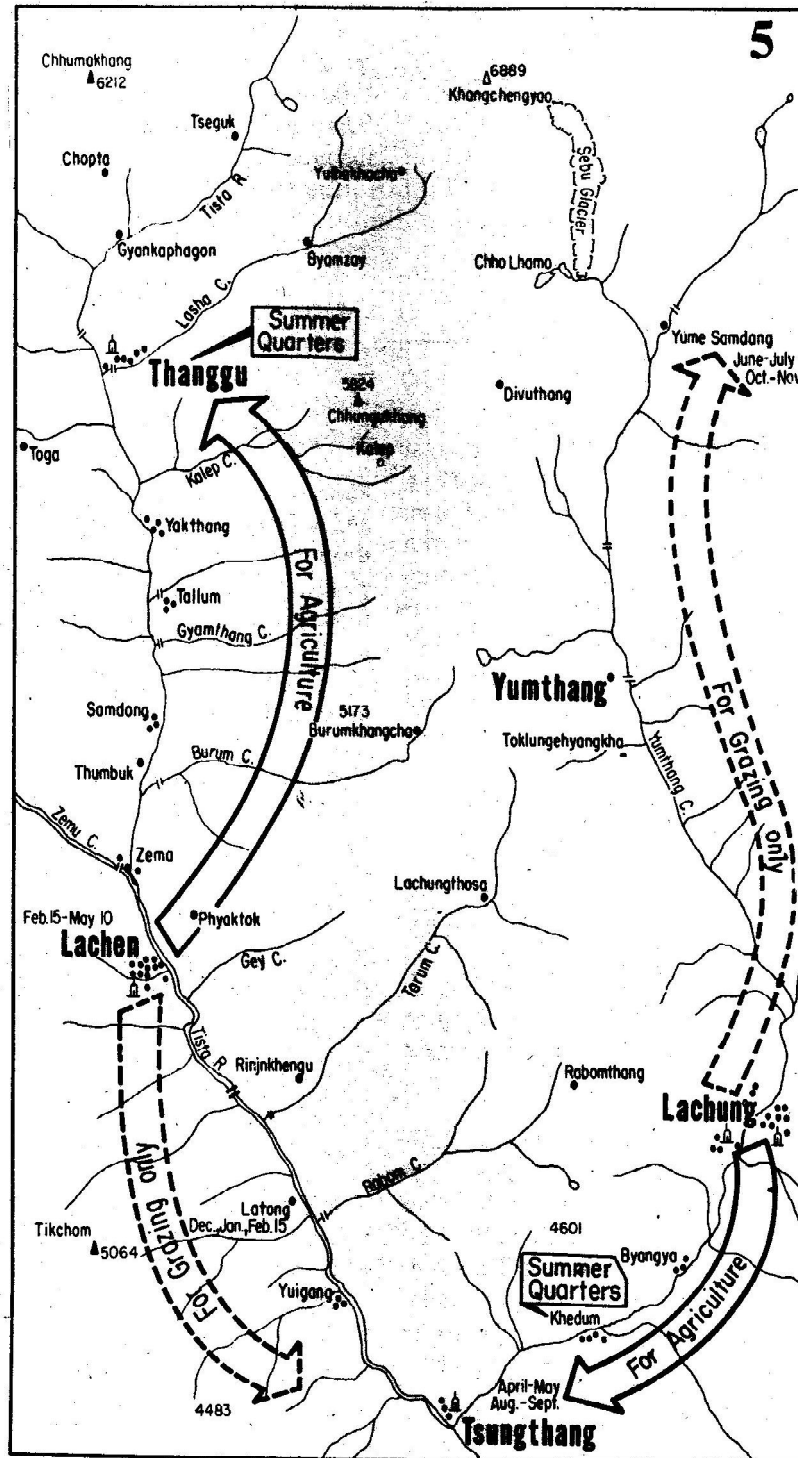
- to find out a better variety than Pusa 33 for the area located below 920 m.
- to screen out a suitable variety for the area situated between 920 and 1300 m elevation.
- to find out a variety suitable for the area situated above 1300 m elevation.
- to identify suitable varieties for direct sowing.

Maize: About 90 per cent of the total population and households of Sikkim depend on maize cultivation for their living. Maize occupies the largest area and hence it is the most important staple food. It is cultivated in altitudes ranging from 300 to 2500 m. Among the high yielding varieties, Vijay composite has been found promising for lower and mid hills. However, in some places local varieties have given better results than Vijay. Farm practices for this crop are very much similar to the practices observed for maize in plains. Many investigations are carried to understand the effect of sowing date on grain yield in regional research stations.

Wheat: Wheat occupies an important portion in the cereal map and ranks third both in production and area in the state. The area under wheat as per the 1979-80 Census is 7650 ha. Farm practice of this crop is very much similar to that of practised in plains. The following points with regard to wheat crop are mentionable:

- It was a highly successful crop in East and West districts of the State.
- Encouraging results obtained for the sonalika variety in the State upto 2200 m altitude.
- Successive adaptive trials were taken up at various parts of the State.

LACHEN LACHUNG - Transhumance Pattern



Under All India Coordinated Wheat Improvement Project, the whole country is divided into different zones. Sikkim falls under Far Eastern zone. Though the recommended varieties include 'Sonalika', 'Kalyan Sona', 'Janak', and 'UP 115', Sonalika is only popular in Sikkim. This is a short duration variety and was introduced in 1975-76. Since then its coverage in terms of acreage has increased tremendously and is now widely adapted. Regarding the date of sowing, many experiments were conducted in Regional Research Stations particularly at Mangan and the optimum date was decided as second week of October. Land is seen well drained before cultivation. Two to three ploughings are done followed by planting. Fertiliser is applied depending on the availability. Seeds are sown at the rate of 100 kg ha⁻¹ giving a rowing space of about 20 cm and at a depth of 4 cm. Weeding is manually done in the fields which often include *Chenopodium* sp., *Crispum arvensis*, *Convolvulus* sp. and *Cyperus rotundus*. Grossy weeds include *Setaria* and *Avena* sp. Crop comes to harvest in three to three and half months. Conventional methods are followed for thrashing to separate the grain from the plant. Sun drying is made to reduce the moisture content and it comes to about 10 per cent before storage. Storage is made in the traditional bamboo bins or gunny bags or aluminium boxes, which have capacity of one or two tonnes. This stored grain is used for *Thumba* preparation. Milling is done in stone grinders, rarely operated through water mills, called "Chakkis" to get flour which is used in the preparation of *Roti* (bread) and other food items.

Kodo Millet (*Paspalum scrobiculatum*): This is another important crop grown in this region. Because of its multiple use, this has become their essential requirement in their daily routine. It is a rainfed crop and grown for both grain and forage. Grain is used for preparation of 'Chang', a kind of beer brewed by the majority of people in Sikkim. Sometimes it is also used for distillation into country liquor. Its grains being

coarse, are occasionally grounded for use as *Roti* (bread) or *Champa* (flour). The average yield runs to 800 kg. A trial is conducted recently to improve the yield at regional sub-centre, Samdang (Dzongu) under rain-fed condition with an objective to screen out better variety than the existing ones. Various varieties were tested and the experimental data reveal that 'PR 202' gave the highest yield followed by 'HBP T-6.' 'PR 202' is recommended in Dzongu zone for cultivation in preference to other varieties.

Cardamum: The large cardamum is the cash crop in this region. The commonly cultivated varieties are of Ramsey, Sawaney and Golsey.

It is grown as pure crop under shady trees on hill slopes. Out of the total area cultivated in Sikkim (11, 204 ha), 61.2 per cent is located in North Sikkim and from this, major part is from Dzongu zone. Planting materials are obtained either by rising seedlings in nurseries or by separating rhizomes from clumps of large plants. Planting time is May-June. Three clearings of plantations are generally done annually for removing weeds, weak and unproductive shoots, diseased clumps etc. Harvesting starts from August and continues up to November. Fruits, after separating from harvested panicles are cured on kiln.

The crop prefers plentiful and well distributed rainfall, generally above 200 cm per annum and at an altitude range between 600 and 1800 m. Dzongu falls in this range and provides a good situation to this crop. Though soils here are considered acidic, the plant thrives well and yields satisfactorily. Farmers are aware of the cultural practice of this crop and take care of the crop at every step with great precision. Propagation is carried out by two methods:

- (i) raising seedlings from seeds in nurseries and transplanting them.
- (ii) separating rhizomes from a clump of large growing plant and planting the individual rhizomes as separate plants.

The second method is more common in practice. Such planting materials are observed carrying viral diseases and reduce the life of plantation as well as productivity. It is therefore emphasized by the Government through VDO's (Village Development Officers) to raise healthy planting materials from seeds in order to check the spread of viral diseases in cardamum. The area selected for new plantation is prepared under the shade of trees. The trees generally occur in cardamum plantations are 'Uti' (*Alnus nepalensis*) 'Saur' (*Betula* sp.), Chilauni (*Schima wallichii*), Panisaj (*Terminalia myriocarpa*), Pipil (*Bucklandia populnea*) etc. The planted seedlings are transplanted in pits in the months of May and June. The spacing followed is 150 X 150 cm. The vegetatively propagated plantations start flowering and fruiting after three years where as transplanted planting materials come to fruiting after four to five years. Weeding from time to time, proper maintenance of shade and filling of gaps are the only operations up to first flowering stage. After flowering, special attention was given to clearing of base of the flowering clumps. Flowering starts from April to May and continues up to June-July. Clearing and cleanings are done periodically. This is meant to maintain proper shade, prevention of damage to flower buds and fruits and for the healthy growth of new shoots. Though farmers are not aware of all the benefits accrued out of it, they do it out of routine. The harvesting of fruits commences from August and continues till November. The fruits have to be harvested by cutting peduncles and taking out whole panicles. The operation is done with the help of locally made chisel shaped knives. The panicles containing ripe fruits are carried to the temporary shade at drying place for separating fruits out of the panicles and subsequent drying and curing. The fresh fruits are dried on kiln, constructed by farmers in the plantation itself. A kiln consists of stone walls plastered with mud, an opening for putting firewood and a bamboo platform on top. Generally the size of such kiln is 2.0-2.5 m wide, 2.5 to 3.0 m long and 1.5 to 2.0 m high. The fresh capsules are

spread on the bamboo structure, and fresh cut wood is burnt underneath to provide smoke and fire for drying of the cardamum. Usually it takes three days of continuous smoking to complete drying. The fruits lose about 65 to 70 per cent of its fresh weight during drying and by this crude method of processing, farmers obtain low quality dried capsules. As such, there is demand from farmers' side to provide an improved kind of kiln to obtain better quality of processed capsules.

Simul Tarul (Manihot esculentus): This is cultivated in many regions of Dzongu zone. Plant is herbaceous, with elongated tuberous roots. The tuber rich in starch is eaten as such. It can also be commercially exploited to obtain starch, sago and flour. It is one of the most important crops of this region after cardamum. Cultivation starts during the month of March with the soil being treated with cowdung and other available manures. Afterwards ploughing is done and bigger stones and unpulverised soil is hand picked and thrown out. The older parts of the stem are sown keeping a distance of about one and half meter from plant to plant. For two months, i.e., until June, these older stems do not show any growth, but during June, they sprout out and in a month grow to a size of one meter. During August, when the plant is about to produce tubers, the basal part of the plant is covered with soil from the surrounding area so to see that the growing tubers do not come out of the soil. If the plant base is not properly covered with soil, the tubers produced will be smaller in size, thus effecting the production. Tuber grow to a maximum size in the month of December. From December onwards till January, these tubers are removed and used for various purposes. The vegetative parts are eaten by pigs and some older parts are stored to sow them again in the next growing season. There are two varieties in this species and these produce red and white tubers. These two kinds are used for different purposes. A local drink called 'Tumba' is prepared from these tubers.

Seed Potato: Seed potato production is the most important occupation of the farmers who live at higher altitudes. Out of total area of 2025 ha under potato, the area under seed potato production is about 1220 ha. The average yield of seed crop stands at 80 quintals per ha. Rabdi, Bhaseng, Okery, Saprinagi (West district) Lachung, Lachen, Thangu (North district) Rabangla (South district) and Padainchen (East district) are the main seed potato production areas in the State. These areas present favourable environmental conditions like low temperature, good exposure, high wind velocity. Till mid seventies 'Aukerseggen', 'Ultimus' and 'Pimpernel' were the prominent varieties. These varieties thrived well in almost all acidic soils. Preparation of field includes planting before the snow, two ploughings and plankings after snow and application of farm yard manure for improving the soil texture. The optimum date for planting of potato is 15th of February. For Lachen and Lachung it is during March. For 40-50 gm seed size, the optimum spacing of 60 cm row to row and 20 cm tuber to tuber was found to give best results.

PROBLEMS AND STRATEGIES FOR DEVELOPMENT

Trees are put to a variety of uses, by various population groups inhabiting the area. Besides, there is a bewildering degree of admixture of herbs and shrubs which are used for specific purposes. During the intensively conducted fieldworks, information on various plant species used for various purposes has been recorded. Plants in these surroundings provided them with shelter, food and medicines. Among the collections of the plants, depending on the economic use, they are grouped under separate headings. Thus six groups of plants were identified (Venu et al., 1990). Some of these plants are used in a limited scale while the other were exploited maximum because of inherent irregularities. Also, some of these plants are used by specific population groups. There are many problems associ-

ated with management of the forests.

State owned forests are divided in three categories, viz., 1. Reserve forests, 2. *Gorucharan* (Communally owned) forests, and 3. *Khas* (Communal) forests. Besides, there are two minor kinds of reserves, viz., 1. Slip reserves 2. Road reserves. Privately owned forest are three types and (1) *Kazis* (Hereditary Ministers during Monarchial rule) (2) Gompas and (3) the Royal family. For proper administration of the forests, the State is divided into five ranges. Northern range has headquarters at Mangan while eastern range with Pakyong. Gyalshing is the headquarters for North western range while Namchi, the headquarters for South-west range. For Gangtok range, the headquarter is located at Gangtok itself. Each range is divided by blocks. Thus western range (South) consists of fifty one blocks while western range (North) has four blocks. Eastern range is with thirty four blocks while Northern range is with nineteen blocks. The following are the problems associated with forests:

Information on Forest Resources: For proper management of forest resources, a strong statistical base is absolutely necessary. Sikkim harbours about 30% of the forest cover in its total land area and goes with National Forest Policy. Satellite and aerial photography data are necessary to ascertain these facts.

Marking System: The common noticeable damage is owing to illicit felling of trees particularly near all habitations of the state. The marking system has become ineffective. This has resulted in many instances of overfelling and illicit cutting.

Demarcation of Gorucharan and Khas Lands: State owned forests are divided into five categories, viz., (a) Reserve forests (b) *Gorucharan* forests (c) *Khas* forests (d) Slip and (e) Road reserves. Large scale encroachment on *Gorucharan* and *Khas* forests has taken place. Lack of proper demarcation of these areas from other lands has caused considerable damage.

Fire: Fire is an annual feature of the foot hills up to 1500 m and extends to higher altitudes rarely. It may be due to careless burning of fields, or leaving camp fires by tourists or by natural processes.

Wastage in Wood Processing: There is a great deal of "waste" at all stages of production and utilisation and reduction of "Waste" is a must to cope with the shortage of forest products. It requires modern logging techniques for felling and logging of trees.

Grazing: Cattle grazing is heavy in accessible areas. In the lower altitude regions such as Rangpul, Singtam and Rangpo towns, heavy grazing by cattle hardly left any undergrowth. Cattle grazing in reserve forests with no control has adversely affected the natural regeneration of forests of Lachen and Lachung areas.

Land Slips: Because of heavy deforestation near habitable areas land slips are a common feature near many villages

Conversion of Forest Lands: Intensive cropping with cut or faulty terracing in the hill slopes also aggravated the situation in many localities of East Sikkim. At very high altitudes in Dzongu, *Jhumming* is still practised resulting in the heavy land slips to the down Tista basin.

Other Miscellaneous Problems: In road reserves, near Mangan and Singik in North Sikkim and Rabangla and Temi-Tarku of South Sikkim, people lop heavily 'Pipli' and 'Toon' for fodder. Theft and illicit removal of forest trees (particularly costly woods) is to be brought under control immediately. Very poor on-road and off-road transport system in this region resulted in the inability to make full utilisation of the high altitude coniferous forests seen in Zongri, Bakhim of West Sikkim. In foot hills of Sikkim, many tropical trees are found but only species like *Shorea robusta* and *Alnus nepalensis* are exploited. With developing science and technology,

secondary timber species can be made to replace the principal timbers in a variety of uses.

Correction Measures: Improvement of on-road and off-road transport is imperative in the proper management of entire ecosystem.

—The area is recorded to have sixteen bamboo species and the Forest Department should establish a bamboo arboratum as a germ plasm bank.

—Orchid flora which is abundant in Sikkim up to 1500 m is to be exploited commercially. Though there are few nurseries in the State, many are developing exotic spices in their trade instead of concentrating on the native species.

—Agroforestry is one of the established and time honoured systems in the management of forest land. This practice should be improved in East district of State as the pressure for food and wood is on increase.

—Juniperus plantations are to be established to offset increasing cutting of trees for pencil industry.

—The planting of soil binding species such as *Agave* species is to be encouraged to control land slides which occurs during and after rains.

—*Phyllostachys* sp., *Bambusa* sp., and *Arundinaria* sp. are to be encouraged as part of garden plantations as they would substitute for many daily requirements of the population.

—Adequate staff is required in the management of State forests. A department, teaching forestry, is essential to meet the staff requirement and also make people aware of the importance of forestry.

—Detailed survey of the flora of the region has enabled us to identify various groups of plants in relation to their ethnobotanical importance. A programme of Social forestry in designated areas should be initiated to meet the needs of daily requirements of the populations. Social forestry programmes should be in the following lines:

(a) Around 30 new medicinal plants are col-

lected and identified. Besides, there are many more known medicinal plants growing in this region. Possibility of cultivation of these economically important plants is to be investigated.

(b) Fodder is always scarce in Sikkim Himalayas. Naturally growing grasses and some fodder yielding trees like *Leucaena leucocephala* and *Ficus cunia* are to be planted in large scale to meet the growing demands.

(c) Firewood has become a scarce commodity. Valuable species like *Alnus nepalensis*, *Shorea robusta* and *Castanopsis* species are being used for firewood purposes. But energy plantations like *Salix* and *Populus* are of greater use as firewood plantations. Large scale plantations of these species would be helpful in the firewood demands.

(d) Around 20 plant species are identified as wild food plants of the region. Organised cultivation of these plants form a potential replacement in the food scarcity of many population groups.

(e) In the replacement of Energy plantations, the pressure on *Alnus* species, *Castanopsis* and *Juglans* for firewood would be released. A long term programme basing on continued sustenance would enhance the profitability on forest resource.

(f) Dye yielding plants, such as *Rumex nepalensis*, *Juglans regia* and *Rubia cordifolia* be planted and their cultivation is to be encouraged to supply the dye material to the carpet industry in Sikkim.

(g) Systematic study of this region also revealed crucial nature of few plants particularly genera like *Dendrobium* and few *Rhododendron* species on the verge of extinction. Though few plant species are suggested as endangered species, a more detailed survey would help in the status of these plant species and also the need of urgency in their care.

AGRICULTURE

Though agriculture is one of the important sources of income, it remains as a way of living

rather than commercial proposition for multiple reasons. Different groups of populations have varied dependence on forests to supplement the income from agriculture. Bhutias of Lachen and Lachung practice transhumance and utilise grazing grounds at higher elevations for rearing sheep and yaks. Through this activity, main emphasis is given to pastoral activities and agriculture is secondary. Transhumance is an highly evolved practice and an integral part of their life cycle. This is a sound ecological method by which resources are exploited optimum simultaneously avoiding the adverse weather conditions. Two types of transhumance were recorded in Sikkim, the Lachenpa transhumance is practised by Bhutias of Lachen while the Lachungpa transhumance was observed by Bhutias of Lachung. Migratory routes and period stay vary in both these types of transhumance (Fig. 5).

Agriculture advancement is low because of some inherent handicaps associated with hilly region.

- Agricultural holdings are small in size and not profitable.
- Slopes are so steep and the productive top soil with applied manures often wash away every year.
- Majority of the soils have a pH between 5.0 and 6.0 which make it necessary to correct it for increasing productivity of lands.
- Sikkim's climatological conditions provide high humidity to the atmosphere and this favours proliferation of diseases and pests. This calls for adequate plant protection measures in the State. Most of the diseases prevailing in the State are not identified.
- Poor transport and communication pose a big problem because of which not only timely availability of agricultural inputs is affected but also make it impossible for the farmers to transport their produce for marketing.
- Use of improved and time saving implements are to be introduced in the agricultural practices, though complete mechanisation cannot be achieved in hilly terrain.
- There is no uniformity in the use of fertilisers

- and pesticides throughout Sikkim. Excessive use of these inputs in East Sikkim is resulting in leaching into Tista river. Contrary to the conditions in East Sikkim, other parts of State generally use low levels of fertilisers. This is due to non-availability and high costs.
- Many high yielding and short duration varieties have been identified by agricultural farms depending on the region, but unfortunately, a good number of farmers are less willing to adopt these strains. Perhaps, demonstration farm and educating through films will be of some help in introduction of these varieties.
 - With regard to rice, most of the varieties are low yielding, late in maturity, very tall and susceptible to lodging. The efforts are on way to bring adaptive varieties to various regions of the State.
 - Though *kodo* millet constitute as one of the principal staple foods in older times, yet no efforts were made to replace or improve the traditional varieties.
 - In the processing of cardamum the fruits are dried in a traditional kiln and get poor skin colour and low quality. As such, there is demand from farmers side to provide an improved kind of kiln to obtain better quality of processed capsule.

In the foregoing account, problems associated with forests and agriculture are detailed. Besides, possible solution for these problems are also suggested. At this juncture, it is worth noting that many of the problems associated with various ecological zones are different due to ranging climatological conditions, forest types and different types of crops grown. Besides, different population groups differ in their economic activities. Thus Lepchas of Dzongu have a distinct economic activity when compared with that of transhumant population of Lachen and Lachung or Nepali populations of East Sikkim. In the east and south Sikkim, agricultural activity with regard to field crops is intensive. West Sikkim, which has drier climate grows mandarine orchards extensively. In the habitable portions

of North Sikkim, higher altitude and favourable ecological conditions large cardamum plantations along with apple orchards and potato cultivation dominate the agriculture scenario. The tasks of development agencies/extension units are not uniform and to be viewed in the light of various identified ecological zones and at a second stage, on the composition of various ethnic groups inhabiting the area. It is also imperative to identify the skills of these populations groups and their economic activities in relation to resources availability. Only in this light, all developmental programmes initiated by these agencies are adapted with full success and contribute significantly for both the economic upliftment of the people and sustainable development of the region.

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