LIVESTOCK ECONOMICS AND ITS IMPACT ON THE ENVIRONMENT OF NORTH SIKKIM

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is a bonafide study of the author to the best of my knowledge and belief. This study may now be placed before the examiners for evaluation.

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CHAPTER I

INTRODUCTION

1.1 THE PROBLEM

Physical environment and human economic pursuits have always been found to be very intensely and closely knit together entities in the history of human kind down the ages. In the historical process of evolution of a social and economic order, domestication of animals as one of the avenues of human economic sustenance gradually gained momentum which at later stages played an important role as a major economic enterprise. In the process, many such growing human economic pursuits by dangerously encroching upon the natural ecosystem have caused eco-degradation to an amazingly high proportion.

In the persent day world economy, the significance of domestic animals termed as livestocks is thus enormous. The physical environment of certain parts of the earth has been so congenial/suitable for certain animals that the commercial rearing of those animals has been proved to be highly successful thereby significantly adding to the national income. Thanks to the modern technology which has of late entered into the livestock farming and has revolutionised the production process. In countries like Australia, New Zealand and the Netherlands etc. livestock farming is supposed to be highly mechanised and thus the level of productivity has reached par excellence in these countries. On the other hand the worlds celebrated grasslands such as the praries and the pampas etc. have come up with highly developed livestock farming.

It is in this perspective that livestock rearing and the production mechanism all the world over have a direct impact on the overall micro environment of the area concerned. Besides, there is a striking difference between the livestock rearing in the hills and plains. In addition to the traditional varieties of livestocks adapted to a particular type of environment there is a concious transfer of animals from one place to another in a commercial venture.

In this age of acute environmental crisis livestock rearing in commercial scale particularly in the hills has become a matter of concern for the planners and policy makers in view of the fact that overgrazing in the hill slopes has always posed serious threats to the fragile mountain ecosystem in an atmosphere of unorganised and unscientific planning. Therefore overgrazing coupled with other human interferences in the hills have quickened the process of environmental deterioration thereby causing unwarranted hardship to the inhabitants of both the hills and the plains. Introduction of modern technology in livestock farming and crop husbandry has also added to the environmental problems. Under the expansion programmes of the livestock farming, fresh lands are being brought in on the hill slopes , livestock slaughter on commercial scales are also coming up. Due to various infrastructural development programmes for commercial livestock farming, the hill environment is being seriously affected. However, in view of the favourable geographical conditions for the growth of specific kinds of livestock for commercial farming in the hills, the prospect of commercial farming is always brighter with scientifically organised management system. There is hardly any doubt about it.

Like the other areas of the world India has tremendous prospect of livestock raising in its different parts particularly in the cooler hills of the Himalayas. The hill states in the Himalayas particularly posses tremendous scope and appropriate conditions for commercial livestock farming. Moreover, the highlanders in the Himalayas have a traditional pastoral economy which has been handed over from generation to generation with their typical kinds of livestocks such as yaks, sheep and goats etc.

Keeping the above discourse in view the present study is a modest attempt to highlight the livestock economics and its impact on the environment of North Sikkim i.e. the northern part of Sikkim state which is a formidable mountainous territory and forms a significant part of the Eastern Himalayas. Prior to going in to further details of the study it will be meaningful to discuss in a nutshell the present state of environmental conditions in the Himalayas and their influence on the adjacent plains of the country.

1.2 Himalayan Environment.

The Himalayas exercise a great influence on the environment and economy of the people inhabiting the greater part of northern India constituting mainly the Indo-Gangetic and Bramhaputra plains. This vast mountain range acts as a formidable natural barrier and particularly prevents the monsoon winds crossing over to Tibet (China). It acts as an obstacle for free migration of flora and fauna and over and above the human culture (Khoshoo, 1992).

The mountainous tract and the sediment areas of the Himalayas constitute 16.13 percent (5,23,00 sq.km) and

22.26 percent (720,000 sq.km) of the total land surface of India respetively. Thus the grand total of the Himalayan region is, 1249,000 sq.km. which accounts for 38.4 percent of the total land surface of India, The Himalayas and its sediment areas suport 450 millon people i.e. half the country's population. Almost 50 percent of India's power requirement is met by over 100 dams built across the Himalayan rivers and in addition these rivers irrigate millions of hectares of cultivable land. Today there is wide spread deterioration of the Himalayan environment caused by rapid deforestation, over grazing of the natural grasslands, indiscriminate felling and cultivation of the steep hill slopes.

The environment and economic damage caused by the rivers of the Himalaya is quite catastrophic. On an average flood caused by Himalayan rives affects as much as 8 million hectares of cropped land in the plains, besides heavy sedimentation of reservoirs down stream. For many years there has been national concern about the wide spread deterioration of the environment leading to economic hardship of the people of the Himalayas. The condition and the trends of Himalayan environment notably forest, soil, water resources, geology and overall economy have been decumented by numerous authors and institutions such as Dhar and Kaul (1987) ICAR (1978), Murthy(1981), Jhingran (1981), Pal and Sah (1987), Zobel (1987), Guleria (1987), Rodger (1990), Ramakrishna (1990,1992), Swaminathan (1992), Menon(1992), Valdia (1992), Purohit (1992), Kharkwal (1993), Mani (1994), Sharma (1994) and many others.

More recently an outstanding review of the above problems concerning the conservation of terrestrial resources

in the Himalayan region which are mainly of geophysical (Land, water) and biological (people, livestock, flora and fauna) in nature has been taken up by the G.B.Pant Institute of Himalayan Environment and Development(1992). The institute has formulated an action plan for conservation of the Himalayas.

However, the geologists now consider that the Himalayas are the earths youngest mountain range that has been built up almost 60 million years ago. The floating Indian subcontinent is said to have smashed into the Asian land mass causing explosive earthquakes and this crash in the process triggered a chain of geological events that have pushed up the Himalayas and therefore this youthful Himalaya is tectonically in a restless state even today.

Tista is one of the main rivers flowing from Sikkim Himalays to the plains of West Bengal and Bangla Desh.The river originates from North Sikkim where the third higest peak (Kanchenjunga 8598m.) of the world is located. The entire North Sikkim is the catchment of river Tista. Hence any disturbance in the Sikkim Himalayas would have catastropic effect in the plains of Bengla Desh and West Bengal (Fig.1). In order to better understand and effectively manage the fragile mountain ecosystem in North Sikkim there should be concerted effort to check erosion caused by the disturbance of the sub-surface soil by achieving zero cultivation or resorting to grassland farming with grass and legume combination.

As the aim and objective of the present study is to evaluate the crop and livestock farming at different altitudes of North Sikkim where the farmers have been rearing livestocks

for centuries, the main emphasis of the study has therefore been placed on the overall system of land use, the economics of livestock production in the region and their cumulative impact on the grazing grounds and the mountain ecosystem and environment of North Sikkim.

1.3 DIFFUSION OF DOMESTIC ANIMALS A HISTORICAL PERSPECTIVE.

Domesticated animals have had a long association with man over millenia. Finding from various old historical excavated sites show that the domestication of the animals began at the end of the old stone age and as the man's dependence on animals grew in course of time, the domestication received due prominence during the new stone age. Many cave paintings showed that primitive man was attached to animals and often considered them as superior and admired them. The origins of the domestication of livestocks have been documented by Zeuner (1963), Rice *et. al* (1970), Busted and Hines (1984), Mason (1988), Busted (1991) and many others. Their findings are reviewed below.

The first animals to be domesticated was dog which was often reffered to as "Man's Best Friend". In America the dog is considered as "Sacred Cow" as Indians consider cow as sacred in their own country. In New Zealand, the dogs are used for mustering sheep and cattle especially in the rugged southern mountains. However, many cultures bar dogs and consider them as unholy animal. Presently, the dogs are used for detecting crimes: they also provide assistance to handicapped people and are used in animal facilitiated therapy. Their skeleton remains were found as far back as the new

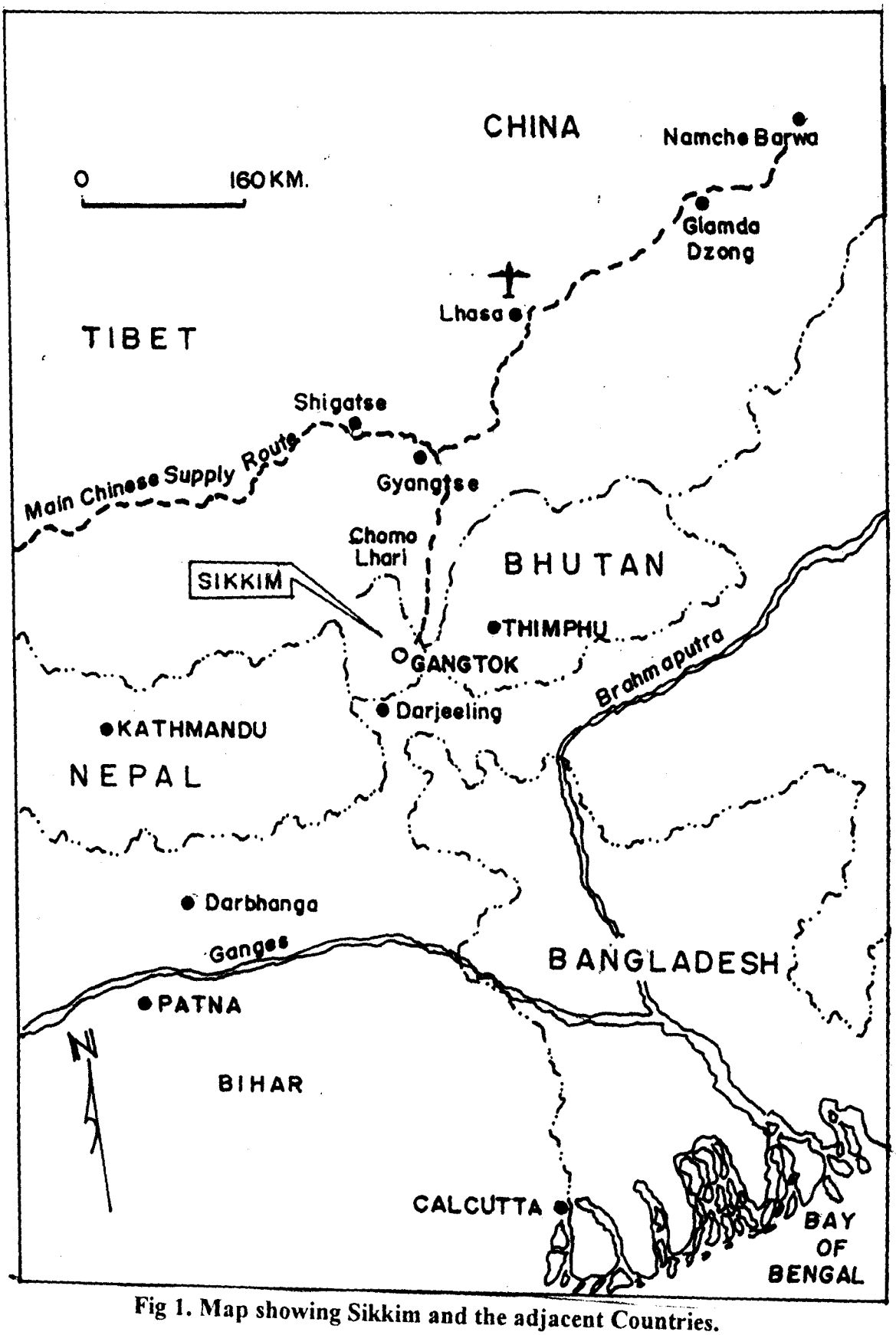


Fig 1. Map showing Sikkim and the adjacent Countries.

stone Age possibly as far back as old stone age. The various breeds of dogs existed during the peak Roman civilization and record of representation of dogs in Egyptian monument dates as far back as 3400 B.C.

The domestication of dog was followed by sheep and goat. The genus of sheep i.e. Ovis is derived from the Sanskrit avi, meaning guard or keep. Some remains of animals sheep or goat have been excavated at the sites of the Swiss lake dwelling of Neolithic times. Domestication of goat was one of the most vital events in early human civilization as goat provided such essentials as meat and milk to human being as food and skin and fibre as dress materials to protect them from heat, snow and cold. They thus helped mankind to survive the natural calamities including famine. However, today the goat is being widely discouraged in view of the fact that these animals are held responsible for causing widespread environmental degradation because of their nature of grazing to roots.

The cattles were domesticated after sheep and goat in both Europe and Asia during the new stone Age. Cattle are deemed as the most important of the domesticated animals. In many cultures cattles symbolize God and are literally worshiped. They are also considered as valued members of human families. The record of domestication of the Indian type humped cattle dates as far back as to 2100 B.C.

Next to cattle, are buffaloes which were also domesticated by man. In the third world countries the buffaloes are put to wide use as milk producers, work animals, sources of meat and as protectors to human being in racing & fighting

etc. It has been reported that the people of Mohanjo-Daro even had buffaloes contributing to the economy of the land as long as 5000 years ago.[1]

Regarding Yaks it is generally belived that the domestic yaks were originated rom wild yaks somewhere in 2500 B.C. and were first domesticated in Tibet China). Each domestic animal has had a rather restricted and simple origin and each breed has been developed through various process of selection . In course of time the unique features of domesticated animals have great socio-conomic relevance. Pertainning to security, income generation and human trition. These features incorporate largely their functional contribution, in terms of meat, milk, wool, fibre, hide & skins sources of power (draft for agriculture operation, transport) sources of non-conventional energy in producing biogas and sources of fertilizers (dung and urine). All these have made man purely pendent on livestock for his economic progress and livelihood.

1.4. DISTRIBUTION OF DOMESTIC ANIMALS IN THE WORLD COUNTRIES IN DIFFERENT CLIMATIC ZONES.

The livestock survived on earth through many centuries. In the olden days they were free to wander in search of food and shelter and there were no human interferance. Thus in course of time their population increased, different species origenated in different places and each got adapted to the peculiar conditions of the environment surrounding them. Today they are found all over the world in various agroecological zones in extremes of climates from tropical dry desert to

1. Randhawa, M. S. The role of domesticated animals in Indian History. *Scientific Culture*, 3(5), 1944. p. 11.

wet tropics with high temperature, humidity and rainfall, from low altitudes with lust vegetation to high altitude mountain areas with low rainfall, short plant growing period and sparse vegetation.

The cattle, Yak and buffaloes are true ruminants and classified under family Bovidae. These animals fall under the genus Bos but are divided into different groups as follows :

1.4.1. CATTLE

The cattle are classified under the Tourine group and are further divided two species as follows :

Latin Name	Important character and area of distribution
1. *Bos taurus*	humpless-European Countries, Great Britain, New Zealand, USSR etc.
2. *Bos indicus*	With hump-India, Asian countries, Africa.

1.4.2. YAK

Yak falls under bisotine group along with bisons. The species, the local nomenclature and the area of distribution of Yaks are given below :

Species	Local nomenclature	Area of distribution
1. *Bos grunnious*	Yak	Himalaya, China, Mongolia, Buryat, Tadikistan, Kirgiz, Nepal,Afganisthan, Bhutan, Sikkim (India). (Plate 1)
2. *Bos bonasus*	European bison	Europe.
3. *Bos Bison*	American bison	U.S.A.

1.4.3. BUFFALO

The group for buffaloes fall under Bubaline group and have four species distributed all over the world.

	Species	Local nomencluture
a.	Bos bubulis	Indian buffalo
b.	Bos caffer	African buffalo
c.	Bos mindorensis	Mindora buffalo
d.	Bos depressicornis	Celebes buffalo

The buffaloes are also found in south east Asian countries including China.

1.4.4. SHEEP AND GOAT

Sheep and Goat belong to the family Boviae and are very closely related. The sheep are found all over the world in various climatic conditions in European countries, such as Australia, NewZealand, Asia, Africa, South America, and Mediterranean countires etc. In terms of production, the developing countries produce 40 to 60 percent of total wool and mutton produced in the world. Unlike sheep, 94 percent of the total goat population of the world i.e. 557 million are found in the developing countries namely Africa, Asia, Far East, Near East, Latin America etc. It is probable that the goats were first domesticated in Western Asia and from Western Asia, the goats spread through two important routes such as : (i) from Afganistan and Mongolia or north China, and (ii) from the Indian Sub-Continent through Khyber pass to South East Asia[2]. However, Pigs and horses are distributed all over the world.

Davendra, C. Goat and rural prosperity, planary paper presented at (Fifth International Conference on goat, New Delhi, 1992, March 2-8 p. 6-25).

1.5. DISTRIBUTION OF HIMALAYAN LIVESTOCK IN VARIOUS CLIMATIC ZONES

In the Himalayas the livestock rearing has been a traditional vocation of the people since time immemorial. Therefore economy of the entire Himalayas is basically agropastoral. The area is conducive for livestock farming. Out of 449 millions of domestic animals in the country, nearly 9 percent are in the Himalayan region. The details of types and their percentage distribution are as follows (Table 1.1).

Table 1.1
Livestock distribution in Himalayan region

LIVESTOCK	PERCENTAGE
1. Cattle	47.5
2. Buffalo	13.5
3. Goats	15.8
4. Sheep	10.4

Sources : Action Plan for Himalaya-Himavikas 2.1992. P. 52-54.

In addition, Yaks and Mithuns are also found in the Himalayan region though their number is not very high. These animals have adapted themselves in the high altitudes of the mountains. The following discussion would give insight into the breeds and types of livestock in different climatic zones of the Himalayas.

1.5.1 CATTLE AND BUFFALO

The Indian breeds of cattle are grouped into six categories[3]. Amongst these the two important breeds i.e. "Ponwar" and "Seri" are mostly found in the Himalayan region having rugged terrain. These two breed are grouped under one category known as heterogenous mixture. They are samll and their skin colour are black, dun or red often with large patches and white markings. These animals are active with sure-footed with small sheaths. Their horns are short though in some cases they are slightly large horned. Ponwar breed is found in the foot hills of the Himalayas and are mostly restricted to Plilibhit district of Utter Pradesh. The Seri breed of Sikkim, Darjeeling parts of Nepal and Bhutan [4].

Buffaloes are found in Jammu and Kashmir, foot hills of Utter Pradesh, Himachal Pradesh, Assam, Manipur and Tripura.

1.5.2. SHEEP AND GOAT

India has vast genetic resource in sheep (40 Breeds) and goats (20 breeds). These breeds are developed over thousands of years as per our social agricultural and geoclimatic needs,

SHEEP :

Sheep is an important livestock species especially in the mountainous regions where crop or dairy farming are not economical.

[3] Food & Agricultural Organization Manual. Zebu cattle of India and Pakistan, Rome 1953.

[4] Nagarcenkar, R. Cattle and buffalo breeding. In (Tata, S. N. and Lokeshwar, R. R. *eds.* Hand book of Animal Husbandry, New Delhi, *Indian Council of Agricultural Research.* 1990. p. 1-42.

The different breeds of sheep distributed in the different agro-climatic zones of Himalayas are enumerated below [5]:

(i) EASTERN REGION.	BREEDS OF SHEEP.
Bihar, West Bangal. Orissa. Assam, Meghalaya. Arunachal Pradesh, Mizoram, Manipur,Tripura,Nagaland,Sikkim	Shahabadi, Chhotanagpuri; Genjam; Belagri; Bonpala and Gharpala and Tibetan breed.

(ii) NORTH TEMPERATE REGION.	BREEDS OF SHEEP.
Jammu and Kashmir, Himachal Pradesh, hilly region of Uttar Pradesh. Changthangi and Kashmir	Rampur Bushair, Gaddi Gureg, Karnah,Bhakarwal,Poonchia Merino.

GOATS.

The goats are scattered througt out the Himalayan region and their breeds are described below on the basis of their locations.

(i) NORTH TEMPERATE REGION	BREEDS OF GOATS
Jammu and Kashmir, Himachal Pradesh, parts of Utter Pradesh.	Chamba, Gaddi, Kashmiri Chegu, Pashmina goats, Chengthangi, Bakhawal.

(ii) EASTERN REGION	BREEDS OF GOATS
West Bengal, Assam, Tripura, Sikkim, Orissa, Nagaland.	Black Bengal, Assam, Hill goats, Banpals. Singhali

5. Acharya, R. M. Sheep production. In (Tata, S. N. and Lokeshwar, R. R. *eds*. Hand book of Animal Husbandry, New Delhi, *Indian Council of Agricultural Research*. 1990. p 43-118

1.5.3. YAK AND MITHUN

In India, Yaks are reared by the highland farmers living above 8,000 ft. above sea level in the Himalayas where no cultivation exists. Their distribution in the Himalayas are as follows:

STATE.	DISTRICTS.
1. Jammu and Kashmir	Ladhak.
2. Himachal Pradesh	Kinaur, Lahul & Spiti.
3. Utter Pradesh	Kumaon, Almora, Pithoragarh.
4. Sikkim	North, East and West District
5. Arunachal Pradesh	West Kameng and Tawang.

Mithun (Gavaeous frontalis) are found in Nagaland, Upper part of Assam and Arunachal pradesh and Mizoram.

1.5.4 OTHER LIVESTOCK

Other livestocks distributed all over the Himalays include the different breed of Equines such as horse, ponneys, mules and donkeys. These animals are mostly used for transportation in the interior Himalayas. Poultry and pigs are also reared in the Himalayan region.

1.6. Aims and objectives of study

The aims and objectives of the present study could be ennumerated as follows :

1. To assess and evaluate the present status of the livestock ownership, size and composition of livestock holdings in the three eco-zones of North Sikkim under study.

2. To study the different breeds of livestock and poultry main tained by the farmers, their housing methods, the current practices of feeding, breeding, health management of the livestock at the farmers level and the like.

3. To assess the potentiality of grazing lands in terms of available grass and soil resources, the capability of carrying animals.

4. To study the effects of climatic factors and relief on the productivity of livestock and poultry.

5. To study the level of productivity of livestocks and poultry and the economics of production of such livestocks in terms of capital investment, demand of the products return and marketing facilities etc. in the region.

6. To study the economic traits like age at maturity, age at first calving, lactation length, dry period, calving interval etc. of the three existing important dairy animals like yak, local "siri" cattle and crossbred cattle.

7. To study the relationship between the livestocks and the existing agricultural paractices in the region and their impact on the overall environment of North Sikkim.

8. To study the impact of livestocks on vegetation, soil and water conditions in the region.

9 To study and analyse the nutrient status of soil and the characteristic vegetations of three different climatic zones in North Sikkim which largely include the major grazing

grounds of Muguthang, Lhonak, Chho-Lhamo, Chopta and Lachen grazing grounds in North Sikkim.

10. To analyse study the content of various micro nutrients such as copper, zinc and iron in different grasses and fodder samples collected from different altitudes of North Sikkim which are essential for growth of the livestocks.

11. To study the performance of exotic grasses and legumes at farm levels in North Sikkim in terms of productivity.

12. To bring out a comparative analysis on the economics of livestock farming, agricultural farming and agriculture and livestock combined at Lachung village as a case study.

13. To study the different types of fodders such as fodder trees, fodder plants, grasses and legumes at different altitude in north Sikkim.

14. To study the role of introduction of various modern innovations such as animal cross breeding programme and health care programmes etc. in the process of development of livestocks in North Sikkim.

15. To make an assesment of the various infrastuctural facilities available in the region in terms of transport & communication and institutional facilities including banking and hospital etc. and to ascertain as to whether government sub sidies are available for promoting livestock development in the region in general.

16. To study the attitude and level of awareness among the

farmers for adoption of improved practices such as modern health care, nutritious feeding to the animals and cross breeding etc.

1.7 HYPOTHESIS

The following hypotheses have been formulated for the present study.

1. Forage Production is the backbone of the livestock industry. Feeding of livestock judiciously with nutritious forage is very crucial for ensuring optimum level of milk, meat and wool production.

2. Crop Husbandry in the steep soils of North Sikkim has to be replaced by livestock farming to save the soil from erosion and prevent the environment from deterioration.

3. The profit from livestock farmings depends mainly on the low cost of livestock maintenance and production.

4. The farmers of North Sikkim depend mostly on livestock farming for their sustainance and income.

5. The pasture land of North Sikkim especially in Lhonak, Chho-Lhamo and forest blocks of lower altitudes are mismanaged and thus exposed to soil erosion.

6. The environment of North Sikkim is susceptible to damage under existing Agricultural practices.

7. The animal husbandry and dairying in particular, offer scope for sustainable economic development in North Sikkim.

1.8. PLAN OF WORK AND METHODOLOGY

In order to study the impact of livestock economics on the environment of north Sikkim various methodological steps have been adopted. As the present work is an empirical investigation, extensive field works have been conducted on various aspects of the study. For the purpose structured questionnaire schedules have been prepared on different aspects of farm economics of Various livestocks. The farmers have been interviewed accordingly. (Plate 2) Data and informations on the physical environment of the area and the socio-economic conditions of the livestock farmers have been gathered through direct interview. The location of the study area is shown in Fig.2.

1.8.1. Village and forest block survey for livestock production.

Two sets of detailed proforma were thus developed for the field study the details of which have been given in Appendix I & II.

The particulars of proforma	Proposed studies
1. Schedule - I	Survey of households located in the Forest Blocks.
2. Schedule - II	Survey of households in the villages for livestock production and activities.

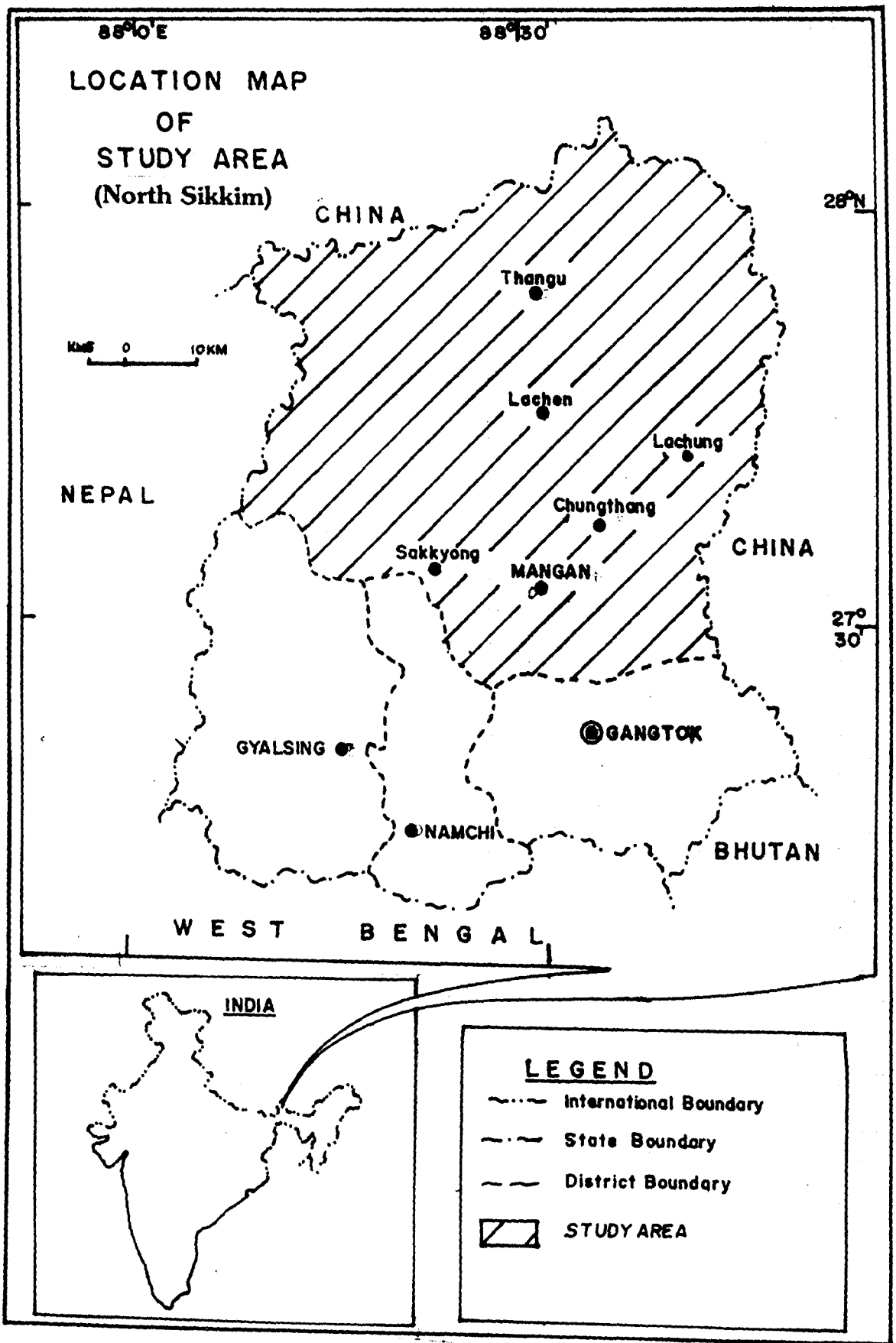

88°0'E
88°30'
LOCATION MAP
OF
STUDY AREA
(North Sikkim)
CHINA
28°N
Thangu
KMS 0 10KM
Lachen
Lachung
NEPAL
Chungthang
CHINA
Sakkyong
MANGAN
27°
30'
GANGTOK
GYALSING
NAMCHI
BHUTAN
WEST BENGAL
INDIA
LEGEND
International Boundary
State Boundary
District Boundary
STUDY AREA

Fig 2.

While evolving the sampling procedure for the study it was felt that the sample households should come from areas representing different agro-climatic regions and based on this, North Sikkim was divided into three ecological zones.

1. Dry high Zone	Lhonak, and Chho-Lhamo
2. Continental Sikkim	Lachen and Lachung
3. Sub-Tropical Humid Lower Zones	Chungthang, Mangan, Dzongu, Phensang, Kabi etc.

In the Dry High and Continental Zones the coverage of villages for house hold survey was 100 percent. However, in the subtropical zone as much as 30 percent of the villages were randomly selected for the survey. In addition to above, the Forest Blocks of Lachung, Mangan and Phodong were also covered. The total number of households covered zone wise from the above villages are given in table 1.2 and Fig. 3

Table - 1.2
LIST OF SELECTED VILLAGES IN NORTH SIKKIM

Eco-Zones	Total no. of household as per 1991 Census	No. of household Covered under the survey	Percentage of coverage
A. DRY HIGH ZONE			
Lhonak, Muguthang and Chho-Lhamo	17	17 13 herdsmen*	100
Total		30	
B. CONTINENTAL SIKKIM			
(i) Lachen	488	122	25
(ii) Lachung	503	118	23.45

* In addition 13 household have been recorded during the field survey.

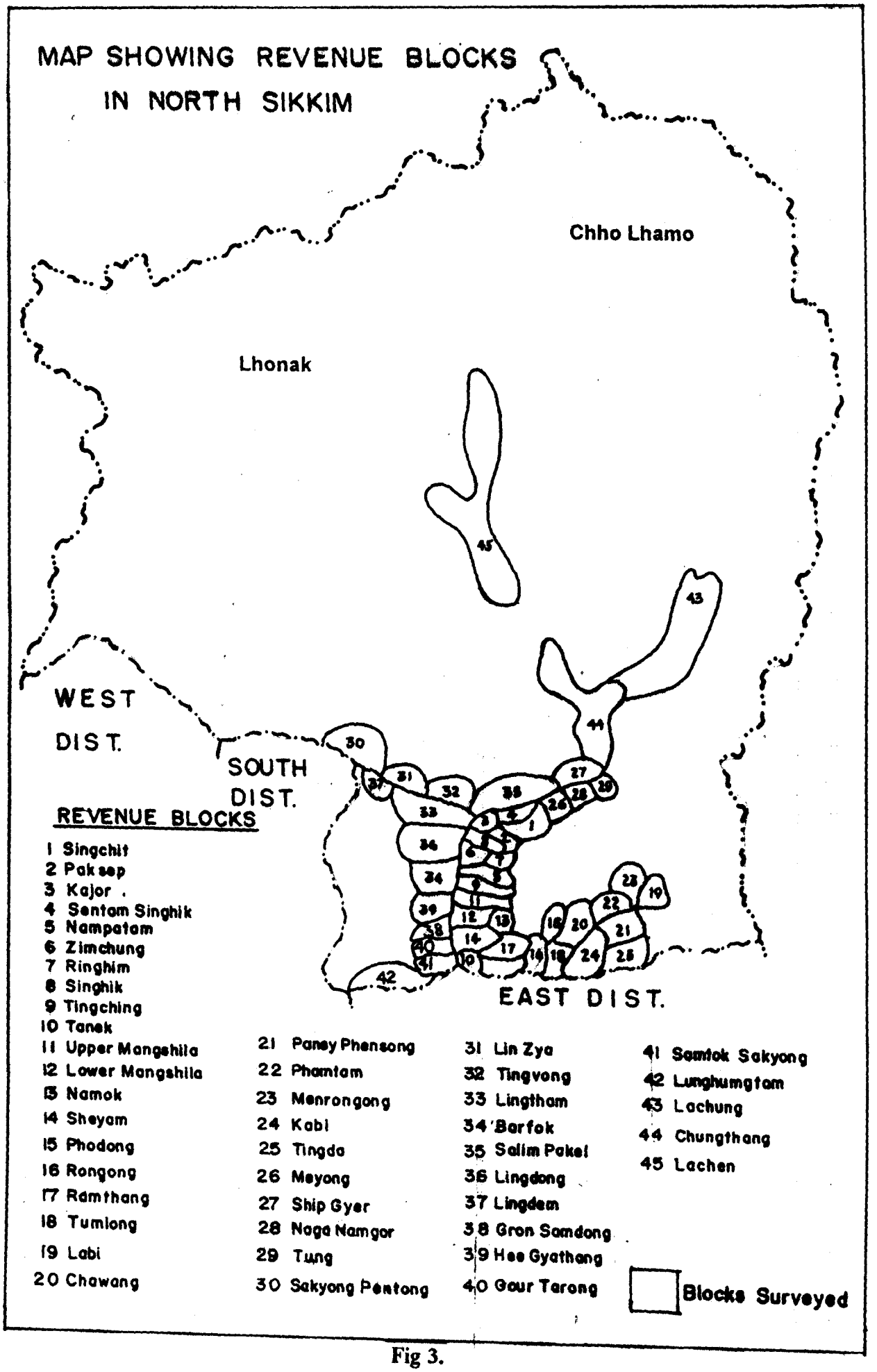

MAP SHOWING REVENUE BLOCKS
IN NORTH SIKKIM
Chho Lhamo
Lhonak
WEST
DIST.
SOUTH
DIST.
EAST DIST.
REVENUE BLOCKS
1 Singchit
2 Pak sep
3 Kajor
4 Sentam Singhik
5 Nampatam
6 Zimchung
7 Ringhim
8 Singhik
9 Tingching
10 Tanek
11 Upper Mangshila
12 Lower Mangshila
13 Namok
14 Sheyam
15 Phodong
16 Rongong
17 Ramthang
18 Tumlong
19 Labi
20 Chawang
21 Pansy Phensong
22 Phamtam
23 Menrongong
24 Kabi
25 Tingda
26 Meyong
27 Ship Gyer
28 Naga Namgor
29 Tung
30 Sakyong Pentong
31 Lin Zya
32 Tingvong
33 Lingtham
34 Barfok
35 Salim Pakel
36 Lingdong
37 Lingdem
38 Gron Samdong
39 Hee Gyathang
40 Gour Tarong
41 Samtok Sakyong
42 Lunghumgtam
43 Lachung
44 Chungthang
45 Lachen
Blocks Surveyed

Fig 3.

C. SUB-TROPICAL LOWER HUMID ZONE

1. Chungthang	592	108	18
2. Shipger	84	29	34
3. Naga Namgor	80	20	25
4. Pakshep	49	14	28
5. Kazor	74	23	31
6. Singhik	381	59	15
7. Hee-Gyathang	227	61	26
8. Lingthem	187	49	26
9. Gnon Samdong	67	16	23
10. Ramthang	74	19	25
11. Kabi	182	83	45
12. Tingda	126	32	25
13. Mangan	169	44	16
TOTAL:	3283	797	25.54

D. FOREST BLOCKS:

1. Lachung Forest Block	54	15	27
2. Phodong Forest Block	18	5	27
3. Mangan Forest Block	21	4	19.05

The above findings have been given in the respective chapters.

1.8.2. Analysis of soils and fodder samples including identification of plants.

The nutrient content of the soil and the plant nutrients were analysed at the Soil Laboratory Department of Agriculture, Tadong, (Government of Sikkim). The materials and

methods have been discussed in the relative chapters.

As regards the studies of the vegetation of Chho-Lhamo, Chopta and Lachen grazing grounds, the plants were collected in flowering stage along with leaves, flowers and roots. The botanical names were identified at the Botanical Survey Gangtok Branch, Govt. of India.The plants specimens were also handed over to the same department for further future use.

1.8.3. Methodology adopted to assess the existing grass lands resources of North Sikkim.

North Sikkim has 908.61 sq.km. or 21.50 percent of land under alpine scrub and pasture land. These areas are mostly located in the famous grazing grounds of Lhonak, Muguthang, Chho-Lamo Donkung high lands (Plate 3). In order to assess these grazing lands, their resources, capability of carrying animals, their potentiality and impact of the present management and utilization system a numeral method has been proposed. The adoption of the present methodology is divided into two parts as follows:

1.8.3.1. Resource and potentiality of grassland.

For assessing the present pasture land capability, the method proposed by Jaiswal (1989) with some modification was adopted. Under this system equal marks have been given to eight proposed parameters with the assumption that each of these parameters would contribute equally to the productivity of the grazing land. The details of these are given in Appendix III and the summery is presented in Table 1.3.

Table 1.3

Gradation parameters proposed for assessing the grassland resources

SI.No.	Details of parameter	Allotment of Scores
(a)	SOIL CAPABILITY	
	(i) Soil fertility	10
	(ii) Soil reaction	10
(b)	EXTERNAL LAND FEATURES	
	(i) Natural slope of land	10
	(ii) Vulnerability to erosion	10
	(iii) Vegetation and grassland cover	10
(c)	ENVIRONMENTAL CONDITIONS	
	(i) Climatic conditions	10
	(ii) Water availability	10
	(iii) Natural Soil drainage	10
	Total	80

Source: Modified by self from the proposed "Land use capa bility classification a numerical approach" in the *Journal of Hill Research*, 2(2) 1989 July-December. p. 166-167.

Based on the above score, the variation of allotment of scores to the proposed different grades of pastures of grasslands are given in Table 1.4.

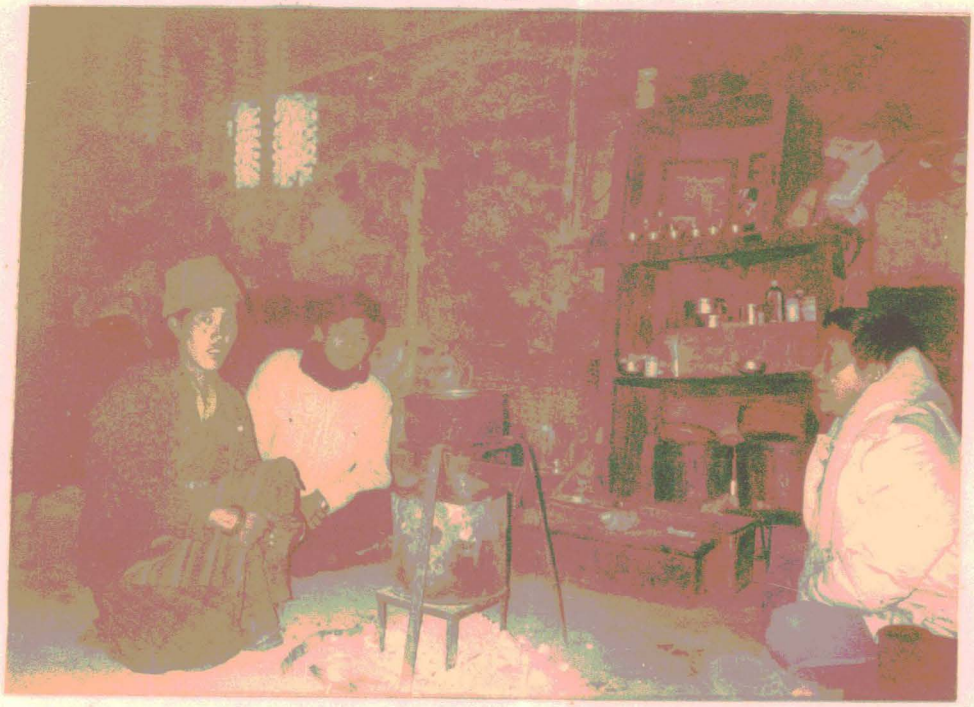


Plate 2. Author while intervewing the farmer at Donkung (5000 m.a.l.) Chho Lhamo area-underground shed. Yak dung is used as fuel. Background white and brown yak cheese handging ready for sale.

Plate 3. Chho Lhamo Lake in North Sikkim. The yaks and sheep are wintered in Chho Lhamo areas.

Table 1.4

GRADATION OF GRASSLAND RESOURCES OF NORTH SIKKIM

Grade of grassland	Range of score	Ramarks
I	60-80	Suitable for intensive grass and forage cultivation.
II	45-59	Suitable for grass & forage cultivation with intensive management practices only.
III	35-44	Suitable for perennial grass and legume plantation without much disturbance of the soil.
IV	Below -34	Suitable for three tier-grass bushes and fodder trees plantation only.

Table 1.4 shows that the grazing grassland with total score of 60 to 80 is suitable for intensive grass and forage cultivation with the use of modern equipments as it is done in New Zealand. For Grade II of 45-59 total score one has to take intensive management practices i.e. control the grazing and reduction of the animals should be based on the growth of the grasses and legumes. Grazing land grade III should not be disturbed and emphasis must be on the perennial grasses

and legumes as the grazing ground is vulnerable to erosion. The grassland under 34 scores should be utilized for intensive three type vegetation system i.e. Fodder trees, Fodder bushes and the grasses on the ground cover. This would avoid the rain hitting on the ground directly as the area falls under high rainfall zone. The intensively or the corrosive effect of the rain would be reduced as it would first hit on the fooder tree, then on the fodder bushes and then on the grasses. The animals raised in these areas should be stall fed and no grazing should be allowed.

1.8.3.2. ASSESSMENT OF THE PRESENT MANAGEMENT OF THE GRAZING LAND

The alpine grasslands of Lhonak, Donkung and Chho Lhamo have been grazed for centuries and so far no studies have been undertaken to assess its ecological conditions. The following points were taken into consideration while assessing the present status of the grazing land at Lhonak,Chho-Lhamo and Kerang (Chho Lhamo) by visual estimation (Appendix IV).

1. Human disturbance.
2. Livestock disturbance
3. Poisonous plant occurence.
4. Growth of grasses and other fodder tree canopy cover.
5. Dependence on crop waste.

The first four points as indicated above are the main parameters which have been proposed for assessing the management system of grazing land in the region. The human disturbances on the grazing grounds are on rise owing to in-

crease in population and in migration. More and more people thus occupy the grazing grounds and cut fodder trees for fuel thus exposing the land for soil erosion. The second point relates to disturbrances caused by livestocks in many areas. The livestocks are let to graze in one area throughout the year causing serious overgrazing and soil erosion. The presence of poisonous plants in the grazing ground would reduce the lviestocks number and even the existing herd would not be in a position for higher production.

The third point relates to the growth of grasses and other forage materials. Better is the management of grassland, better would be the compsotion of grasses and forage materials etc. Lastly the dependence on crop waste is not considered a desirable point as livestocks depending on crop wastes would be subjected to higher methane production and higher soil erosion largely to disturbance of the soil. As for as the above parameters are conerned a score of ten equal points has been given to each of the above parameters and the details of the scores based on the severity of the individual effect are given in Appendix IV.

The grazing grounds of Lhonak and Chho Lhamo forests block are surveyed on individual scoring which is based on the condition of the grazing ground with plenty of grasses with no evidence of human and animal disturbances etc. The principle is that more the evidence of these disturbances lower the scores. Accordingly different scores have been proposed based on the condition of the grazing grounds. Table 1.5 presents the gradation of the resent grasland management in North Sikkim.

Table 1.5
GRADATION OF THE PRESENT GRASSLAND MANAGEMENT IN NORTH SIKKIM

Grade of grassland		Range of score	Ramarks
I	40-50	Excellent Management practices adopted.	
II	30-39	Medium management with rotational grazing.	
III	20-29	Highly disturbed grassland with over stocking of livestock.	
IV	Below-19	Not suitable for grazing immediate withdrawal of livestock.	

The grazing grounds with 40-50 scores are considered as well managed grazing grounds. With scores varying between 30 to 39 the grazing ground also considred better managed and the farmers practice rotational grazing system. The grassland with 20-29 scores are however not found to be well managed grasslands and grassland having scores lower below 19 or catagorised as Class IV types are badly managed. In this case stocks should be withdrawn immediately to avoid further deterioration of the grazing grounds.

The findings of the above have however, been discussed in Chapter VI. In addition to above the present study was conducted on the basis of historical and functional approaches. The comparative method, both synchronic and diachromic over space and time was adopted for understanding the three identified zones of North Sikkim. The data for this study was collected both from primary as well as from secondary sources.

Various published and unpublished materials were also consulted for understanding the livestock frarming system in the above three zones. But the emperical facts were collected through intensive fields investigation.

The analysis of qualitative data are made through systematic and analytical description of the facts. While the quantitative facts were analyased on the basis of tabulation and statistical calculations.

1.9. LITERATURE REVIEW

The literature on various types of livestocks their production economics and their influence on soil, vegetatin and environment of north Sikkim is very limited. Nevertheless an attempt has been made to procure as many literature as possible on the present study. The following is the review of literature procured on various aspects of the study.

1.9.1 RESEARCH ON GEOGRAPHY OF VEGETATION

North Sikkim is the classical land of research, especially in the field of high altitude studies on Himalaya. Hooker from 1848-1849 carried out detail studies on features of the vegetation of north Sikkim. The other botanists who subsequently undertook studies on vegetation of North Sikkim after Hooker were Gammie (1891), Gammie (1893), Smite and Cave (1911) on vegetation of the Zema and Lhonak valley, Pradhan (1962) and Sharma and Ghosh (1970) on flora of Lachen. The studies on forest of north Sikkim were followed by Shebbeare (1934) on the conifers of Sikkim, Duncan (1935) and Pradhan and Lachungpa (1990) on Rhodendrous and by Roy

Chowdhury (1951), Rai and Rai (1994), Negi (1994) on general forests. Similar studies on alpine plants were attempted by Gammie (1894), Burkhill (1907),Sahni (1960) and Sahni (1981). Botanical exploration, identification and listing of grasses of north Sikkim were carried out by a host of authors who mainly include after Hooker. They are Smith and Cave (1911), Nelmes (1940), Pradhan (1940) on Kiku grasses, Bor (1952), Whyte (1957), Sahni (1960), Thapa (1966) on primitive maize and Sahni (1981) on overall grasses of North Sikkim. Finally studies on the medicianl plants of North Sikkim were carried out by Biswas (1956).

1.9.2. ENVIRONMENT OF NORTH SIKKIM

North Sikkim with an area of 4226 sq.km. is the biggest district in Sikkim. Entire Sikkim including North Sikkim is classified under agro-ecological zone of Humid Eastern Himalaya Region Zone II (Saikia 1991). On regional analysis based on Vegetative structure the state is divided into three zones, i.e. dry high zone, continental zone and tropical zone (Schweinfurth 1957). Very interesting work has been done in the field of geology in North Sikkim. Hooker (1854) was the first person to report on sedimentary formations of North Sikkim and shales and limestones out cropping at Chho-Lhamo to be nummulite bearing and hence of Tertiary age. His work was followed by Garhood (1903) at Lhonak Valley, Hayden (1907), Wager (1939), Auden (1935). Rama and Bhattacharya (1971), examined the entire section from Pauhunari spur in the West to lhonak peak in the East and were able to locate new palaeozoic horizons and by discovering new fossil bering horizons, have also solved the controversy by proper delineation of hitherto referred Jurassic

formation in he East and the Jurassic to Cretaceous formation in the West. Mukhopadhya (1982) carried out detailed studies on fluvial geomorphological evaluation of Tista basin of north Sikkim. He has described Tista basin as a region of spectacular landslides. In addition environmental features and problems were also reported by Hooker 1851), Sherwill (1892), Humbold (1851), Kanai (1963), Chowdhari (1978), Vhora (1981), Swaminathan et. al. (1982), Khan (1986), Chattopadhyay (1986), Yonzona (1986), Samaddar (1986), Bhasin(1989) and Bhatt et. al. (1993). Regarding the soils of North Sikkim Bhutia et. al. (1986) analysed the soils of subtropical Humid Zones and Continetnal Zones of North Sikkim and thier findings are presented under soils of North Sikkim in chapter II. However, there is no report on the soils of Dry High Zone i.e. Lhonak and Chho-Lhamo regions.

In the field of paleontology a new carboniferous trilobite was discovered by Chandra and Sen (1981) and they have mapped the occurence of Trilobite in Chho-Lhamo. Permian fossils were also recorded from the Chho-Lhamo area (Gupta and Waterhouse 1979). Finally the most disturbing trend in the environment of North Sikkim was the discovery of Chinese nuclear debris in Changme glacier of North Sikkim (Bhandari et. al. 1982).

1.9.3 ECONOMY OF NORTH SIKKIM

Lall (1981) has given a vivid description on various aspects of North Sikkim such as the two important northern communities i.e. Lachenpas and Lachungpas and the closure of Sino Indian border in 1962 and its effect on the culture, economy,trade and production of traditional handicrafts of the two communities. The two communities were basically herds-

men and traders till then. It has been reported that as many as 28 Lachungpas and 27 Lachenpas lost their investment in Tibet due to closure of border trade. Now trade occupies only a small place in their economy which is mostly based on animal husbandry, agriculture, horticulture, state government and army contract works, carrige of loads for government and army and as labourers on roads. Survey on the prospect of livestock development,availablility of feed and fodder,and development of grasslands,migration routes etc.were conducted by Sahni (1960),Paljor and Sharma (1970 unpublished) and Balaraman (1981). The survey on poultry production was conducted by Sachdev(1980).The popularity of rearing livestock amongst the Lepchas of Dzongu area of north Sikkim was recorded by Gorger(1938). The economic problems of hill in the Himalayas especially Sikkim has been projected by the Indian Institute of Hill Economy established in 1974 in Darjeeling. Various authors from this institute and also from other organizations have scholarly contribution on the study of the economy of Sikkim.The authors include in the field of animal husbandry and dairy development Khera et.al. (1976), NDDB (1976), Krishnamurty et.al. (1976), Solanki(1978), Paljor (1982), Pal (1982), Paljor (1987), Dorjee and Sharma (1989), Gupta(1992), Balarman & Golay(1991), Schmidth(1994), Balaram(1994), Sundriyal (1995). In the field of agriculture the author are Rustamjee (1971), Subba(1984), Debnath (1986 a), Bhutia (1992), Denholm and Jodha (1992), Sharma and Banskoata (1992), Gupta (1992) and Das(1994). The scope of setting up of industries in the region has been reported by Solanki (1978) and Sankrityayana (1986).The land problems and their management have been documented by Hope Namgyal (1966), Dasgupta and Mukhopadhya(1978), Singh and Basnet (1982) and

Dhamala(1986). On the history of Sikkimese economy in general, future potentials have been written by Debnath(1977), Bhattacharya (1984), Debnath(1986 b), Debnath (1986 c), Dasgupta (1986), Siakia(1991) and Gupta(1992).Finially on eco-tourism by Avasthi et. al. (1994).

1.9.4. LIVESTOCK AND ENVIRONMENT INTERACTION

Today livestock is being identified as a major threat to the global environment. With the increase in global livestock population from 2.3 billion in 1950 to 4 billion today and poultry population from 3 billion is to 11 billion now, a major portion of the worlds food grains is being diverted towards livestock feeding. Such increase in livestock population has also led to over grazing of pasture land there by leaving it vulnerable to wind, snow and rain erosion, shrinkage of forest land in view of indistriminate cutting of tree branches for livestock feeding and finally emission of methane gas which has green house effect. Al these factors are ruining the earths fragile ecosystem. In North Sikkim Lall (1981) predicted that the loss of traditional grazing facilities in Tibet (China) would result in serious overgrazing of the grassland. Reference on grazing pressure on quality of pasture and animal production have been made by the Task Force of the planning commission (1982). Mukhopadhyaya (1982) observed deterioration of grass cover with increase in grazing pressure between 2100 m. to 3000 m. above Lachen. *Poa annua* community was dominant inseveral grazed area instead of other good grasses. Overstocking of large herds of cattle and uncontrolled grazing is mainly responsible for destroying young tree seedlings and thus impeding forest regeneration (Yonzone 1986).

1.10. OUTLINE OF CHAPTERS.

As far as the scheme of chapterization of the present study is concerned, the study has been split up into 8 chapters.

Chapter I is the introductory chapter which highlights such important points as a brief introduction about the study, the study area, data base, objective, plan of work and methodology and literature review ect.

Chapter II deals with a detailed description of the physical set up of North Sikkim highlighting various aspects such as its delimitation and areal coverage, land form and geology, climate (precipitation, temperature and humidity etc.), vegetation, soil and drainage etc.

Chapter III, presents the geographical conditions required for livestock rearing in North Sikkim. The important factors discussed in the chapter are bio-climatic (regimes i.e. availability of water, landform, soil fertility, topography, natural and man induced hazards etc.),population scenario, agricultural scenario, transport and communication, processing of milk and its products and finally feed and fodder resources of North Sikkim.

Chapter IV primarily deals with the distributional patern of livestock in North Sikkim and their economic importance with adequate emphasis on the varieties of poultry and livestock along with their related wild species, levestock composition and population dynamics and the types and concentration of livestock population in three identified eco-zones.

Chapter V discusses the role of socio-cultural factors in the process of diffusion of modern innovations in the study area. The objective of this chapter is mainly to understand as to how these factors helps the farmers in their decision making process to go in for modern innovations. Such factors include largely the educational background and occupation status of the farmers, the source of communication of knowledge about modern innovations, exposure of the farmers to new ideas, livestock rearing traditions, preference for crossbred livestock, preference for breeding cows and finally the animal health care system.

In Chapter VI based on the field survey data the economic traits such as the age at first calving, lactation length, dry period and calving interval etc. of the milch animals namely, yak, local "Siri" cow and crossbred Jersey cow found at different eco-zones have been assed. Subsequently, a comperative analysis on the economic of milk production separately for three milch animal such as yak, local cow and crossbred cows have been presented. The chapter also highlights the economics of livestock farming verses crop and vegetable farming at Lachung valley where both the system of farming are widely practised. Similarly a detailed economic cost analysis taking various cost components in to accounts of the farmers in the dry high zone namely Chho-Lhamo and Lhonak has been carried and presented in the chapter.

Chapter VII encompasses a detailed discussion on the interaction livestock and environment in India in general and in North Sikkim in particular. The important environmental issues discussed in the chapter include the nutrient analysis

of the soil of Dry High Zone, the assesment of the micro-nutrient content of the different grasses and fodders found at different altitudes varying generally between as low as 1830 m to as high as 5300 m, the assessment of the present system of management of livestock and the grazing grounds and the assessment of the productivity of the grassland of North Sikkim etc. Besides an inventory on the different types of vegetation namely grasses, fodder trees, poisonious plants etc. has been prepared and also their characteristic studies and evaluation of the performance of exotic grasses and legumes has also been done. The distribution of households in relation to land and cattle holding sizes at different ecozones and the environmental awareness of the respondents concerning felling of trees and their ecological impact and lastly the conciousness of the farmers about health and hygiene pertaining to livestock products as carriers of diseases have been very systematically explored.

Chapter VIII is the concluding chapter which embodies the main findings along with a number of valuable recomendations and suggestions as far as livestock development in North Sikkim is concerned.

CHAPTER II

PHYSICAL SET UP OF NORTH SIKKIM

2.1 INTRODUCTION.

The State of Sikkim is bounded in the north by the vast stretches of the Tibetan Plateau (China) and to its west, lies the kingdom of Nepal. In the east, the State is bounded by Bhutan and the Chumbi vally of Tibet (China). The Darjeeling District of the State of West Bengal stretches along its southern boundaries. Geographically: Sikkim lies between 27° 4'46" N to 28° 7'48" North latitudes and between 88° 55' 25" to 88° 0'58" E longitudes extending approximately 114 km. from north to south and 64 km. from east to west. Since north Sikkim has been chosen as the area under the present study, it will be meaningful if the study area is defined in terms of its extension, delimitation and relative location .

North Sikkim as stated above is thus bounded by Nepal in the West, Tibet (China) in the north and east. In addition, the region has distinct mountain chains that separate itself from the neighbouring countries such as Nepal, Bhutan and Tibet (China) Singalila Chain of mountains in the west that commences from Kanchendzonga and stretches towards south, separates north Sikkim from Nepal. Similarly, central Himalayan chain that runs towards the north forms a natural boundary with Tibet (China) and in the process is broken up into many massive peaks such as Kanchendzonga, Kabru, Pyaramid, Tongsang, Lhonak peaks, Chomo Yommo, Kanchengyao and Pauhunri all lying in the east. The Dongkya or Chola chain runs from Pauhunri to the south and forms boundary between Tibet (Chain) and Bhutan. The elevation of the region varies between as low as 800 m. to as high as 8579 m. above sea level. Owing to this great altitudinal variations within a relatively smalls geographical space, climatic conditions to a varying degree from sub-tropical through alpine vegetations to perpetual snows generally prevail in the region.

The enclosed valleys are deeply cut by V shaped water courses (Plate 4) and their greatest effect is distinctly visible at Chungthang where two rivers namely Lachen and Lachung meet (Plate 5)

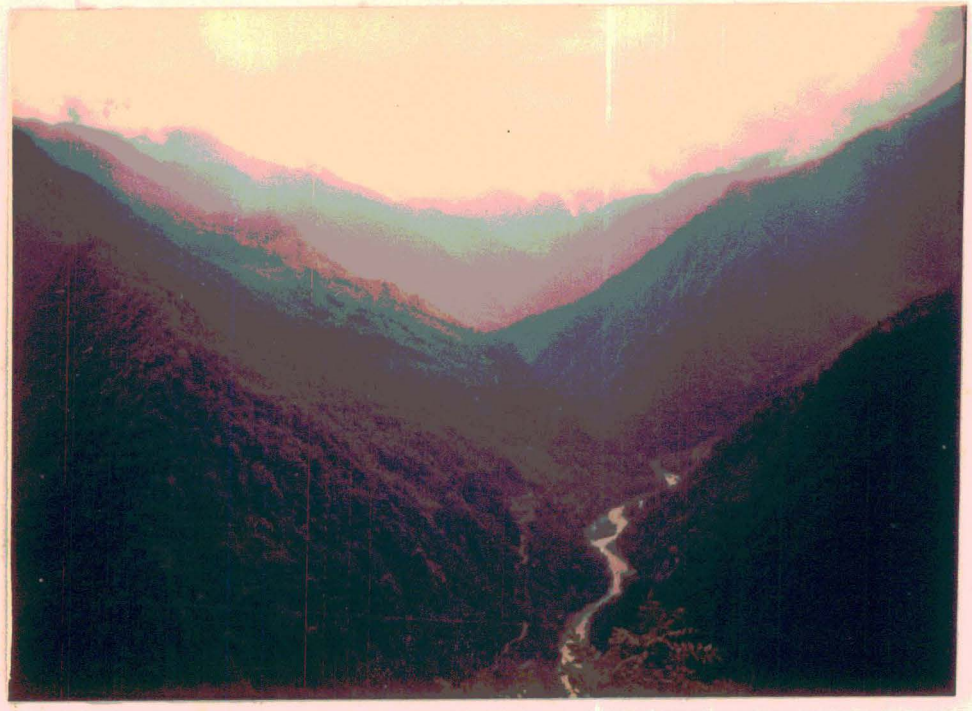


Plate 4. V shape Valley with meandering river Tholung (North Sikkim). The rivers are swift and not navigable.

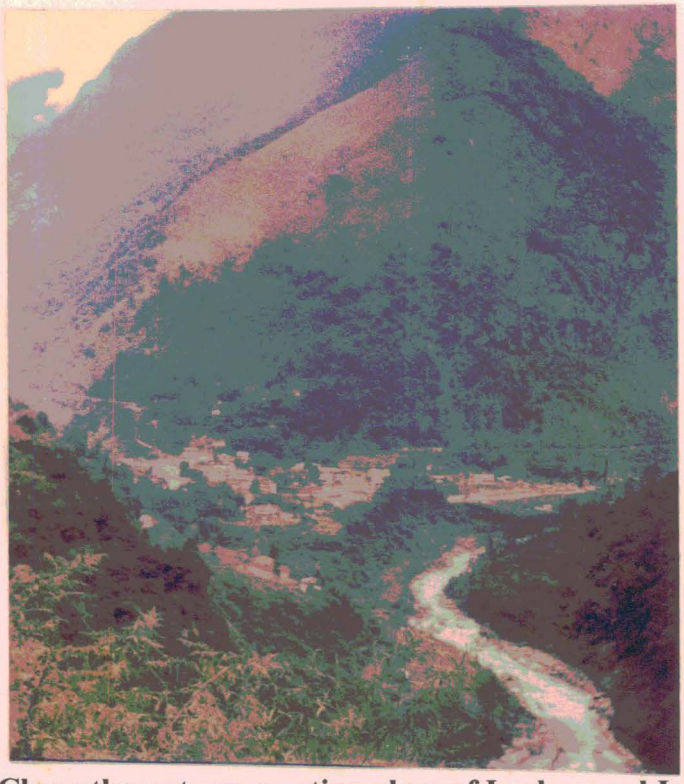


Plate 5. Chungthang town meeting place of Lachen and Lachung river.

2.2 AREA AND DELIMITATION.

North Sikkim consitutes of 4226 sq km. which accounts for about 60 percent of the total area of the state i.e. 7096 sq. km.. The break up of the area statistics of North Sikkim which is based on the survey conducted by the State Forest Department is given in Table 2.1.

Table 2.1

AREA STATISTICS FOR NORTH DISTRICT OF SIKKIM

(Area in sq. km.)

SL.No. Class/Category	Area under Reserved Forests	Area falling under Revenue Block	Total Area	Percentage to Total geographical
1. Crop Land	0.00	95.77	95.77	2.27
2. Mixed Forest	476.70	177.93	654.63	15.49
3. Conifer Forest	557.80	42.64	600.44	14.21
4. Forest Blanks Scrubs	103.21	0.00	103.21	2.44
5. Alipine Scrub/ Pastures	890.00	18.53	908.61	21.50
6. Alipine Barren	649.61	0.00	649.61	15.37
7. Snow	1115.77	0.00	1115.77	26.40
8. Lakes, Streams Dry Rivers	80.93	10.86	91.79	2.17
9. Township	0.00	0.17	0.17	0.01
10. Major Land slides	1.61	0.00	1.61	0.14
11. Misc.	4.39	0.00	4.39	0.10
Total	3880.10	345.91	4226.01	100.00

Source: The Sikkim State Forest Department and RRSSC, Dept. of Space Govt of India (1988).

From the above table it can be seen that the total area available for cultivation in North Sikkim is as little as 95.77 sq. km. which accounts for about 2 percent of the total geographical area. However the area under the Forest is estimated to be 1255 sq.kms. that accounts as much as 30 percent of the total geographical area of the region. The area available for grazing is 908 sq.kms. i.e. 22 percent of the total area of North Sikkim. From this it could be infered that North Sikkim has tremendious scope for livestock development in future.

2.3. GENERAL GEOLOGY

Transversely, from south north the Sikkim Himalaya can be divided into four tectonic belts nemely (i) Foot hill belt (this belt falls in Darjeeling hills of west Bengal) (ii) Inner or lesser Himalayan belt (iii) Axial belt and (iv) Trans axial belt.Each tectonic belt is separated by Tectonic Thrust.

The stratigraphic units from north to south as worked out by different geologists are as follows :

Formation /group	Lithology
Gondwana	shale/sandstone with thin bands of coal. Pebble/boulder bed (Age - permo - carboniferous)
Uncoformity Buxas	Dolomites Limestone, Slate Calcareous & non-Calcareous & non-Calcareous purple phyllites. (Age-pre-Cambrian)
Thrust Dalings	Chloritic Phyllite, Sericitic Phyllitic, quarzitic phyllite, Phyllitic quarzite,Massive & thin bedded quarzites, Talc & Sulphide mineralisation (Age Pre-cambrian).

Thrust Gneiss	Biotite gneiss, high grade garnetiferous schist, Tourmaline bearing gneiss, Lingtse granitic gneiss. Calc gneiss, Marble, graphites etc. (Age Pre-cambrian)
Lachi Series/ Chho-Lhamo formation	Limestone, shales & quartzites (Age Jurassic)

The distribution of the above litho-units may be seen in Fig. 4 in the southern part of North Sikkim namely Dikchu, the rocks are classified under Darjeeling gneiss and are made of higher grade metamorphites. Similarly, at Mangan the rocks are of Chungthang gneiss which are again of higher grade metamorphites.

In the north of Kanchenzonga around Pauhunri, the important series include Chho Lhamo, Lechi, Mount Everest Limestone and Everest pelitic series etc.[6]

The photography of the Chho-Lhamo series of rocks are shown in plate 6. The plate shows extensive damage caused to the grazing ground by intensive weathering of Chho Lhamo series of rocks. This is a common feature at Lhonak, Muguthang and Chho-Lhamo grazing grounds where the debris along with screes are piled up. The situation is further aggrevated by the presence of strong wind in the high altitude areas, leading to spreading up of small stones all over the grazing ground there by affecting the growth of the grasses adversely.

6. Rama, V.K. and Bhattacharya, M. Sedimentaries of North Sikkim. Records of the Geological Survey of India. Vol. 106(2) 1975. P 75-85.

Plate 6. Photo showing the extensive damage caused to the grazing ground by intensive weathering of Chho Lhamo series of rocks.

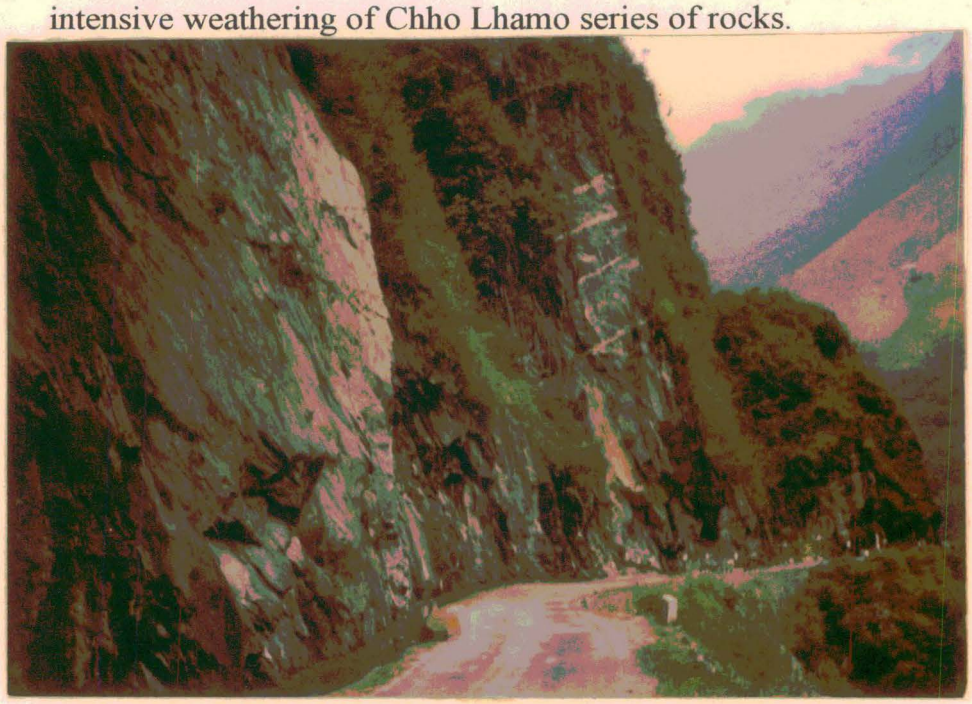


Plate 7. Steep angle of Dip of Chungthang rock series, showing the proximity of the axial belt of the Himalaya. (Such steep gradient of the slopes is typical of North Sikkim).

Chakraborty *et. al.* (1980) carried out geological survey between Lachen & Lachung covering an area of 225 sq. km. and their findings are indicated below:

(i). Northern part	The rocks banded gneiss, granite gneiss augen gneiss, streaky gneiss and migmatite all intruded by massive biotite granite, quartz-tourmaline rock and pegmatite.
(ii). Southern part	The rocks mapped are Kyonite Sillimanite-garnet, biotite-quartz schist, cal-granulite, marble and quertz ite.

Plate 7 shows the steep angle of dip of the Chungthang rock series showing the proximity of the axial belt of the Himalaya. The steep gradient of such slopes are typical of North Sikkim where in goat, wild goat and sheep can only graze in such areas.

2.4 CLIMATE

Climate plays an important role in determining the nature of the Landscape and the type of flora and fauna of the region. Understanding the climate of a region is very important especially in livestock management as it affects animal productivity through its influence on the vegetation growth and animal physiology. The main climatic factors include air temparature, air humidity, air movement (wind velocity), precipitation, (rain, snow etc.) radiation (solar and long wave) atmospheric pressure and so on.

For hilly and mountainous environments, Hussain (1988) recommends collection of metereological data from a large number of Metereological stations so as to determine the variation of temperature and rainfall within a short distance.

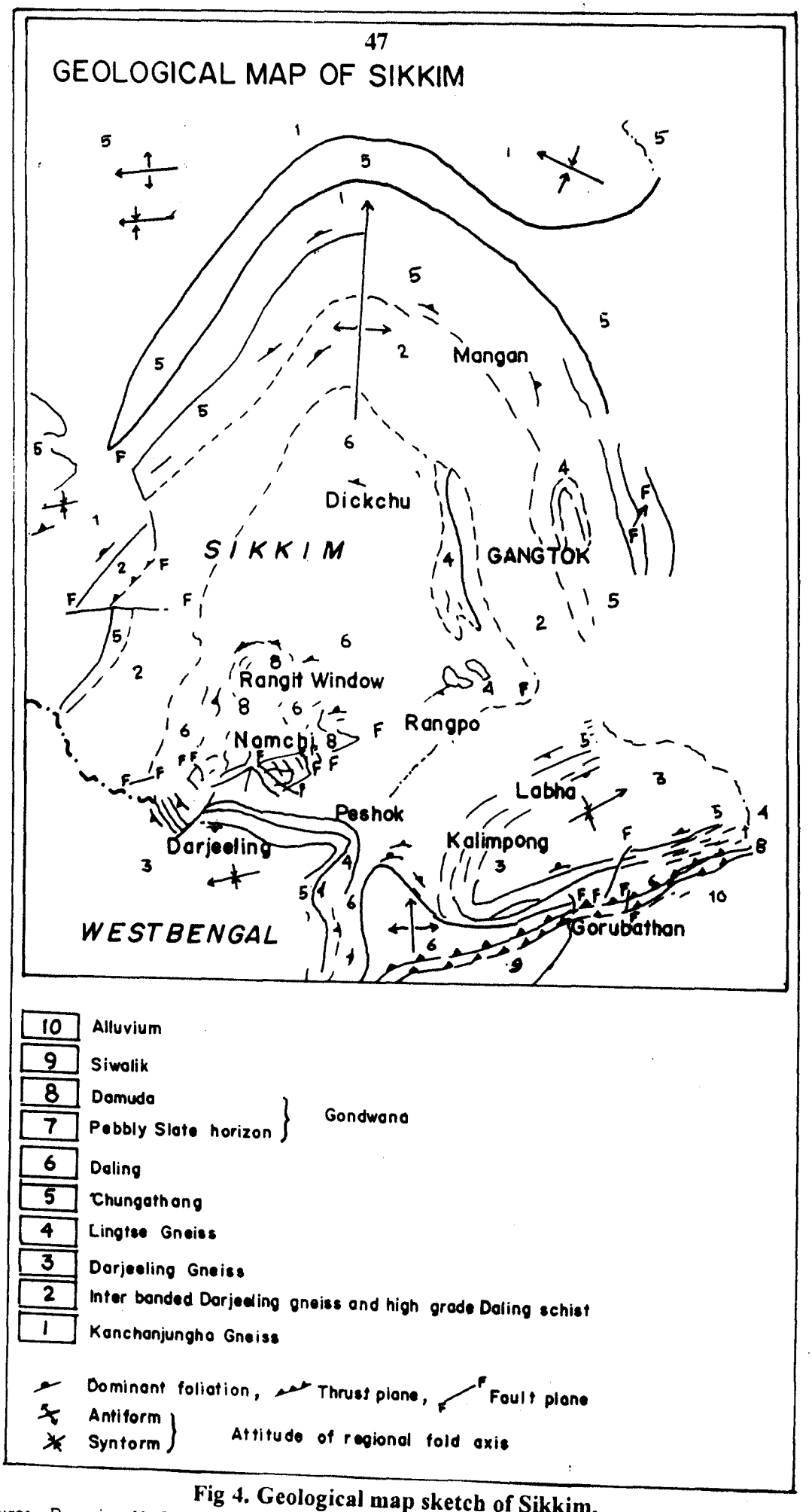


Fig 4. Geological map sketch of Sikkim.

Source - Banerjee, H. & Chakraborti, B. Special Publication Geological Survey of India 1984 Vol. 12 P. 251-259.

Keeping the importance of the above points in view an attempt has been made to collect information on Meteorological data from as many stations located at different elevations in Sikkim as possible. Unfortunately, except Gangtok, there are no organized Meteriological station in Sikkim. The data have thus been collected from various source such as State department farms, dakbunglows and Border Roads organization etc. The details of the location of meteriological stations in the region are as follows:

SL. No.	Name of the meteorological station	Elevation in metres
1.	Dikchu	869 m.
2.	Gnon Sandong	1100 m.
3.	Mangan	1310 m.
4.	Singhik	1402 m.
5.	Manul	1408 m.
6.	Chungthang	1631 m.
7.	Lachung	2633 m.
8.	Lachen	2697 m.
9.	Yumthang	3673 m.
10.	Thangu	3812 m.

North Sikkim is located in proximity to border of Tropical Warm Gangetic plains and the alpine Tibetan (China) plateau including permanent snow capped Himalayan mountains. A cross section from Gurudongmar lake to the Bay of Bengal is Shown in Fig. 5 to gain an insight into climatic zone. In view of this unique geographical situation there is observed a gradual change in climatic conditions like rainfall, temperature etc. from south to North in Sikkim.

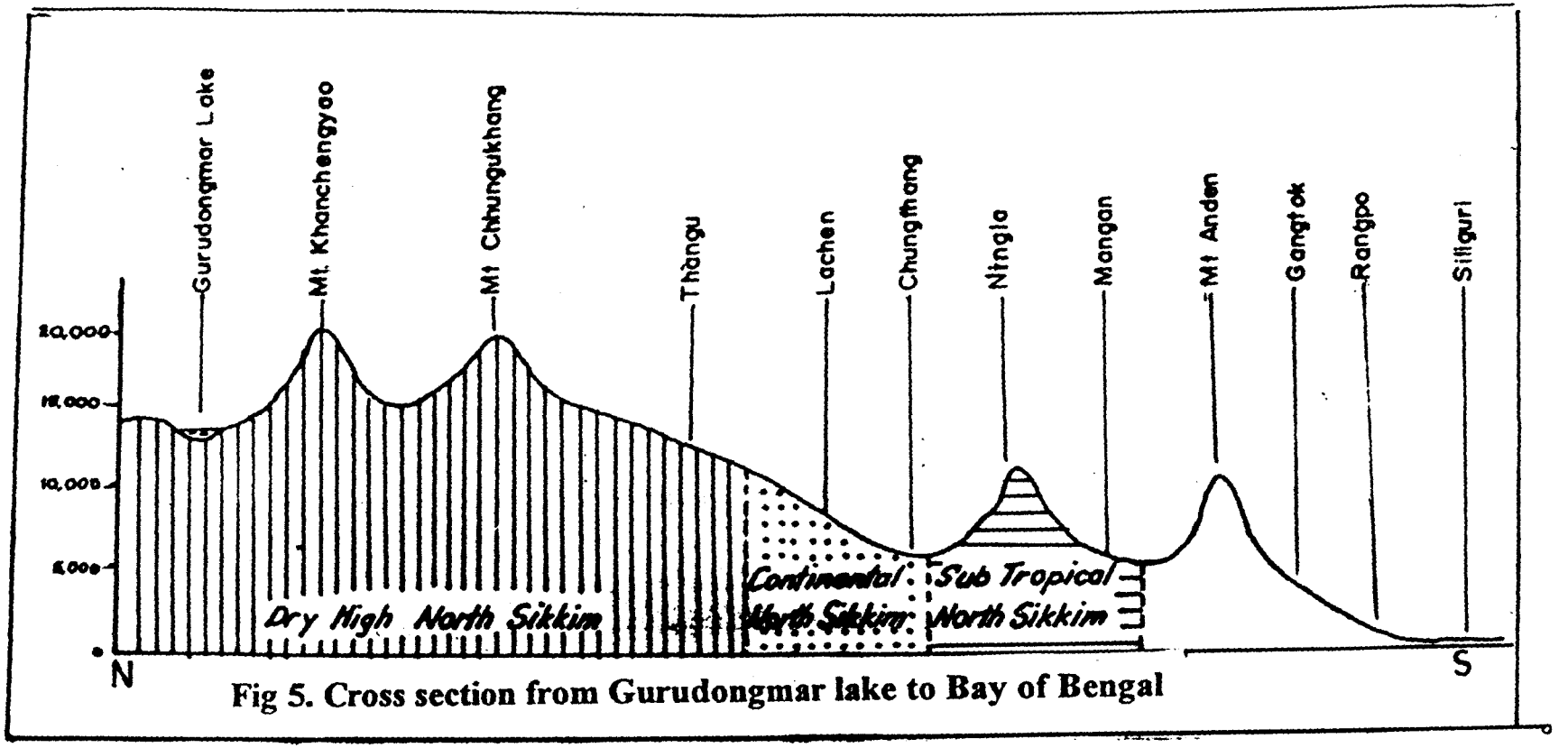
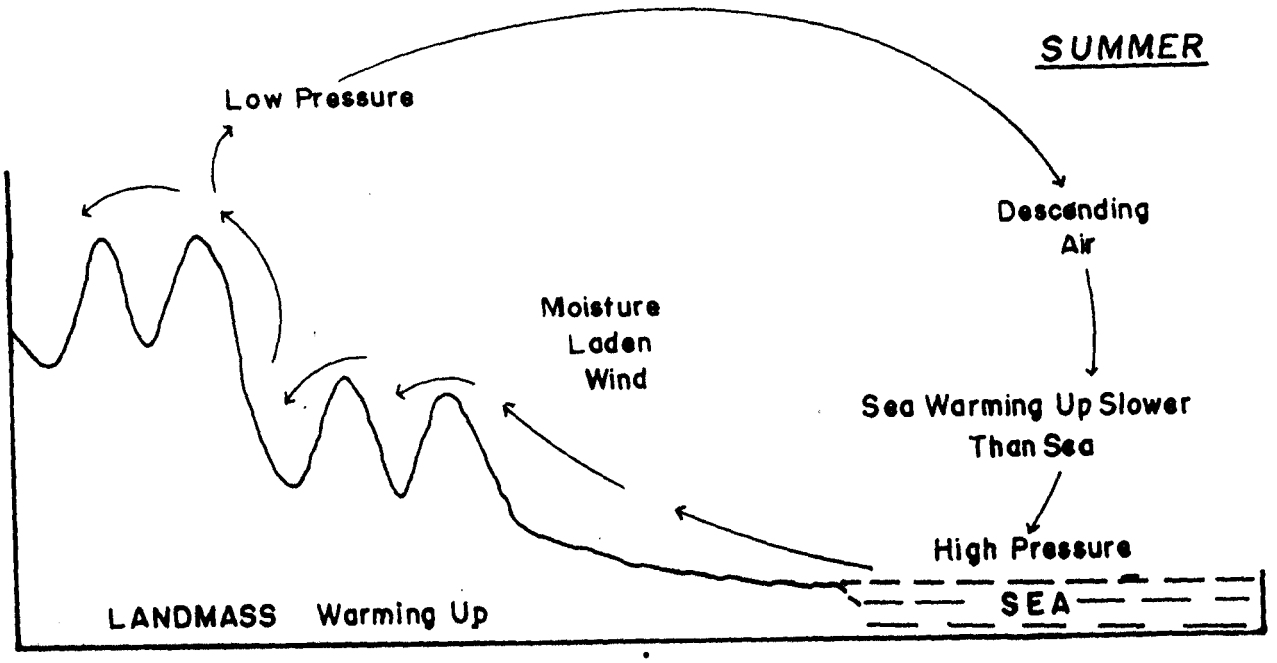


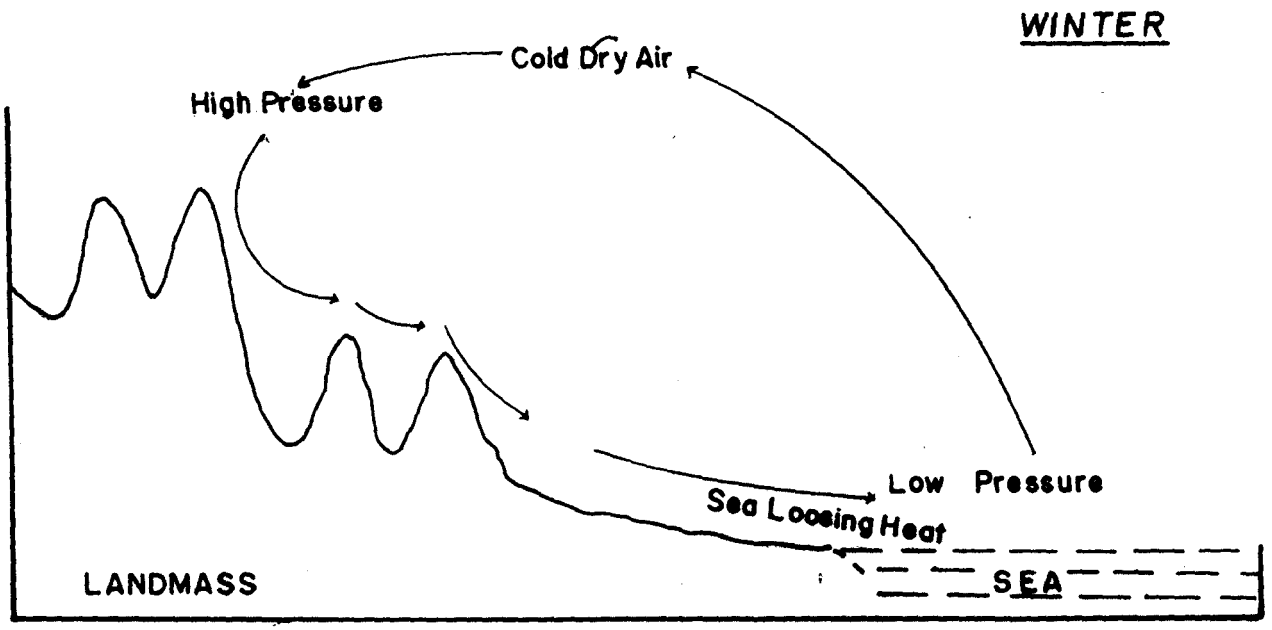
Fig 5. Cross section from Gurudongmar lake to Bay of Bengal

Moreover, the rainfall in North Sikkim is governed by the arrival of monsoon. During the month of March and April the cold heavy airmass over the Himalayas including Sikkim begins to warm up and gradually low pressure zone is created while high pressure zone is established over the Bay of Bengal and thus the moisture laden winds blow from Bay of Bengal to North Sikkim .(Fig. 6). Similarly, the reverse situation is created in winter where the sea cools faster than the land mass and the coldwind blows from the mountains to the plains.(Fig.6.).

2.4.1 PRECIPITATION

In North Sikkim the rainfall generally increases with increase in altitude. This trend is normally observed up to the village Manul located at 1408 m. a.s.l. altitude. But beyond this village the rainfall again starts decreasing with increase in altitude. At Dikchu (869 m. above m.s.l.) the annual rainfall is 3234 m.m. and at Gaon Sandong (1100 m. above m.s.l.) the annual rainfall 4243 m.m. But at Manul (1408 m. above m.s.l.) the annual rainfall is highest i.e. 5648 m.m. However, the annual rainfall decreases above Manul. This could be substantiated by the fact that as one goes higher up from Chungthang which is located at about 1631 m. above m.s.l. the annual rainfall keeps decreasing. Thus, Chungthang at an altitude of 1631m. above mean sea level receives an annual rainfall of 2447mm. Similarly, Lachen which is located at 2697m. above mean sea level registers an annual rainfall of 1652 mm. In the process and still at higher altitude Thangu, located at 3812 m. above m.s.l. receives the lowest annual rainfall of 821 mm . From the above variation in annual rainfall pattern, the entire north Sikkim is divided into three regions (Fig. 7) i.e. Dry High Zone where the annual rainfall is between 500 to 850 mm followed by the Continental upper zone where the annual rainfall ranges from





SCHEMATIC DIAGRAM SHOWING ATMOSPHERIC PRESSURE AND WIND DIRECTION IN NORTH SIKKIM AND BAY OF BENGAL. Source - Adopted from Tregear, T. R. China a geographical survey. Kent, Hodder & Stoughton, 1980. p. 5-36.

Fig 6.

1500 to 2000 mm and finally the sub-tropical Lower Humid zone where its mean annual rainfall ranges from 2447 to 5648 mm, (Table 2.2).

Table 2.2

MEAN ANNUAL RAINFALL IN NORTH SIKKIM

Zone	Elevation (in m.)	Mean Annual Rainfall (in mm)	No. of Annual Rainy days
(A) SUB-TROPICAL HUMID ZONE			
1. Dikchu	869	3234	152
2. Gnon Sandong (Dzongu)	1100	4334	N.A.
3. Mangan	1310	3240	161
4. Singhik	1402	2989	169
5. Manul	1408	5648	N.A.
6. Chungthang	1631	2447	N.A.
(B) CONTINENTAL UPPER ZONE			
1. Lachung	2633	1704	155
2. Lachen	2697	1652	161
3. Yumthang	3673	1474	160
(C) DRY HIGH SIKKIM			
1. Thangu	3812	821	100

Source: (i) The rainfall figure for (Dzongu) Gnon Sandong has been recorded by the Department of agriculture Government of Sikkim (ii) The rainfall figure for Manul has been analyzed by self from the records maintained by 46 Border Roads Task Force (iii) The rainfall records of the other stations have been taken from the report of the High Level Central Team on Land Use in Sikkim, 1981.

2.4.2 TEMPERATURE

North Sikkim could be divided into three distinct Climatic divisions such as Continental upper zone, dry high Sikkim and subtropical humid zone which are primarily based on a wide variation in temperature in the region.

For the present study, the temperature conditions prevailing at the subtropical humid zone and the continental upper zone have been taken into consideration.In view of non availability of data the temperature conditions of dry high Sikkim have not been analysed. The data on temperature have been procured from various sources such as the Border Roads Organisation, Department of Agriculture, Govt. of Sikkim and the report of the High Level central Team an Land Use in Sikkim, 1981 etc. Thus the temperature recorded at Lachung and Manul have been obtained from the Border Road Roads Organization. The following discussion on the temperature conditions in the region exclusively pertains to the subtropical Humid Zone and Continental upper zone.

2.4.2.1. PREVAILING TEMPERATURE IN CONTINENTAL ZONE

As has been said earlier, Continental upper zone in North Sikkim could be considered as an area extending between altitude 1600m to 3812m. The following picture emerges from the temperature conditions prevailing in the area. As Lachung and Lachen fall under the continental upper zone, the mean, mean maximum and mean minimum temperature recorded at these stations could be seen in Appendix v . The mean minimum temperature ranges between 3.9 $^{\circ}$ c in January to 19.50 $^{\circ}$ c in July at Lachung while at Lachen it ranges between 1.5 $^{\circ}$ c in January to 17.8 $^{\circ}$ c in July. Lachen therefore seems to be Colder

than Lachung. The mean maximum temperature ranges between 13.5 ° c in January to 26.25 ° c in July at Lachung while at Lachen the same varies between 6.9 ° c and 17.8 ° c in January and July respectively. The mean minimum temperature recorded at Lachung during the month of January is 5.75 ° c and in July the mean minimum temperature recorded is 12.75 ° c. At Lachen similarly the mean minimum temperature recorded in January is -3.9 °c where as in July the same is 8.4°c. The fluctuation between mean minimum and mean maximum temperature appears to be very singificant in this zone. From the pattern of temperature in these two stations it could be observed that the temperature starts rising from January onwards till October and again from the month of November onwards the same starts declining. Thus, based on the temperature pattern as highlighted above various season, in these areas could be demarcated in various seasons as follows.

Seasons	Months
1. Winter Season	November to march
2. Spring Season	March to May
3. Summer Season	June to October

2.4.2.2. SUB-TROPICAL HUMID ZONE

This climatic zone extends between altitude of 400 m. to 1600 m. in the region. The average mean, average mean maximum and average mean minimum temperatures recorded at Gnon Sandong (Dzongu) (1100m. above sea level) and at Manul near Mangan are given in Appendix VI. The mean temperatures recorded at Manul and Gnon Sandong in the month of January are 12.27° c and 11.25° c respectively which appear to be al-

most similar. Similarly, the mean temperatures recorded in the month of July are 24.667°c 24.50° c for Gnon Sandong and Manul respectively. The distribution of mean minimum and mean maximum temperature is shown in Appendix VI.

2.4.3 RELATIVE HUMIDITY

The relative humidity recorded at Gnon Sandong (Sub-Tropical) are presented in Table 2.3. At Lachen the average relative humidity ranges between 66 percent to 88 percent with the starting of the monsoon season, the relative humidity keeps increasing from 71 percent in April to as much as 88 percent in the month of August. There after at starts declining from the month of september till it reaches its minimum i.e. 66 percent in the month of December. At Gnon Sandong the relative humidity invariably remains above 70 percent except for the month of May and reaches as much as 85 percent in the month of July coinciding with the heavy downpour.

Table 2.3

MONTHLY AVERAGE RELATIVE HUMIDITY RECORDED AT GNON SANDONG AND LACHEN, NORTH SIKKIM

Months	Gnon Sandong	Lachen
	Rel. Humidity (in percentage)	Rel. Humidity (in percentage)
January	79	68
February	82	70
March	77	66
April	71	71
May	63	76
June	79	78
July	85	78
August	82	88
September	76	86
October	74	76
November	72	68
December	70	66

Sources: (i) The data for Gnon Sandong has been obtained from the Agriculture department, Government of Sikkim (ii) Lachen has been taken from Mukhopadhyay, S.C, Tista Basin, A.study in fluvial geomorphology. Calcutta, K. P. Bagchi 1982. Page 25-31.

2.4.4 WIND AND SNOW LEVEL.

Almost throughout the year the southernly wind predominates driving humid air masses in the inner valleys and crosses the Chungthang gap to enable the conifer forests to grow in the valleys of Lachen and Lachung. This scenario is observed up to Yumthang.

There is a marked difference in snow level in north Sikkim. In the southern side of Mount Kanchengyao the snow level is 4650m. Whereas in the northern side the snow level varies between 5700m to 6000m indicating relative dryness towards the northern region. The timber line at Thangu is at about 4200 m and the forest boundary is at an altitude of 1800m. above mean sea level.

2.5 VEGETATION OF NORTH SIKKIM

Based on the vegetative structure the entire Sikkim has been divided into three vegetative zones i.e. Tropical Humid Zone, Continental upper zone and Dry High Zone.[7] Similarly adopting the same approach, North Sikkim is divided into three important climatic zones i.e. sub-tropical Humid zone, continental zone and Dry High Zone. In place of tropical humid zone, sub-tropical humid zone has been proposed as there are no *Shorea robusta* tree species in north Sikkim. Moreover the climatic data on temperature and precipitation of the region is well suited for the assessment of a hierachical bioclimatic classification of the Holdridge "Life Zone" classification. This system has been adopted by F.A.O. (1988) while formulating environmental guide lines for resettlement projects [8].

The names of the botanists and plant explorers who have contributed towards the vegetation of north Sikkim have already been reviewed in Chapter I and their observations on the vegetative zones and the forest types of North Sikkim are summarized in the next page.

7. Schweinfurth, U. Die Horizontale and Vertikale verbreitungder vegetation in Himalaya. Bonner Geogr. Abh. H. 20, 1957 p 372.

8.Burbridge, Peter R., Norgaard B. Richard., Hartshorn Gary S. Environmental guide lines for resettlement projects in the Humid tropics. FAO Rome. 1988.

2.5.1 SUB-TROPICAL HUMID ZONE

The altitude of this vegetation zone generally ranges between 800m to 1600m above sea level. In the lower hot and moist valleys of North Sikkim the prevailing vegetative structure is found to be a mixture of tropical and sub-tropical species.

The details of the important species found in this zone are as follows :

Acer sp.	*Magnolia Cambelli*
Alnus sp.	*Machilus edulis*
Aralia sp.	
Betula sp.	
Berberis sp.	*Michelia Carthcartii*
Buddleia sp.	*Prunus*
Glcichenia sp.	*Pyrus*
Hydrangea sp.	*Pieris llek*
Quercus pachyphylla	
Quercus annulata	
Quercus lanuginosa	
Quercus lamellosa	*Styraok*
Rhododendron arboreun	*Sorbus*
Rhododendron dalhousiac	*Symplocos*
Rhododendron barbatum	*Sikkimia*
Rhododendron falconeri	

The important plants that grow in the undergrowth of the lower humid zone forest of North Sikkim are *Aracas*, *Impatiens*, *Seneciones*, *Helichrysum*, *Epilobium*, *Pediculars cordyalis* etc. The important grasses are *Arundinella bengalensis*, *Saccharum*, *spontaneum* and *Setaria palmifolia* etc. at an elevation of 1700 m. *Themeda candata* with *Cnicus sp.* form dominant grasses.

The bamboos form main components of the grassland in this region. These include *Chimonobanibus callosa, Cephalostachy mlatifolium Dandrocalamus Sikkimensis*. The valuable broom grass *Thysanolaena agrostis* is widely cultivated in this zone for commercial purposes. In the landslide areas, the first plant to colonize is *Alnus nepalensis*. However on the newly cut rocks for road construction, the first species to colonize is *Thysanolaena agrostis*. This zone has also taken up cardamom (*Amomum cardamom*) plantation in extensive scale particularly in the shady areas and this unique system has increased the forest cover in this zone. The classification of the decidous and high cloud forest in this zone are as follows :

Elevation	Species
1800-2100 m.	*Michella, Cathertic, Magnolia, Machilus edulis.*
2100-2400 m.	*Quercus lamellosa, Magnolia excelsa, Magnolia cambelli*
2400-2700 m.	*Quercus Lamellosa, Quercus Pachyphylla, Acar, Magnolia, Arundinaria, Rhododendron.*

At an elevation of 2000 m. the transition of the tropical hill forest to decidous hill forest seems to be complete and above 2500m. *Rhododendron sp.* is extraordinarily widespread. However,above 2700m. altitude the conifers generally take over.

2.5.2 Continental Upper Zone

The elevation of this zone generally between 1600m to 3812m above mean sea level. The narrow Chungthang gap separates the lower sub-tropical humid zone from Upper Continental Zone. In this upper part of Sikkim *Rhododendron arboreum*

is distributed in the areas ranging in altitude between 1500 m. to 1800m. *Taxus baccata* appears at 2100m. and *Tsuga species* at 2100m. altitudes. The slope above Chungthang is normally barren and remains mostly grass covered and few pine trees occur only in the ridge (plate 5). The plant species of Lachen and Lachung areas are described separately below.

2.5.2.1 Vegetation of Lachen Valley

The Lachen area commences from Chungthang and covers the western tributary of Lachen river upto Lachen (2400m to 3300m). The vagetation recorded in this area at an elevation of 2400m to 3300m. are discussed below :

Species at lower river beds of Lachen	Range of distribution at different elevation
1. *Larix Griftithii*	2400m - 3300 m
2. *Tasuga dumosa*	2100m - 3000 m
3. *Picea morind*	lower limit 2400 m
4. *Alnus nepalensis*	upper limit 1800 m

The mixed pine forest *Taxus baccata, Junipers* are supported by extensive larch trees which are characteristically the most important trees of the inner valleys of Eastern Himalayas. Several deciduous trees appear in between the above mixed pine forests and the details of these species are recorded in the next page.

(a). Deciduous trees (generas)

Alnus	*Pyrus*
Acer	*Prunus*
Betula	*Salix*
Corylus	*Sorbus*
Fraximus	
Juglans	

(b). Shrubs:

Berberis	*Rosa*
Euonymus	*Rubus*
Elacagnus	*Rhododendron*
Gaultheria	*Ribes*
Llek	*Sambucus*
Litsaea	*Spirala*
Lonicera	*Virburnum*

In addition to above, the following species plants of North America and South East Asia are also found in this belt.

1. NORTH AMERICAN PLANTS :

Aralia	*Magnolia*
Buddlein	*Panax*
Camellia	*Sassafras*
Deutzia	*Stauntonia*
Enkianthus	*Skimmia*

2. SOUTH EAST ASIA PLANTS :

Egelhardtia	*Marlea*
Lauzaces	*Orchis*

2.5.2.2 VEGETATION OF LACHUNG VALLEY :

Lachung covers the Eastern territory of the Continental moderate Sikkim. As the valley opens, the first hamlet to come across is Khedum. Khedum is located at the same sea level as Darjeeling, yet there is a marked difference in vegetation cover in this micro region.

This valley contains rich deciduous cloud forests alongwith inner conifer forests and also deciduous trees similar to Lachen valley. The pine forest continue to grow in the upper region of the valley of Lachung and reach their upper limit at 3900m. The vegetation of the summer grazing grounds of the upper Lachung valley is briefly described below :

(a) Yumthang: The valley is generally boggy and grass covered along with *Hippophae salicifolia*. The pine forest is dense particularly on the slopes towards Yumthang glacier.

(b) Taukra : The valley floor of the grazing ground is covered with dense *Rhododendron species* and grasses.
(c) Sebu Valley : In Sebu Valley *Larix Griffithii, Picea spinulosa* and *Tsuga dumosa* reach their upper limit of 3200 m and are then replaced by *Abies densa* along with *Prunus, Pyrus, Acer* and *Rhododendron*. From 3300 m the *Juniperus recurva* takes over. This valley is famous for cow farming. Valley floor of Sebu Chu is covered with dense *Rhododendrons* and growth of *Aconitum nepalensis* is prominent.

(d). Gora valley: The south face of the valley bear pine forests and the rest are grassy meadows.

2.5.2.3 SUB-ALPINE ECOSYSTEM

Generaly at 3900 m the conifer forests change into sub-alpine forest level in North Sikkim. This level is generally made up of *Juniperus, Betula, Salix, Pyrus aucuparia* and *Rhododendron*. Area between Lhonak and Zema subalpine *Rhododendron* forests with thick bamboo under growth are found in sheltered places.

Thangu is the last home of the subalpine forest in the Lachen valley. The existing generas are *Betula, Lonicera, Sorbus* and *Rhododendron*. In the Lachung region *Rhododendron* alongwith *Salix, Pyrus foliolisa* and *Pimicarophylla* form an impassible dense forest at upper Tankara and Sebu valleys. Yume Samdong (3900 m) the highest part of the Lachung valley is the last level for sub-alpine, forest which consists of *Rhododendron*, *Junipers, Salix, Betula, Ephedra* and *Lonicera* showing the continental eco-system.

2.5.2.4. ALPINE ECOSYSTEM

Alpine level begins from the timber line. In general in Eastern Himalaya, the *Rhododendron* carries across to the alpine level, however, in North Sikkim the herbal flora increases in abundance and the coverage of *Rhododendron* decreases and there is a distinct transition between moist alpine zone and the alpine steppe.

The alpine vegetation of the upper Zemu valley is divided into three parts i.e. North exposed, the South exposed and the area in the immediate vicinity of the glacier.

(i) SOUTH EXPOSED SLOPES:

The exposed slopes are at a height of 5085m (Nachegah) and 5150 m (Tangchung). The area which faces the warm moist air streams from South is snow free in the early part of the year and countless rivulets are dried and in summer, the flora typical from 3900 m. climbs up on these slopes upto 5100 m. The species are as follows:

Anenome	*Cassiope*
Anaphalis	*Draba*
Corydalis	*Gentiana*
Ieontopodium	*Saussurea*
Pedicularis	*Sakifraga*
Potentilla	*Sedum*
Primula	*Salix*
Rheum	*Siveertia*

(ii). NORTH EXPOSED SLOPES.

The North exposed slopes have snow between 4200 m and 4500 m. during the month of July and the area is almost completely covered by *Rhododendron* bush.

(iii) VEGETATION IN THE GLACIER REGION :

The area around the glacier is barren composed of sleep hill slopes. The *Rhododendron* is far more sparse in this area alongwith *Gentiana, Primula* and *Salix*.

2.5.3 DRY HIGH SIKKIM

The Dry High Sikkim zone constitute the vast streatches and gently rolling countryside of Lhonak Highlands and Chho-Lhamo Highlands. The Lhonak Highlands are surrounded by snow covered peaks like Leh in Lhadak. The vegetation of these two highlands are described here separately.

2.5.3.1. LHONAK HIGHLANDS.

The vegetation limit in this valley is upto 5400m. The vegetation is mainly of Tussock type and *Juniperus* and *Rhododendron* grow close to the ground in hemispherical shrubs. The trees and bushes are completely absent. The prominent plants recorded in thisregion in addition to the above two species are:

Androsa selago	*Potentilia microphylla*
Alardia sp.	*Potentilia frusticosee*
Brayo sp.	*Primula muscoides*
Cochlearia sp.	*Polygonum nummalarefolium*
Cortia sp.	*Polygonum Hookeri*
Draba sp.	*Rheum nobile*
Lanuginosa sp.	*Rheum spiciforme*
Meconopsis horridula.	*Saxifraga imbricata*
Myosatis Hookeri	*Saxifraga ramulosa*
Saussurea sp.	
Thlaspi sp.	
Veronica sp.	

2.5.3.2. Chho-Lhamo Highland

Chho Lhamo area starts from upper Thangu. The vegetation structure shows more of the alpine steppe and there is gradual transition of wet alpine level of Thangu & Chopta area to dry alpine steppe of the Chho-Lhamo Highlands.

The vegetation zone in these highlands goes upto 5000 m. in the southern flanks of Mount Kanchengyao while area of Kanchengyao facing towards north, the vegetation level is between 5700 m to 6000 m. The plant recorded in this highlands are:

(a) In flatland swamps	*Zannichellia palustris Ranunculus aquatilis*
(b) In dry areas	*Arenaria* (hemispherical cushions)
Androsace	*Artemisia Leontopodium*
Astragalus	*Mysosolis*
Carek Hoorecroftii	*Meconopsis horridula*
Drava	*Nardostachys*
Delphinium	*Oxytropis chiliophylla*
Ephedra	*Pedicularis*
Erigieron	*Rosa*
Gentiana	*Rhododendron nivale*
	Sibbaldia Sedum

The rocks are mostly covered with lichens with patches of *Androsace* and *Sedum*.

2.6 The Soils of Sikkim.

The National Bureau of Soil Survey and Land Use Planning, Culcutta have identified 6 soil series Sikkim and the details are as follows:

Soil Series	Soil Sub-Group
1. Markong Hilley	Typic Haplumbrepts
2. Gompa	Lithic Haplumbrepts
3. Lingtse, Losep, Namthang	Typic Dystrochrepts.
4. Machong	Lithic Dystrochrepts.
5. Thekabong, Chatrikhola, Phadamchen	Umbric Dystrochrepts.
6. Putuli, Simkharka, Nandugaon	Lithic Udorthents.
7. Majhitar	Acquic Udifluents.
8. Tarku	Ultic hapludalfs.

The soil are mostly of Inceptisol, Entisol and mollisols orders.

Nutrient Statue of the Soils:

Bhutia, *et al* (1986) analyzed over five thousand soil samples all over Sikkim and mean values of pH, organic matter, Nitrogen, Phosphorus and Potassium are given in table 2.4.

Table 2.4

Mean Values of pH, Organic Matter, Nitrogen, Phosphorus and Potassium in the Soil of Sikkim.

Type of Test	South	East	West	North
1. P.H.	5.75	5.80	5.5	5.23
2. Organic Matter%	3.09	4.17	2.88	4.40
3. Nitrozen kg/Hact.	477.00	422.00	383.00	482.00
4. Phosphorus ($P_2 0_5$) (PPM)	30.99	24.75	24.54	37.18
5. Postassium ($K_2 0$) (PPM)	138.00	127.00	142.00	93.00
No. of soil samples	1392.00	1380.00	1722.00	749.00

The land Use and Environment Department conducted the soil survey of Rongnichu Catchment (East Sikkim) in different altitudes ranging from 1,000 to 4,400 m. The findings are given in Table 2.5 and Table 2.6.

Table 2.5

Soil Reaction and Mechanical Composition

Altitude	Soil Reaction	Mechanical Composition			Texture
	(pH)	Clay%	Sand%	Silt%	
1000 m	5.5	6.5	87.8	5.6	Loamy sand
2800 m	4.7	28.5	37.4	34.0	Silty clay loam
3200 m	5.6	17.5	53.8	28.6	Silty Loam
3900 m	5.2	32.5	41.8	25.6	**Silty clay Loam**
4400 m	4.7	27.5	47.8	24.6	Silty Loam

source : Land Use & Environment Department, Govt. of Sikkim, Gangtok.

These results indicate that the soils are mostly acidic with PH ranging from 4.5 to 5.8. Inspite of being rich in organic matter (2.07 to 5%), they are deficient in available nitrozen and phosphorus. The potassium content has been assessed as low.

Table 2.6

RONGNICHU (EAST SIKKIM) NUTRIENT STATUS OF SOILS AT DIFFERENT ELEVATIONS

Altitude (m)	Organic matter	N (kg/ha)	P (PPM)	K (PPM)	Zn (PPM)	Cu (PPM)	Fe (PPM)
1000	4.15	193	50.7	91	1.3	0.22	5.1
2800	3.15	281	6.2	123	1.5	0.30	44.3
3200	2.07	235	61.6	191	1.6	0.26	20.2
3900	3.39	306	25.4	195	1.6	0.26	22.1
4400	5.00	413	4.9	219	0.7	0.15	67.2

Source : Land Use & Environment Department, Govt. of Sikkim, Gangtok.

The soils in general are characterised by low PH, high organic matter, low cation exchange capacity, and high lime requirement. Inspite of high organic matter content the available Nitrogen content of the soils is not upto the mark. The soils have moderate Phosphorus status but fairly well supplied with Potassium. Deficiency of Ca, Mg and among micronutrients Zinc, Copper, Boron and Molybdenum are commonly observed. On the other hand the elements like Fe, Mn. Al are at toxic level. Soils have varied colours as grey, brown to black, red, yellow miked red and black. Red and yellow subsoils are very common. At lower altitude grey, mixed red and black soils are common and higher altitude brown forest soils are common. The soil are by and large loamy in texture with varying amounts of coarse fraction and hence susceptible to erosion. The soil depth and fertility depends on the location whether on a flat valley or on moderate slope or on a steep gradient. However, on an average

the soil depth at hill slopes is reported to be 60 to 90 cms. In North Sikkim the details or the soil report pertains only upto Lachen and Lachung valleys only. No soil studies have however been carried out in the Lhonak, Muguthang and Chho-Lhamo areas.

2.7 PHYSIOGRAPHY AND DRAINAGE.

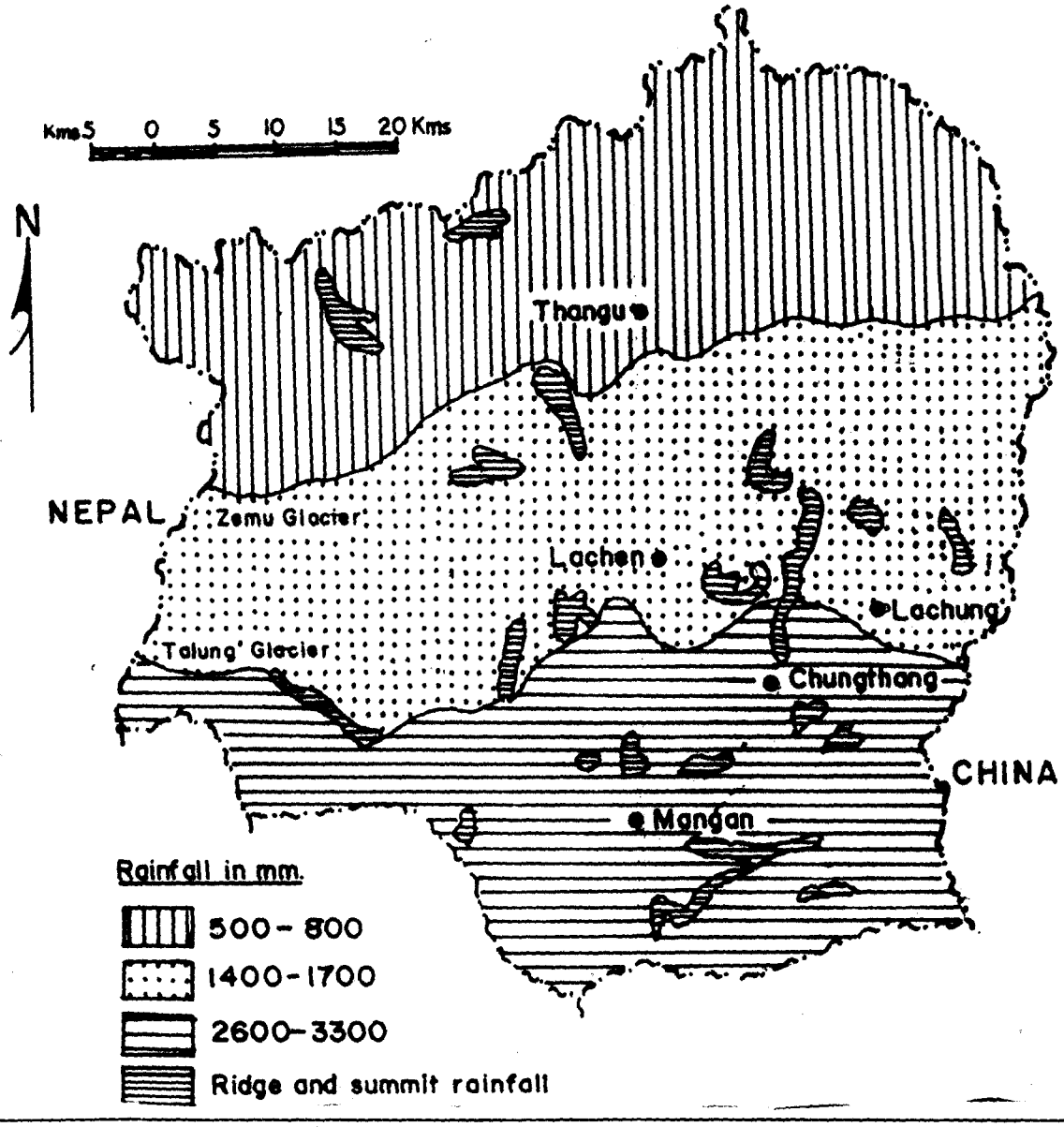
The North Sikkim is divided into three important physiographic regions i.e. the elevated dry area of Lhonak and Chho-Lhamo, the U shape valleys of Lachung, Lachen, Zema and Tholung and the V shape valleys of Dzongu, Mangan, Mangshila to Kabi. The entire area of North Sikkim is hilly and mountainous barring a few hundred square kilometres of flat and undulating land in Lhonak and Chho-Lhamo region. The physiography of north Sikkim have been plotted in Fig.8., the general trend of the mountains is from east to west but the chief ridges of Sikkim runs more or less in the north to south direction.

The North Sikkim is drained by river Tista along with its innumerable tributories. The name of the river Tista has been derived from the word "Trisrota". The five drainage zones or water shed and the major tributories of river Tista are plotted in Fig.9. and the details are discussed belowed.

2.7.1. LACHEN WATER SHED

Lachen water shed is the biggest area of the Tista catchment in North Sikkim. It is in this zone where Tista river originates from Pauhunri glacier (27 55'N 88 45' E) near Dongkya La (7128 m.) in the east. The ista river at the source is known as Chumbu Chu and other sources of this river are Gurudongmar and Chho-Lhamo Lake. The river takes a southward course at Donkung and Gyagong and further southward direction at Tsopta and meets

Fig 7. DISTRIBUTION OF RAINFALL IN NORTH SIKKIM



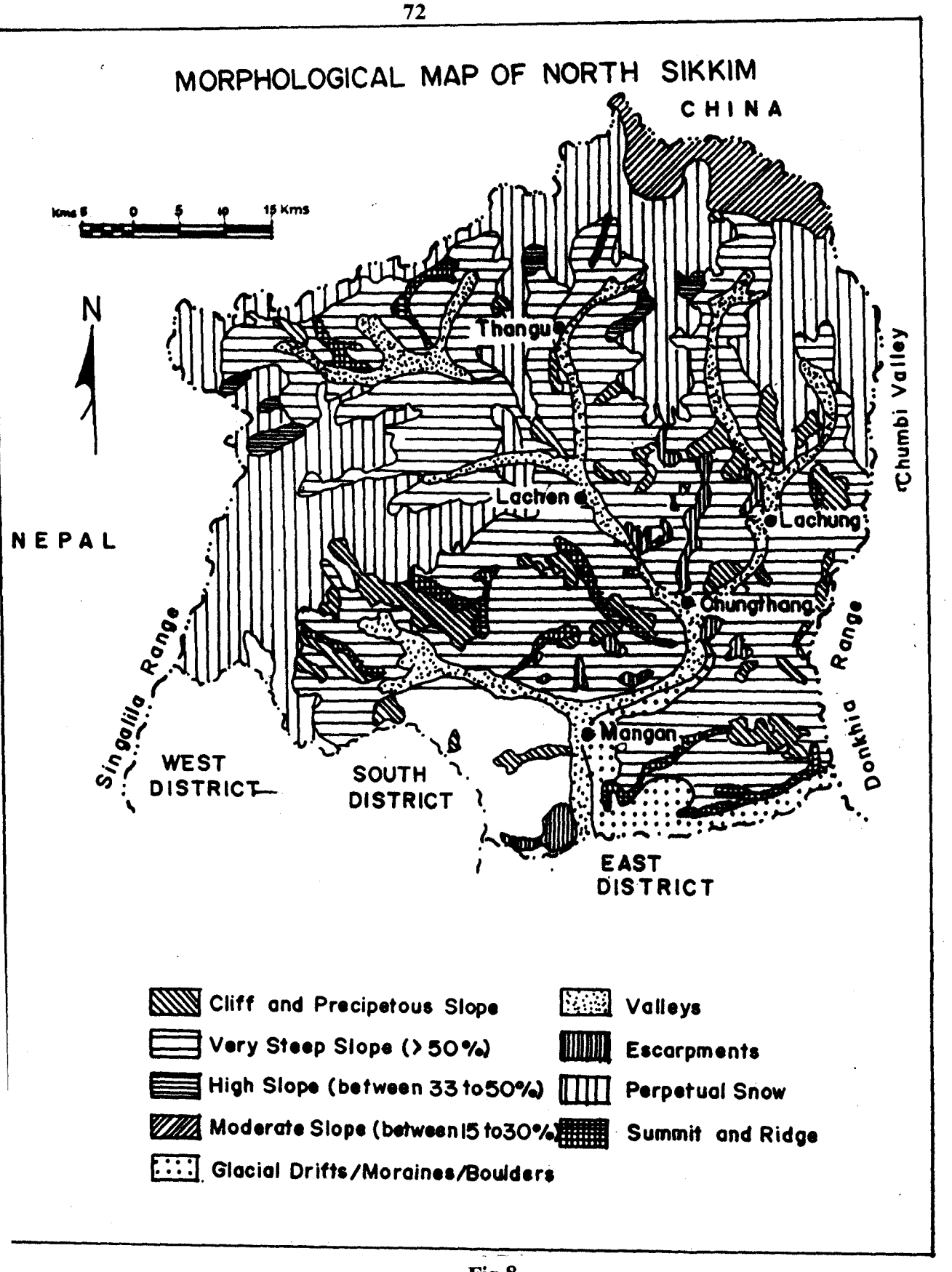

MORPHOLOGICAL MAP OF NORTH SIKKIM
CHINA
Kms 5 0 5 10 15 Kms
N
Thangu
Lachen
Lachung
Chungthang
Mangan
NEPAL
Singalila Range
Chumbi Valley
Donkhia Range
WEST DISTRICT
SOUTH DISTRICT
EAST DISTRICT
Cliff and Precipetous Slope
Very Steep Slope (> 50%)
High Slope (between 33 to 50%)
Moderate Slope (between 15 to 30%)
Glacial Drifts/Moraines/Boulders
Valleys
Escarpments
Perpetual Snow
Summit and Ridge

Fig 8.

the Zema Chu at Zema (27 45'N; 88 32'E). The upper course of Chumbu Chu is marked by development of wide, flat with U shape valleys known as Chho-Lhamo regions and similar landscape may be seen upto Talum near Yakthang in North Sikkim. The Lhonak region of this water shed is seperated by high ridges of Lunak La (18000 ft) running from north to south. The landscape of Lhonak region is very similar to that of Chho-Lhamo region. The Muguthang is a small village with small settlements in the area. The important tributories of Lhonak Chu draining in this area are Naku Chu, Khora Chu and Goma Chu. The important sources of Lhonak Chu are Lhonak glacier, Langbu glacier, Changsang glacier, Ghora Lake or Ghora Cho etc. The Zemu Chu or Zemu meets the Lhonak Chu at Zedong and finally at Zema it meets the river flowing from Chho-Lhamo regions. The Zemu river derives its source from Zemu glacier which is the biggest glacier in North Sikkim. From Zemu onwards the river is known as Lachen Chu and as the river descends the vallies starts to contract and take the form of V shape. The Lachen and Lachung river meet at Chungthang (27 36' N; 88 40' E).

2.7.2. LACHUNG WATER SHED

The Lachung region is drained by Lachung Chu and its main tributory is Sebazung Chu. The main source of Lachung Chu is Chaugme glacier, Sebu Lake, etc. The valley is flat and takes the form of U shape upto Khedum near Chungthang.

The other three water sheds in the region are Tolung water shed, Chungthang, Mangan and Hee Gyathang, Mangan Samdong watershed.

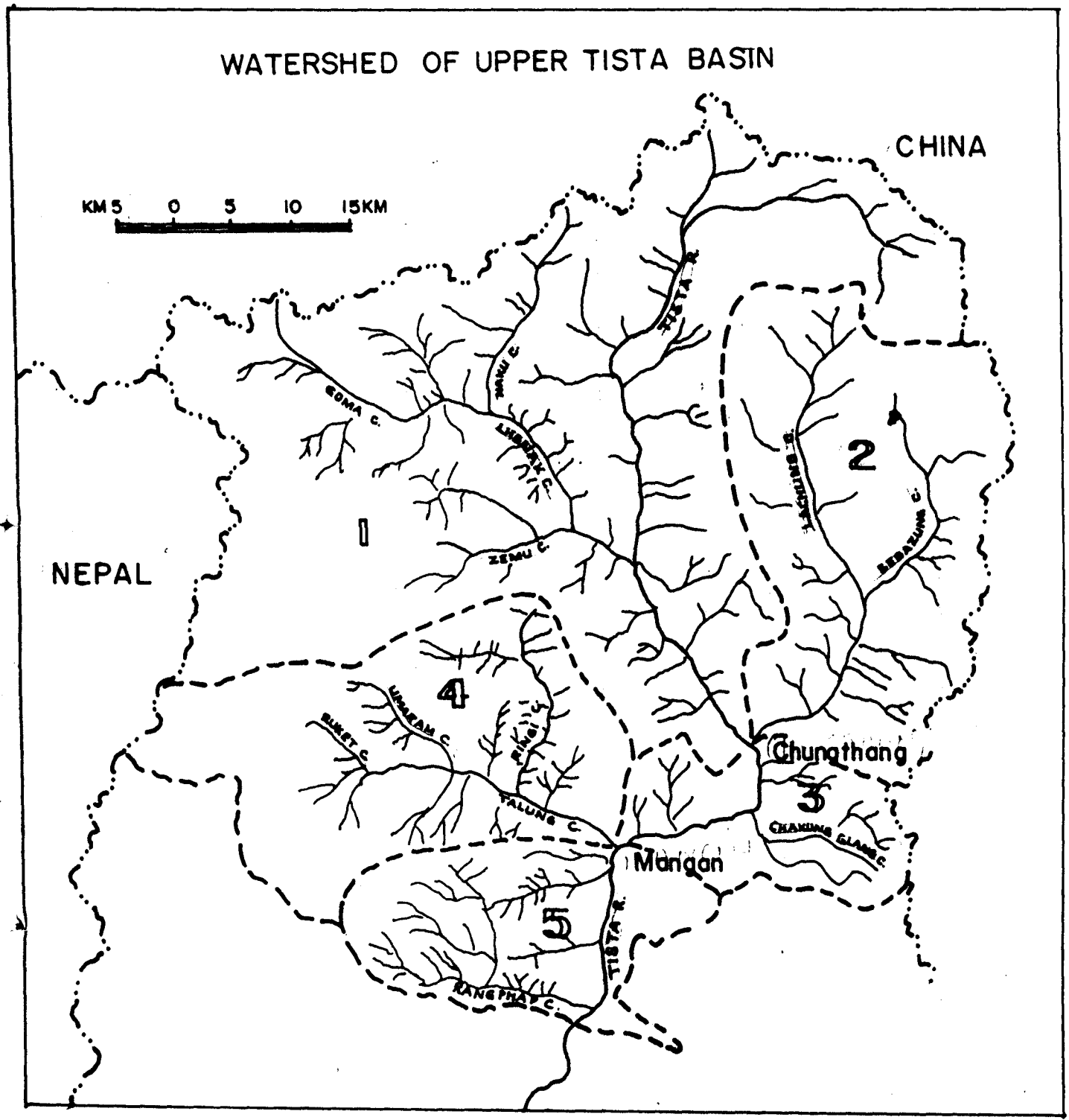

WATERSHED OF UPPER TISTA BASIN
CHINA
NEPAL
KM 5 0 5 10 15KM
TISTA R.
EOMA C.
ZEMU C.
LACHUNG R.
REBATUNG C.
1
2
3
4
5
Chungthang
Mangan
TALUNG C.
TISTA R.
RANGPHAO C.

Fig 9.

CHAPTER III

GEOGRAPHICAL REQUIREMENTS OF LIVESTOCK REARING IN NORTH SIKKIM

3.1 INTRODUCTION.

Geography plays an important role in the rearing of livestocks in any region. Growth and development of livestock largely depends on favourable georgaphical conditions that are mainly of physical and socio-economic in nature. The physical conditions incorporate large expanses of grasslands, fertile soil that can promote the growth of nutritious grasses, favourable terrain conditions, availability of water, temperature conditions as per the requirement of the livestocks and required amount of annual precipitation etc. The socio-economic conditions largely include the economic conditions of the farmers, their educational status and the infrastructural facilities available in the region. These infrastructural facilities include adequate accessibility in terms of a good network of transport and communication for marketing of the products, institutional facilities such as credit facilities through banks and cooperatives, extension services for adoption of scientific and modern innovations, adequate facilities for scientific training of the farmers educational status and the percapita income of the farmers and so on and so forth.

Keeping the above discourse in view, it will be meaningful to discuss the physical and socio-economic factors that affect livestock rearing in North Sikkim these will throw light on the problems and prospects of livestocks rearing as an important economic enterprises in this region.

The identified ecozones of North Sikkim are beset with innumerable physical and socio-economic problems that impede the process of livestocks development in the region. The factors that contribute to these problems include prolonged and severe winter especially in the dry high and continental zones, high incidence of rainfall particularly during monsoon season in the sub-tropical zones, vast expanses of land with steeper slopes, high altitude, relatively less ploughable areas, high proportions of unimproved grasslands, low soil fertility, an inadequate network of transport and communication system, lack of infrastructural facilities for processing and marketing of the milk and milk products and last but not the least the prevailing socio-economic conditions of the livestock Farmers in the region.

The effect of some of the above factors appear to be mild in certain eco-zones and severe in others. Hence with a view to understanding the spatial variations of these factors, their magnitude of variations and inter relationship among them, an arbitrary grouping has been done which include physical factors, biological factors, natural and man induced hazards, socio-economic factors, communication and transport, infrastructure for processing and marketing of livestock products and lastly the requirement of fodder resources. The following discussion thus highlights the above said factors affecting livestock development in the region.

3.2 Physical factors

The key physical factors that would primarily affect the livestock population and their growth pattern are mainly the bio-climatic regime, availability of water, soil fertility status and the general land form characteristics.

3.2.1 Bio-Climatic regime

Among the environmental factors, atmospheric temperature has the greatest influence on the important physiological functions of livestocks change in climate and atmospheric temperature thus affect the internal combustion i.e. metabolism, respiration, body temperature, and behaviour habits, fertility, and production etc. of an animal.[9] In European breed of cattle, the milk yield is not affected between 4°c to 12°c temperature. However, the milk yield is found to have decreased with the temperature going below 4°c. The same trend of decrease in yield has also been observed when the temperature is above 21°c[10] . It has been shown that different kinds of animal diets play a significant role in combating the cold or low temperature conditions, thereby increasing the resistance of the animals against the environmental hazards (Table3.1).

Table 3.1

Critical Temperature of animals at different levels of feeding

Types of animal	Animals fed on maintenance ration	Animals given full feed
Fully fleeced sheep	(-)6.1° c	(-)4.4° c
Short coated steer	10° c	(-)9° c
Fully coated steer	(-)10° c	(-)20° c
3 day calf 1 gal milk/day	12.8° c	
20 day calf 1.5 gal milk/day	7.8° c	

Source: Joyce, J.F, *Review Tussock Glassland Mountain Lands Institute New Zealand.* 14, 1968. p. 2-10.

9. Thomas, C.K. and Sastry, N. S. R. Problems of Dairy production in hot regions. In (Dairy bovine production, New Delhi, Kalyani publishers, 1991. p 106-126.
10. Hafez, E.S.E Bioclimatological aspect of animal productivity. *World Review of animal production,* 3(14), 1967. p. 22-37.

Table 3.1 presents the critical temperature of animals fed at different levels of feeding below which the animals must produce more than normal body heat. However, below this temperature the heat production must increase regardless of food supply if the animal is to survive. At low temperature therefore extra food is needed by the animals to cope up with the cold condition. A well-fed animal can thus withstand as low a temperature as minus 20° C. As yak is a high altitude animal and is able to survive even in very low temperature conditions, it could be infered that a well-fed yak with plenty of hairs might also withstand a low temperature even less than minus 30° C. Satisfactorily high levels of milk production with higher temperature range have been achieved by Friesian cows kept under very hot conditions the maximum and minimum temperatures being 41° C and 26° C respectively in United. Arab Emirates by provision of shade, water spray, good management and feeding.[11] There are some specific breeds which can also tolerate and adapt to colder conditions much better than the other breeds. As for example milk production of Jersey cows decreased sharply when the atmospheric temperature dropped below 1.7° c. However, Frisian cows remained unaffected even at (-) 12° C.[12] With a view to understanding the climatic conditions of north Sikkim, informations were collected from different sources such as villages, and development blocks etc. situated at varying altitudes as have been indicated in chapter II. For temperature studies, the villages covered were Gnon Sandong (1100 m) and Manul (1408m) falling Under sub-Tropical zone and Lachen (2697m) and Lachung (2633m) Under the continental zone. Similarly for rainfall studies the villages covered include Dikchu and Thangu which are situated at 869 mtrs and, 3812 mtrs altitudes above mean sea level respectivety. As far as the study of relative humidity is concerned, the villages covered were Gnon Sandong and Lachen. From the above studies concerning cli-

11. Ansell, R.H. Maint. European dairy cattle in the near east. *World Animal Review, 20. 1968. p. 1-7.*
12. Yeck, R.G., Stewart, R.E. A ten year summary of the psychoenergetic laboratory dairy cattle research at the University of Missouri. *Trans American Society of Agricultural Engineering,* 2, 1959, p 71-77.

matic conditions in North Sikkim the following picture emerged. The average monthly minimum temperature recorded at Lachung varies from zero degree centigrade in the month of November to as low as minus 5.75° C in the month of January. In the month of February, the temperature recorded is minus 3.25° C. The mean minimum temperature in the same area shows an increasing trend and keeps rising from the month of March onwards with the advent of summer i.e. from 1.25° C to 11,50° C in August.

And this increasing trend of temperature persists till October. In comparison village Lachen seems to be colder than Lachung. Its mean minimum monthly temperature recorded is minus 1.4° C in the month of November and this minus trend of low temperature continues till April (-2.0° C). The lowest mean minimum temperature recorded in Lachen is minus 9.7° C in the month of January. The mean maximum monthly temperature recorded in these two villages ranges from 13.25° C to 26.75° C and 6.9° C to 17.2° C in Lachung and Lachen respectively. Therefore neither the minimum temperature of minus 10° C nor the maximum temperature of 27° C will affect the productivity of Dairy cattle and other livestocks in the region. However, these extremes of temperature have a definite bearing on the poultry farming. In case of dairy animals the only precaution to be taken in this zone is to provide an extra feed supplement over and above the general maintenance ration which start from the month of November till March for that of Lachung and the adjoining areas and from November to April for that of Lachen. It could, therefore, be concluded that the prevailing temperature conditions in the continental zone are the most ideal for the growth & survival of exotic European breeds. Manul lying at 1408 m. above mean sea level in the lower sub-tropical zone has the mean minimum temperature ranging between 3.3° C in the month of January to as much 18° C in that of July. The mean maximum

temperature of 30° c has also been recorded here in the month of August. It has, however, been observed that these extremes of temperatures have not adversely affected the productivity of livestock including poultry anywhere in the region. Similarly, the pattern of rainfall and the relative humidity in the region have not been detrimental to the productivity of livestocks.

3.2.2 Avialability of Water

Water is regarded as the greatest limiting factor in livestock management. Without water the animal would die in a comparative shorter period of time. As a matter of fact, the animal body contains 65 percent water which is mostly lost through skin, lungs, urine, faces and considerably through milk in milch animal. Therefore, such loss of water in the animals has to be covered up by providing adequate clean water. In livestock, water plays a very important role in the process of digestion in rumen by creating media which enables bacteria to grow and helps digest coarse cellulose roughages. The water requirement during summer is nearly 50 to 75 per cent more than that of their normal requirement. In milch animal 1 lit. of water is required for every litre of milk produced. Hence adequate amount of water should be made available to livestocks either in the livestock sheds or in the grazing fields.

In North Sikkim water has never been a problem particularly during monsoon season i.e. from May to October. But the monsoon is immediately followed by a prolonged drought period that starts from November and lasts till April and during this period the livestocks have to depend largely on various water sources such as river, ponds and lakes etc. for their water needs. Many of the grazing grounds are found to be very steep and there are neither ponds nor are there lakes around the animals, there-

fore animals have to travel down to the river and other sources for water. Thus in the process much time is lost on travel of the animals from one place to the other. It is therefore imperative that in such areas, necessary provisions be made for sufficient water supply for the animals. By and large, Sikkim is endowed with potential sources of glaciers, and there are numerous streams and lakes which serve as perennial sources of water. Unless the utilization of these sources is properly geared up, to the optimum level it will lead to a situation of artificial water scarcity thereby affecting the growth and productivity of the animals. On the other hand, in north Sikkim the rainfall too decreases with gradual increase in altitude. Though the high altitude areas in the region receive relatively less rainfall, this phenomenon may not affect the livestock farming particularly dairy cattle in view of the fact that such requirement of water could be met from various other sources such as streams receiving water from melting snow, ponds Organised system of water supply etc. More over sheep rearing which is highly susceptible to both snowfall and higher incidence of annual rainfall. However, a study carried out in New Zealand mountains which is contrary to the above fact shows that the cattle farming is well suited to high rainfall areas vis-vis the drier parts of the country [13] . In view of this, the problems and prospects of livestock farming in North Sikkim need further research and investigation despite the fact that the area has all favourable conditions for commercial farming.

3.3 LAND FORM AND SOIL FERTILITY

It is an accepted fact that the performance of livestocks in terms of productivity depends mainly on the topography of the land and the fertility status of the soil. These factors are deemed important as per the requirement of livestock raising and could

13. Hughes, J.G. and others. Beef cattle and their environment. In (Runga, J.*ed*. Beef cattle on Tussock Country. New Zealand Lincoln college press, 1971. p 30-35).

be placed next to climatic conditions only. A good rolling land is therefore required for grazing and is always favourable for the cultivation of grasses and other forage crops. Besides, a good fertile soil with proper depth would provide balanced nutrients to the animal through plants

3.3.1. TOPOGRAPHY

Nearly 80 percent of the total geographical area in North Sikkim appear to be highly undulating and mountainous with steeper slopes. These lands are, however not found suitable for crop farming largely because of undulating terrain conditions. There is a greater probability of the top soil being washed away if cultivation is encouraged on steeper slopes. Hence, the best possible technique of hill farming would be the introduction of the cultivation of grasses and the plantation of legumes and other forage species including tree fodder which will considerably prevent the erosion and leaching of region. These grasses could be harvested without allowing the animals to graze directly. Consequently the animals could be fed under stall fed management system. During the conduct of the field survey, it has been observed that the goats of domesticated and wild related species keep grazing in the steep lands unabated. It has also been noticed that the areas generally grazed by goats are less vulnerable to forest fires and therefore the incidence of fire is negligible in these areas. This phenomenon is largely due to the annual production and subsequent consumption of different kinds of grasses and other forage biomass. From the above discourse it could be inferred that in well established forests goats grazing on the steep slopes may be permitted which could be beneficial in the long run in terms of less vulnerability to destruction by forest fires etc. However it has been recommended that the rearing of goats and sheep should be confined only to alpine pastures above the tree line.[14] (Plate 8).

14. Indian Government. Task Force for the study of Eco-Development in Himalayas, New Delhi Planning Commission, 1982. p. 25-27.

3.3.2. FERTILITY STATUS OF SOIL

In grassland development, soil acidity is one of the limiting factors for the growth of legumes. These legumes fix atmospheric nitrogen in the soil and are highly nutritious for the growth of the livestocks. However, the growth of these leguminous plants is restricted by variation of ph. values in the soil. The soil acidity thus restricts the growth of the plants thereby adversely affecting their nitrogen fixation capacity. Higher acidity also blocks the macro and micro-nutrients to the plants which ultimately tell upon the growth of the livestocks. Upon extensive review of the above issue based on field trials conducted in different soils in New Zealand, it has been reported that high soil acidity is detrimental to the growth of the leguminous plants [15] . This is due to the fact that nitrogen fixation capacity of these plants is adversely affected by high soil acidity which ultimately production of the livestocks so dependent on this tells important physiological process. In north Sikkim, soil acidity in terms of ph values in found to be very low in the sub-tropical zone where as the same is moderate in the continental zone. As far as the dry high zone is concerned, ph values of the soil are found to be normal. Even in the sub-tropical zone, the Agriculture Department as a scientific measure has initiated massive liming and dolomite application in order to reduce the negative effect of soil acidity.

3.4. NATURAL AND MAN INDUCED HAZARDS

The Himalayas are geologically young and therefore are structurally prone to wearing processes. This weakness is further aggravated by yet another two additional factors which could be summed up as follows.

1. The great height of the Himalayas and the steep descent of the drainage channels

15. Paljor, S. Agronomic evaluation of *Trifolium ambiguum*, Masterate Agricultural Science, Thesis, New Zealand, University of Canterbury 1973. p.14-23.

2. Concentration of the high water period in four summer months from June to the end of September.

In North Sikkim too, considerable amount of annual rainfall particularly between June to the end of September brings down huge quantities of debris from steep mountain slopes through the Tista river and many of its tributaries thereby accelerating the process of erosion in the hills.

The effect of natural and man induced hazards have affected the land so much so that the productivity of the soil is decreasing at a very faster rate which has a direct bearing upon the carrying capacity of the land for agriculture and livestock rearing in the region. It way, however, be infered that this physical attribute may further slump down in the passage of time if adequate care is not taken to conserve the soil. The man induced hazards primarily occur due to faulty management of the land which is ought to be minimized through changes in the farming scenarios.

As for instance, in Mamlay water shed, (South Sikkim) soil loss and nutrient dynamics were analysed in water shed areas with 40 degree hill slopes where the farmers have adopted different types of cropping with judicious land management systems. One such profile of cropping is found to be prevalent on the hill slopes from foot hill to hill top and could be summarised as follows: maize cultivation-cardamom cultivation-natural forestbare fallow land. The losses of top soil ground water, susrface run off, organic carbon, total nitrogen have been given in Table 3.2. Prior to going into the details concerning the above physical indicators causing hazards of scales in different agro-climatic regions of North Sikkim it would be meaningfull to throw light on the

significance of the said variables. The significance of some of the variables could thus be summarised as follows:

1. Surface run off.

As a matter of fact, it is the relative rate at which water is removed by its flow over the Surface of the soil surface run off is normally recorded according to its intensity of flow and could be put into as many as six categories such as ponded, very slow, slow, medium, rapid, and very rapid. The hazards of erosion caused by surface run off may vary from slight to moderate if the soils classified under medicen run off are cultivated as compared to that of very repid where the erosion hezard is supposed to be very high. As surface run off is associated with both natural and mani induced hazards such a soil erosion due to land slides, deforestalion etc. it carries considerable significance in analysing natural hazards.

2. Soil loss:

Soil loss or soil erosion is the wearing away of land surface of the action such natural agencies as water and wind. The common soil erosions are geological erosion, acceleratal soil erosion or man and animal induced erosion, wind erosion, water erosion land slides and stream bank erosion. As for example stream bank erosion is found to be extremely serious in the Tista catchment of North Sikkim. As soil loss is an important factor/ phenomenon in environmental deteroration, it carries special significance while analysing & studying natural and man induced hazards.

3. Organic Carbon:

Organic Carbon or organic matter plays a vital role in the productivity and conditioning of soils. It serves as a source of food for soil bacteria and fungi which are responsible for converting complex organic material into simple substances readily used by the plants. The loss of this valuable matter would affect the productivity of crops and fodder of the region, hence carries special signigficance in hazard study.

4. Total nitrogen loss.

Nitrogen is an important soil nutrient. The loss of nitrogen is assoisated with several factors such as erosion of top soil due to land slide and less forest cover etc. Loss of nitrogen therefore carries immense significance while studying the impact of natural and man induced hazards on top soil.

Table 3.2

Run off, soil loss, and soil, water and nutrient loss under different crop/vegetation covers in the Mamlay watershed (south Sikkim).

Crop/Vegetation cover	Runoff (1/ha)	Soil loss (kg/ha)	Organic carbon loss (kg/ha)	Total Nitrogen loss (kg/ha)
Agricultural field (Maize crop)	6426.97	121.83	0.2704	0.0909
Agroforestry ststem (Cardamom crop)	6989.28	65.54	0.0806	0.0327
Natural forest	5581.43	12.11	0.0347	0.0121
Bareland	8097.24	165.65	0.2965	0.1922

Source : Sharma *et, al.* Integrated Watershed Management : Nainital Gyanodaya Prakashan 1992, p. 30-40

A glance at Table 3.2. reveals that under 40 degree slope in the hills the maximum soil runoff is observed in bareland with 165.65 kg. soil loss per hectare followed by maize field with 121.83 kg. of soil loss per hectare. The soil loss from cardamom farming system is reported to be 65.54 kg. per hectare where as the same amounts to only 12.11 kg. per hectare in natural forests. However, under cardamom crop, the same is 60.43%. But the above indicator is found to be the lowest under maize crop farming system i.e. 26.45%. Based on the above finding the soil loss has been arranged in the descending order as follows. Bare land > Agriculture field (maize cultivation) > Agroforestry plantation (cardamom) > Natural forests. It is distinct from the above profile that the loss of soil is the least in case of natural forests. Next to natural forest comes agroforestry where the cultivation of cardamon etc. could be taken up in view of relatively less soil loss. As top soil on the hill slopes is deemed as an of the most important components of a sound hill ecosystem which supports the growth of a good canopy of plants and vegetation here the aim and objective should be to create an ecosystem similar to natural forest i.e. grasses and leguminous silvipastoral system in the region.

3.5. SOCIO-ECONOMIC FACTORS

The parliament of the Republic of India adopted the following resolution in 1954 on the objective of economic policy of the country.

"The objective of the economic policy should be a socialistic pattern of society; and towards this, the tempo of economic activity in general and industrial development in particular should be stepped up to the maximum possible extent". From the above, it could be inferred that the prime objective in our

planning process should not be directed towards achieving an individual and private oriented gain, but it should primarily aim at achieving a social gain. The pattern of development and the structure of socio-economic relations should be so planned that there should not only be an increase in our national income and employment potential but at the same time there should be an appreciable increase and equal distribution of income and wealth. An unique example could be cited as to how livestock farming in the dairy sector could bring the Indian farmers together not only by the pursuits of trade and commerce but also by sharing the profits on equality basis. This is what is found today in Anand, Gujrat which is located about 266 miles from Bombay. The Anand pattern milk producers cooperative farming functions on the most fundamental and basic principle of democracy i.e. the milk froducers cooperative farming is by the farmer, of the farmer and for the farmer. The Anand Cooperative has started from traditional grassroot level with sound management and extension techniques that have been introduced with novelty and painlessly. Today, Anand pattern milk cooperatives have spread all over India[16] and in Sikkim, the three districts i.e. south, west and east are all covered by this pattern under the aegis of Sikkim Milk Producers Cooperative Limited. However, the north district is not covered by this organization and the marketing of milk is supervised directly by the Department of Animal Husbandry and V. S. on similar basis. The people of North Sikkim are basically animal husbandmen. They consume not only milk and milk products but also meat to a great extent and have therefore no problem of food prejudice. The people have thus been rearing livestock as a family tradition in the region since time immemorial. With view to focussing attention on the general socio-ecomic scenario of the region, it will be meaningful to throw light on such important aspects as the trend and growth of population, in the region, agriculture, education and health services,

16. Patel, A. Twentifive years of National Dairy Development Board. In (Gupta, R. K. *ed.* Dairy India 1992, 4 th Annual Edition; New Delhi, Deverson stylish printing press, 1992. p. 49-50).

infrastructural development, social amenities, institutional development such as banking cooperatives etc.

3.5.1. Population scenario in North Sikkim.

Prior to going into the details of the growth of population and its spatial variation in North Sikkim, it would be interesting to throw light on the population scenario of Sikkim as a whole along with its growth and trends over the past few decades and especially since 1891. In 1891, the total population of Sikkim was only 30,458[17] persons and in 1991 the figure has gone upto 40,6457 [18] registering a growth rate of 12.34% to 48% within a period of 100 years. The percentagewise growth rate of population starting from 1901 has been compiled and the same is presented in table 3.3.

Table 3.3
Percentage growth rate of population in Sikkim with Urban-Rural break up

SI. No.	Year	Percentage of Growth		
		Overall	Rural	Urban
1.	1901 to 1911	48.98	N.A.	N.A.
2.	1911 to 1921	7.05	N.A.	N.A.
3.	1921 to 1931	34.37	N.A.	N.A.
4.	1931 to 1941	10.67	N.A.	N.A.
5.	1941 to 1951	13.34	N.A.	N.A.
6.	1951 to 1961	17.76	15.08	17.56
7.	1961 to 1971	29.38	22.42	187.21
8.	1971 to 1981	50.77	39.50	159.73
9.	1981 to 1991	28.47	39.26(-)	27.56

Soruce: Computed by self from Indian Census Reports from 1911 to 1991.

17. Risley, H.H. History of Sikhim and its rulers; population, tribes and chief families of sikhim. In (Gazatteer of Sikhim. Calcutta, 1894. Reprinted by Sikkim Nature Conservation Foundation, Gangtok, 1989. p 27-38.

18. India Census 1991. Final Population Totals. New Delhi, Series 1(1). 1992. p 17-18

It will be seen from table 3.3 that the growth rate of population over the decade is not found to be uniform. The highest growth of population in Sikkim is observed during 1971-1981. This phenomenon of sudden increase in population could be attributed to the migration of people from other States of India to Sikkim as it became the 22nd State of India Union 1974. The negative growth rate in the Urban Sector during 1981-1991 may be largely due to the reclassification of urban areas into rural areas.

The population figures in north Sikkim relating to the growth rate density and sex ratio during 1981 and 1991 are given in Table 3.4.

Table 3.4.

Growth rate of population, and sex ratio in Urban and Rural Areas of north Sikkim

Items	Years					
	1981			1991		
	Rural	Urban	Total	Rural	Urban	Total
1. Population	25675 (97.05%)	780 (2.95%)	26455	30437 (97.43%)	803 (2.57%)	31240
2. Population growth rate%	-	-	-	18.5	2.9	18.09
3. Sex ratio	697	799	835	835	580	827
4. Population Density per sq. k.m.	-	-	6	-	-	7
5. Percentage of Urban population to total population	-	-	2.95%	-	-	2.57%
6. Percentage of Literacy	-	-	29.74	-	-	53.47%

Source : India, Census 1991. Final population Totals, Brief Analysis of primary census Abstract. New Delhi, 1992. Series 1(2). p 288-289.

It will be seen from table 3.4 that the growth rates of total, rural and urban populations are 18.09 percent, 18.5 percent and 2.95 percent respectively during 1981-91. The sex ratio in the region is found to have declined in urban areas from 799 females per thousand males in 1981 to that of 580 in 1991. As far as the rural and urban breakup are concerned the same shows an increasing trend in case of rural areas. As regards the urban population in the region is concerned, it will be seen from table 3.5 that in 1981, the entire region had 2.95 percent of its total population as urban. But in 1991 the share of urban population in terms of percentage has gone down further showing a declining trend, over the decade. The percentage is 2.57 percent the total population. The percentage of literates and education was 29.74 percent in 1981. In 1991, it has gone up to 53.47 percent exhibiting an increasing trend. The population density per sq.km. has however increased from 6 in 1981 to 7 in 1991.

Switching over to the total work force of the region, the following picture emerges. Table 3.5 presents the distribution of workers in various industrial categories in North Sikkim.

Table 3.5

Distribution of Workers in North Sikkim

Items	Years					
	1981			1991		
	Male	Female	Total	Male	Female	Total
1. Cultivatores	3041	2054	5095	3700	2498	6198
	(59.69%)	(40.3%)		(59.70%)	(40.30%)	
2. Agricultural labourers	1171	402	1573	1420	574	2003
3. Household industry	116	40	156	142	32	174
4. Other Workers	4383	1053	5436	3894	1133	5027
5. Totalmain workers	8711	3549	12260	9204	4582	13786

Source : Census of India 1981 and 1991.

North Sikkim has 8.17 percent of the total work force of the state as a whole. As agriculture and allied activities are the main occupations of the people in North Sikkim, cultivators constitute of a substantial share of the total work force in the entire region the percentage being 41.56 percent according to 1981 Census. According to 1991 Census, the cultivators constitute of 44.96 of the total work force in North Sikkim showing an increasing trend over the decade. It will therefore be meaningful to work out the proportion of the cultivators to the total work force of the state. From the date relating to 1991 Census, it is observed that cultivators in North Sikkim alone account for 6.52 percent of the total work force in Sikkim as a whole. It is inter-

esting to note that in North Sikkim, the total number of cultivators as against the total work force is 6198 which accounts for 1.53 percent of the total population in 1981. Next to cultivators are the `agricultural labourers' in the region who also represent an appreciable share in the total work force i.e. 12.83 percent and 14.53 percent in 1981 and 1991 respectively the total workers in north Sikkim. The proportion of workers engaged in household industry is relatively less i.e. 1.26 percent of the total work force in this region in 1991. Other workers constitute of 44.34 percent and 36.45 percent of the total work force in 1981 and 1991 respectively. As far as the total main workers are concerned it could be seen that the same account for 8.32 percent and 8.17 percent of the total work force in Sikkim according to 1981 and 1991 censuses respectively. The workers engaged in agricultural activities have increased from 54.39 percent in 1981 to 59.49 percent in 1991 in North Sikkim .

3.5.2. AGRICULTURE SCENARIO

It is essential at the present situation of development administration that the productivity of the land on the basis of its carrying capacity is reassessed keeping in view the growing human population and the domesticated animals as well in the region. In this respect the research carried out in north India indicates that one hectare of fertile irrigated land put to wheat and rice in rotation farming can produce 800 kgs. of protein and 6400 kgs of TDN * . If the entire nutrients are met through these cereals then this one hectare of land can carry 35 adults a year on the minimum protein and energu requirements. [19] Working out the carrying capacity on the basis of the above formula the requirement of cultiviable land in north Sikkim stands at as much as only 892.57 hectares. Similarly the requirement of cultiviable land for ther entire population of Sikkim based on

19. Sundarsen, D. India's milk production goes up. Indian Farming, Vol. 29 (6), 1979. p 33-36.
* 1 kg of TDN (Total digestible nutrient provides 4000 calories of energy).

1991 census could be worked out as 11,613.06 hectres. However, Sikkim being a mountatinous state, the production Per hectare of cultiviable land is far lower as compared to the plains. As a result the state imports food grains from other states in spite of its own production. Keeping in view the rugged and mountatinous terrain characteristics of this formidable frontier territory, it will be meaningful to throw light on the prevailing land use system and the emerging pattern. The following table presents the land use system prevailing in the state.

Table 3.6
Common land use system in Sikkim

	1958-60 Survey		1980-81 Survey		1989-90 Survey	
Categories of land	'000 hect	% to total area	'000 hect	% to total area	'000 hect	% to total area
1. Forest	262.14	36.20	256.53	36.15	257	36.20
2. Barren and uncultivated land	204.80	28.28	180.25	25.40	270	38.02
3. Permanent pastures and culturable waste	102.40	14.14	72.94	10.28	70	9.89
4. Land under miscellaneous tree crop and groves	4.00	0.60	5.45	0.77	5	0.70
5. Land under cultivation	81.23	11.20	109.07	15.37	135	19.01
6. Land put to non agriculture use	69.39	9.58	85.36	12.03	93.00	13.09

Source : Agriculture census 1990-91 (Govt. of Sikkim).

A glance at Table 3.6 reveals that the total land available for cultivation as per 1989-90 survey accounts for 135000 hectāres as compared to that of 81230 hectares during the year of survey 1958-60. Thus there has been an increase of 66.20% of land for cultivation over the past 3 decades and more. It will be seen from the above table that there are significant increases under barren uncultivated land and land put to non-agricultural use as per 1989-90 survey as compared to the year 1958-60. The reasons of such increase in non-cultivable land over the years may be largely due to conversion of land into fodder based forests which could be further attributed to poor crop return. Appendix VII &VIIa gives the latest figures of the area under different crops, total production and productivity of various agricultural crops per hectre for the entire state of Sikkim during 1992-93. The total food grain production during 1992-93 was 1053000 tonnes whereas oil seed production during the same period was 5830 tonnes. In regard to the performance of important crops, it may however be seen that the productivity of rice comes out to be 1,289.26 kg. per hectare of cultivable land. The all India figure pertaining to productivity of rice per hectare 1985-90 was 17.56 quintals [20] which show a short fall by 36.23%. The yields of maize and wheat per hectare are 1337. 86kg. and 1765.32kg. respectively. The production of pulses in Sikkim seems to be very promising, as Sikkim recorded a production of 881. 67kg. against All India average of 543kg and world average of above 797 kg/ha. during the year 1992-93. In addition to the above production of foodgrains, Sikkim still substitutes its requirement by importing grains from other states as shown in Table 3.7.

20. Singh, P and Majumdar, A.B. Prospect for Agriculture in New Economic Environment, *Agricultural Situation in India*, Vol 48 (7), October 1993. p 531-538.

Table - 3.7
Annual Procurement of Food Grains in Sikkim.

SI.NO.	Items	YEAR 1980	1990
1.	Rice in M. tonnes.	24000	54000
2.	Wheat in M. tonnes.	3000	7200
3.	Sugar in m. tonnes.	1200	2082

Source - Food & Civil Supplies Department, Govt. of Sikkim, 1991.

It will be seen from the Table 3.7 that the food grain import in Sikkim in 1990 as compared to that of the year 1980 shows an increase of 125 percent in case of rice, 140 percent in case of wheat and 73 percent in case of sugar. Sikkim has to depend on other states for its sugar import as there is no cultivation of sugar cane in Sikkim.

As far as north Sikkim is concerned, the area under cardamom exceeds all other crops. The area put to cardamon is thus 7170 hectres that accounts far almost 51 percent of the total cropped land (Appendix VIII). The figures relating to gross cropped areas under different crops, total production of food grains and oil seeds have been shown in Table 3.8

Table 3.8

Estimation of Area, production and average yield of field crops in North Sikkim, (1992-93).

SI.No.	Name of Crop.	Area in '000 hectares.	Production in '000 tonnes.	Yield per/Ha (in Kgs.)
I. Food Grains:				
1.	Rice	1.3756	1.7430	1267.08
2.	Wheat	1.0005	1.7400	1739.13
3.	Maize	2.9733	4.2420	1426.70
4.	Finger Millet.	0.7099	0.6738	949.147
5.	Barley	0.1000	0.1300	1,300.000
6.	Buchwheat	0.1600	0.1800	1125.000
7.	Pulses	0.0720	0.0684	950.000
Total food grains.		6.3913	8.7772	1, 373.307
II. 9. Oil seeds:				
	(I) Repeseed Mustard.	0.220	0.1550	704.5455
	(II) Soyabean.	0.3807	0.3102	814.8148
Total Oil seeds		0.6007	0.4652	774.4298

Source - Agriculture Department, Govt. of Sikkim, 1994.

In addition to the above production north Sikkim depends heavily on import of food grains for meeting its interval demand.

3.5.3. Transport and communication

Accessibility is deemed as the most important factor in the process of social economic development in this tiny Himalayan state. The entire terrain of Sikkim being rugged and mountainous road is the only medium of communication. The interior places inside the state are all connected by roads Sikkim connects the neighbouring states by surface communication only. In view of its steep topography and sharp variation in altitudes, the rivers are swift and therefore navigable. There is also no scope for the development of railways in this state in view of its undulating and rugged terrains. As transport and communication are essential and play an important role in the process of socio-economic development in Sikkim it will be worthwhile to discuss in a nutshell the existing length of road communication in Sikkim and number of vehicles registered and operating there in. The existing length of roads in Sikkim is precented in Table 3.9.

Table - 3.9
Length of Roads in Sikkim in km.

SI.No.	Status of Roads.	Distance covered in Km.
1.	National Highway	55
2.	State Highway	240
3.	Public Works Department.	540
4.	Total Major roads	446
5.	Bridle Roads.	20
6.	Minor Roads.	900
7.	Total roads	2201

Source - Ministry of Road and Transport, Govt. of India, 1991.

From the Table 3.9 it will be seen that the major portions of the roads are under the control of the state Goverment National high way accounts for a neglisible proportion of the total road net work in the state is 55km out of 2201 km of road in the state. However, the State highway and the road under Public works department together account for substantial proportion of the total road length in the state i.e. 97.50 percent. Table 3.10 presents the number of vehicles registered in Sikkim during 1989-90.

Table - 3.10
No. Vehicles Registered in Sikkim (1989-90)

Type of Vehicles.	No.	Type of Vehioles.	No.
Car	1623	Truck	416
Jeep	2900	Motor Cycle	20
Bus	80	Scooter	10133

Source: Data on Road & Transport, Ministry of Transport and Communication New Delhi, 1989-90.

The State has nationalised transport services and its fleets cater to the public by connecting to numerous areas located in remote parts of the state having difficult terrain coditions. It, thus, plays an important role in this hilly state since it holds almost the monopoly in running public buses and trucks inside and outside the state. During 1989, it carried 9.79 lakha passengers. As far as north Sikkim is concerned, the roads upto Lachen and Lachung are very strong and reliable and above these high altitude areas the road networks are prone to landslides and natural hazards. However, the army have opened temporary roads upto Chho-Lhamo region, but the Lhonak region still has

bridle roads. The only alternative of connecting Lhonak region with Thangu could be by digging a tunnel above Chopta. The condition of the roads in Dzongu areas of North Sikkim are very poor and are often blocked during the monsoon season (plate 9). Hence, the maintenance of the roads in north Sikkim in particular is vital with a view to keeping a continuous and uninterrupted flow of perishable items such as milk, meat and eggs. The border roads seem to be well maintained along with the National Highway of North Sikkim from Bridge No. 2 to Lechen and Lachung. However, considerable damages have accured to the flora and fauna in the fragile ecosystem of North Sikkim perticularly during the process of construction of roads and communication. It is high time therefore, that this short of interference be minimized as to maintain a balance the environment and development in the region.

3.6. Processing of milk and its Products.

As a matter of fact, milk is a perishable item and the duration of storage of milk without any scientific aid is very short. Therefore, high bacterial contamination starts after four hours of milking. Once the milk is contaminated it is neither suitable for consumption nor is it fit for conversion into milk products. It order to enhance the storage quality of milk before transportation, the fluid milk has to be preserved artificially. There are 3 methods of preservation of milk, the details of which are given below:

1. Simple chilling i.e. 4+5c (Bacteriostatice condition). This can be done by subjecting the fluid milk in a double jecketted vat wherein chilled water temperature verying between 1° C to 2° C is circulated.Chilled water can be obtained by using various refrigerants namely brine water, 12° C ammonia refrigerant(NH_3) etc.

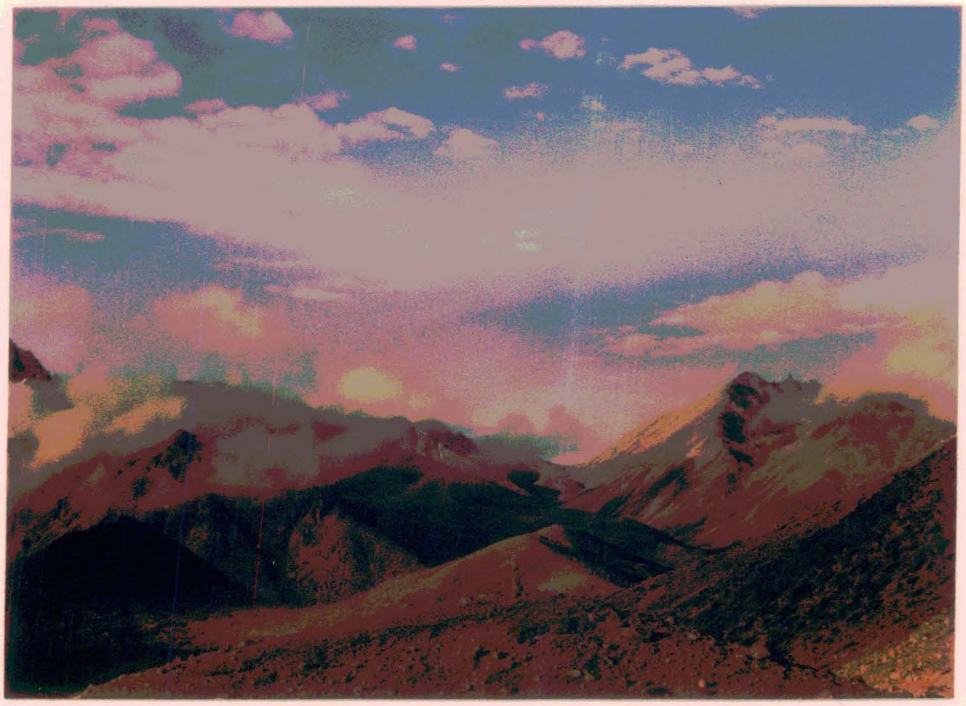


Plate 8. Landscape of Dry high Lhonak region.

Plate 9. Landslide Blocking the road a common sight in North Sikkim

2. The Second method of enhancing the keeping quality of raw milk is to process the fluid milk in a batch pasturizer named by Low temperature long time (LTLT) process. In this method, the milk is processed at a temperature of 43+0.5C for 30 minutes. This process is slow and non continuous and is therefore not suitable for the milk which has already developed maximum acidity (increased percentage of Lactic acid).

3. The third and the existing facility available for processing the milk is through high temperature i.e. short time pasturizer (HTST) method. In this method the milk is proceseed at a temperature of 71.5 ^{0} C for 15 seconds. The process is continuos and easy for operation where the quality of milk is not poor.

In Sikkim there are as many as three plants for processing and preservation of milk. These include one chilling plant and 2 Nos. of fluid milk plant.

1. Chilling plant - This chilling plant has been established at Gyalzing (West Sikkim) and the plant handles 4 TLPD milk (thousand Itrs. per day capacity). The refrigerant feron -12°C is used for covering the normal temperature of water that facilitates various chilling processes of the plant. The chilled milk of Gyalzing is brought to Karfektar Dairy in a insulated milk tanker. The distance between the Karfektar Dairy and Gyalzing Chilling plant is approx. 42kms. At Karfektar the same milk is pasturized before it is transported to Gangtok.

2. Presently there are two Dairy plants at Gangtok and Jorethang. The capacities of the plants are 10,000 LPD and 5000 LPD at per day and are expandable to 25,000 LPD and 15,000 respectively in future. The chilling of milk in these two plants are done by circulating liquid ammonia (NH). The processing is done by HTST method by subjecting the milk at a temperature not less and not more than 71.5 °C (+) 0.5 °C for at least 15 seconds.

The Karfektar and Gangtok dairy plants were established in 1981 and 1982 respectively.

In so far as the development of dairy in North Sikkim is concerned there is a proposal for establishing one LTPD IMCU at Mangan. The unit could be compact and could process and chill the milk at per with HIST Plant. The unit could consist of Microtherm pasturizer which is electricially operated and does not need any broiler for steam production.

From the above discussion, it could be infered that Sikkim in general and north Sikkim in particular have the right conditions for the development of dairy plants in a big way. Processing plants can thus be established if necessary infrastructures are developed to preserve large quantities of milk even ranging from 2500 Ltrs/day to 30,000 Ltrs/day. At present, a number of processing plants have come up at different locations in the state with required infrastructural development to process and preserve quantum of milk ranging between 2500 Ltrs/day to 30,000 Ltrs/day.

3.7. Feed and Fodder Resources

Feed alone constitutes between 60 to 70% of the total cost of production of various livestock products. It has been emphasized that the green fodder production is the most important single factor on which will depend the success of Animal Husbandry development programme. In India about 40% of the total geographical area accounts for grazing resources.

However, the following table would indicate that the country is deficient in total forage and feed production.[21]

21. Singh, P and Majumdar, A.B. "Current Status of Feed and Forage in Management Live stock in India" *Agricultural Situation in India*, Vol 47 (5), 1992. p 375-382.

Table - 3.11

Requirement of feed for Livestocks

SI. No. Type of feed.	Requirement in million tonns	Availability in million tonns	Deficit in million tonns
1. Green fodder	308.1	261.0	47.1
2. Dry fodder	353.0	308.5	44.5
3. Concentrates	25.4	16.5	8.9

Source : Singh and Mazumder - 1992.[21]

The survey undertaken by the National Mission on wet Land development (1991) has reported that out of 55 region only 12 regions i.e. Punjab, Haryana etc. are surplus in forage production. In Sikkim also, the survey conducted by I.C.A.R. (1987) reported similar deficit in forage and feed concentrate production.

As indicated earlier the Agriculture of the State cannot produce sufficient food even for the human beings as the area under crop production is limited and there is no future prospect for expansion. Unlike the other States, most of the farmers of Sikkim have set-aside a small proportion of their land under fodder trees and for growing "amliso" and other newly introduced grasses like napier, cow peas, oats etc.

3.7.1. ASSESSMENT OF FODDER REQUIREMENTS OF NORTH SIKKIM

The fodder reqirements of the livestock of Sikkim have been assessed on the basis of 2 to 2.5 kilograms of dry

matter consumption per day 100 kilograms of livesweight. Hence, for 250 kg. averge live weight animal the total dry fodder requirement works out to be 5 kg. per day or 1825 kilograms of dry matter per year[22]. In order to give an uniform picture for fodder requirement the existing livestocks are converted into standard cow equivaalent units. The cow equivalent units were assumed as adult cattle =1; young stock cattle =1/2; buffalo=2; buffalo young stock=1; sheep/goat=1/2 and other animal 1. For yaks, the cow equivalent units have been assumed as adult yak=1, young yak stock =1/2. The fodder requirement has been calculated for three census years i.e. 1977, 1982 and 1987 and average yearly fodder rquirement has been derived from the average figrues of three years.

Results

The livestock population of North Sikkim depending on grasses and other forage materials as their main source of diet have been shown in Fig. 3.12.

22. Singh, R. and Raman, T. Sustainable livestock in Mountains of Western Himalayan Region. A study in Himachal Pradesh. *Agricultural Situation in India.* Vol. 48(II), February, 1994. p 799-804.

Table 3.12

COMPOSITION OF LIVESTOCK IN NORTH SIKKIM

SI.No. Type of Animal	1977		1982		1987		Percentage
	No.	% to total	No.	% to total	No.	% to total	to change over 1977 to1987
1. Cattle							
(a) Adult males	4531	14.91	3128	10.00	3199	8.85	-29.40
(b) Adult females	5618	18.49	4571	14.61	5074	14.04	-9.68
(c) Young stock	4096	13.48	5804	18.55	6314	17.47	54.15
Total cattle	14245	46.89	13503	43.16	14587	40.36	2.40
2.Buffalo							
(a) Adult males	44	0.14	16	0.05	1	0.00	-97.73
(b) Adult females	108	0.36	58	0.19	5	0.01	-97.37
(c) Young stock	79	0.26	53	0.17	4	0.01	-94.94
Total buffaloes	231	0.76	127	0.17	10	0.03	-95.67
3. Yaks							
(a) Adult males	44	1.47	736	2.35	1100	3.05	146.98
(b) Adult females	1102	3.63	1100	3.52	2027	5.61	83.94
(c) Young stock	791	2.60	825	2.64	1734	4.80	119.22
Total yaks	2340	7.70	2661	8.50	4865	13.46	107.91
4. Sheep	3977	13.09	2556	8.17	3627	10.03	-8.80
5. Goats	8864	29.18	11638	37.20	11871	32.84	33.92
6. Other animals	725	2.39	804	2.57	1186	3.28	63.59
Total animals	30382	100.00	31289	100.00	36146	100.00	18.97

2. It will be from the Table 3.12 that the total livestock in the state has increased by about 18.97 percent during the period 1977-87. The highest increase was recorded in yaks with 107.19 percent during 1977-87. The proportion of cattle in the total livestock population of North Sikkim was very low in terms of the possesion of livestock accounting for as much as 2.40 percent only to the total livestocks in the state. The population of livestock with negative growth rates rates is the highest for buffaloes, the percentage of growth rate being - 95.67 percent. The mian reasons for the decrease in buffalo population in North Sikkim are the prevailing climatic conditions which are hostile to the growth of the animals and nonavailability of quality fodder in the lower region. The goat population during the period 1977-87 has increased by 33.92 percent. It is the second largest animal group reared by the farmers of North Sikkim next to cattle. The goat rearing is generally being discouraged by the Goverment of Sikkim as they are said to cause extensive damage to the vegetation by grazing to roots. However, despite wide spread discouragement, the population of goat in North Sikkim is increasing year by year as this animal is well adopted to the typical high Himalayan environment coupled with difficult terrain conditions. On the other hand, the state Government is encouraging the farmers of North Sikkim to switch over to sheep breeding in extensive scale. It is observed in the region that the proportion of sheep to the total livestock population in the region has substantially decreased, showing a negative growth rate i.e 8.80 during the period 1977-87.

3.7.2. ESTMATION OF FODDER REQUIREMENT

The different livestocks are converted into standard cow equivalent units for estimation of fodder requirements. The number of cow equivalent units for various livestock are presented in Table 3.13

It will be seen from the table-that the total livestock populations in cow equivalent units were 24380 in 1987. The proportion of Cattle out the total livestock in cow-equivalent uints in 1987 was 46.88 percent followed by goats which accounted for 33.94 percent. On the whole the total livestock in cow equivalent units were 21671 in 1977 which increased to 24380 in 1987. During this period the total livestock in cow-equivalent units increased by 12.50 percent. Table 3.15 shows the composition of livestock in cow equivalent in north Sikkim. The data relates to period from 1977 to 1987.

Table 3.13

COMPOSITION OF LIVESTOCK COW EQUIVALENT UNITS IN NORTH SIKKIM

SI.No. Type of Animal	1977		1982		1987		Percentage
	No.	% to total	No.	% to total	No.	% to total	to change over 1977 to 1987
1. Cattle							
(a) Adult males	4531	21.00	3128	10.00	3199	13.12	-29.40
(b). Adult females	5618	26.00	4571	14.61	5074	20.81	- 9.68
(c). Young stock	2048	10.00	2902	9.27	3157	12.95	-54.15
Total Cattle	12197	56.28	10601	43.16	11430	46.88	-6.29
2. Buffalo							
(a). Adult males	88	0.41	32	0.10	2	0.008	-97.73
(b). Adult females	216	1.00	116	0.37	10	0.40	-95.37
(c). Young Stock	79	0.37	53	0.34	4	0.02	-94.94
Total Buffaloes	383	1.79	201	0.81	16	0.07	-95.82

3. Yaks							
(a). Adult males	447	2.06	736	2.35	1104	4.53	146.98
(b). Adult females	1102	5.01	1100	3.52	2027	8.31	83.94
(c). Yung stock	395.50	1.83	412.50	2.64	867	3.57	118.94
Total Yaks	1944.50	8.98	2248.50	8.50	3998	16.40	105.55
4. sheep	1988.50	9.18	1278	8.17	1813.50	7.44	-8.80
5. Goats	4432	20.45	5819	37.20	5935.50	24.35	33.94
6. Other Animals	725	3.35	804	2.57	1186	4.87	63.59
Total Animals	21671	100	20952	100	2438	100	12.50

The fodder requirements for the livestock of North Sikkim has been worked out on the basis of the standerd cow equivalent unit (Table 3.13) and the details are presented in Table 3.14 calculated based on data embodied in Table 3.13.

Table-3.14

ASSESSMENT FOR FODDER REQUIREMENT PER ANNUM IN NORTH SIKKIM (Figures IN TONNES)

SI. No. Type of Animal	1977	1982	1987	Total requirement	Average per year in M.T
1. Cattle					
Adult males	8269.07	5708.60	5838.18	19815.85	6605.28
Adult females	10252.85	8342.07	9260.05	27854.98	9284.99
Young stock	3737.60	5296.15	5761.53	14795.28	4931.76
Total Cattle	22259.52	19346.83	20859.75	62466.10	20822.03
2. Buffalo					
Adult males	160.60	58.40	3.65	222.65	74.22
Adult females	394.20	211.70	18.25	624.15	208.05
Young stock	144.17	193.45	14.60	352.22	117.41
Total Buffalo	698.98	366.83	29.20	1095.00	365.00
3.Yaks					
Adult males	815.78	1343.20	2014.80	4173.78	1391.26
Adult female	2011.15	2007.50	3699.28	7717.93	2572.64
Young stock	722.70	1505.63	3164.55	5392.88	1797.63
Total Yaks	3549.63	4856.33	8878.63	17284.58	5761.53
4. Sheep	3629.92	2234.35	3310.55	9272.82	3090.94
5. Goats	8088.40	10619.68	10833.20	29541.28	9847.09
6. Other Animal	1323.13	1467.30	2164.45	4954.88	1651.63
Total Animals	39547.75	28236.49	44491.67	122275.91	40758.64

The annual requirement of dry matter has been estimated to be 39,547.75 tonnes during 1977 and 44491.67 tonnes in 1987.The annual dry matter requirement worked out on the basis of three years average livestock census figures is 40758.64 metric tonnes. The highest reqirement is for cattle with 41.1 percent dry matter followed by goats with 33.6 percent and yaks with 11.4 per annually. The requirements accounts for 9.8 percent and 3.3 percent of the total dry matter for sheep and other livestock together respectively.

CHAPTER IV

DISTRIBUTIONAL PATTERN OF LIVESTOCK IN NORTH SIKKIM AND THEIR ECONOMIC IMPORTANCE - AN OVERVIEW.

4.1. INTRODUCTION.

Poultry and livestock rearing are important enterprises of the people of Sikkim. Livestocks in North Sikkim are generally found in three different ecological zones which could be summerised as follows:

Zones	Type of livestock
1. Dry High Zone (Lhonak and Chho Lhamo)	Yak Sheep and Pashmina type of Goat.
2. Continental Upper Zone (Lachen and Lachung)	Cattle, Yak, Goat, Equines and Pigs
3. Sub-Tropical Zone (Dzongu, Kabi, Phensang, Mangan etc.)	Cattle, Buffaloes, Goat, Pigs and Poultry.

Livestock is not only reared for milk and meat but it is a primary source of drought power and manure for agricultural farming. Unlike the other North Eastern states of India, cattle farming in Sikkim is widely practised as a mixed farming. A comparative account of poultry and livestock, their population dynamics and compositional changes are presented in this chapter.

4.2. Varieties of Livestocks in North Sikkim.

North Sikkim which constitutes three fourth of the total geographical area of sikkim is an important repository of genetic variablitity of plants and animals. The animals mostly include

Yak, Sheep, Goat, equine and buffaloes etc. Table 4.1 presents different varieties of livestocks along with their related wild species found in different climatic zones in North Sikkim. It will be seen from Table-4.1 that there are various domesticated and wild related species found in different climatic zones. As far as dry high zone is concerned the prinicpal livestocks include sheep, yak, Bhutia type goats and horses. The continental upper zone contains sheep and yak of different kinds, goat, Bhutia type horse, mules and donkeys and cattles, poultry and pigs of different kinds, Similarly, the subtropical humind zone sustains a number of domesticated no of domesticated species such as sheep, goats cattles poultris pigs and buffalars etc. However, poultry and pigs in this zone have wild related species. As far as the economic importance of these animals are concerned the table is self explanatory.

4.2.1. Cattle

The cattle population in the state is by and large nondescript. The local "Siri" cattles that predominate in number in the region are found upto an elevation of 4000m (plate 10). These animals are supposed to be very hardy and sure-footed. The cows of this local breed are poor in quality usually giving 400 to 600 litres of milk in a lactation of about 180 days, followed by a prolonged dry period. the selected cows of this breed may yield upto 1000 litres per lactation with fairly high fat percentage.Their function as the mother of efficient bullocks cannot be ignored especially because in Sikkim owing to hilly and mountainous terrains, farm mechanization to its optimum level has not been possible as yet. The bullocks are found to be generally agile, sure-footed and are mostly reputed for good draftability in rugged and mountainous terrains of North Sikkim (plate 11). Next to "Seri" the crossbred animals with verying exotic blood namely Jersey.

Plate 10. A local "Seri cow at Rabum state Animal Husbandry farm (North Sikkim).

Plate 11. Bullocks - a source of farm power (Lingthem-Dzongu)

Table 4.1

VARIETIES OF LIVESTOCK AND THEIR RELATED WILD SPECIES FOUND IN DIFFERENT CLIMATIC ZONES OF NORTH SIKKIM.

SI. No.	Type of Livestock Domesticated.	Name of the related wild species.	Economic Importance
1	2	3	4
DRY HIGH ZONE.			
A. Sheep			
1.	Tibetan sheep	Bharal or Blue sheep (*Pseudoisnayaur*)	The domesticated sheep for wool and meat. The meat from this zone are prized meat and very expensive. The wild animals are hunted for meat and fur.
2.	Sikkimese sheep Bhera or banpala	Nayan or great Tibetan sheep (*Ovis ammon hodgsoni*).	
B. Yak			
1.	Yak (*Bospoiphagus grunniens*).	No record of wild yaks	the domesticated yaks are used for milk, meat,skin transportation, fuel and riding. The wild species is extinct in Sikkim.
C. 1.	Chengra (Bhutia) type Hairy (Cashmere) goat	Himalayan Tahr (*Hemitragus Jemlahicus*)	The domesticated goats are used for hair, meat, skin etc.

D. Equine		
1. Bhutia Type Horse	Kyang (*Equus Kiang*)	Domesticated horses are used for riding and trasportation. Not much in use in this area owing to high altitude.

CONTINENTAL UPPER ZONE.

A. Sheep	Sheep-wild	Domesticated Sheep used for wool and meat
1. Tibetan sheep 2. Sikkimese sheep Bhera or Banpala or Garpala	Most of the wild sheep found in the Dry High zone migrate to continental upper zone during winter.	
B. Yak		
1. Yak 2. Dzo (yak & Cattle Cross)	No record of wild yaks	Yaks are used for milk, meat, hair and hide.The tent smade out of yak hair are rain and snow proof.
C. Goat		
1. Changra (Bhutia type) Goat.	No record of wild goats.	The domesticated goats are used for hair, meat and skin.
D. Equine (Domesto-	Equines	Riding and transportation
1. Bhutia Type 2. Mules 3. Donkeys	Kyang do not migrate to this zone in winter. Perhaps to Tibet	

E. Cattle 1. Seri type 2. Jersey cross	Not available	Meat, milk and hide and manure and draft
F. Poultry 1. Indegenous Fowl 2. Cross breedsaddle Back and Large white.	Found in lower areas of the continental zone	Meat, Eggs

SUB-TROPICAL HUMID ZONE.

A. Sheep Banpala & Garpala	Not available	Meat and wool for making raris (carpet)
B.Goat 1. Local Singhali 2. Black Bengal 3. Jamunapari 4. Crosses	Not available	Goat in this zone are reared for meat and milk
E. Cattle 1. Local `Seri' type 2. Jersey Cross 3. Holstein Freesian cross. 4. Swiss brown cross.	Not available	Meat, milk and hide and for draft and manure.
F. Poultry 1. Local Fizzle Fowl 2. Local Fowl	1. Red Jungle Fowl(*Gallus gallus*)	Domesticated birds are reared for eggs and meat and wild species for hunting.

3. Rhode Island Cross 2. Kaliz (*Lopura Leucomelanura)*
4. White Leghorn Cross.

G. Pigs 1. Lepcha type 2. Cross Bread-Saddle Back, Hampshire, Large White.	Wild pigs (*Sus scrofa*)	Meat and manure
H. Buffaloes	Not available	Population is very small and reared for milk and meat.

Brown Swiss, Ayshire, Holstein etc. are found in the region. Most of these crossbred animals were brought from the nearby hills of Kalimpong and Darjeeling where a number of exotic cattles were introduced by the early British Tea planters. in addition, the State Government also purchased a pure Jersey herd of 50 heiters and two bulls from Australia way back in 1954 and another herd of pure Jersey of 50 heifers and three bulls were imported from Denmark in 1980 through National Dairy Development board. Artificial insemination has been introduced in the State with frozen semen with effect from 1987 which has become very popular with the small and progressive farmers of North Sikkim. The breeding bulls are, however, being used in far flung hill and remote areas of North Sikkim.

4.2.2. Sheep and Goat

As has been said earlier India has vast genetic resources of Sheep and as many as 40 breeds are adapted to different agro-ecological conditions in the country. In North sikkim, the two

recognized breeds are Tibetan breed and Banpala breed. Both of these breeds have been classified under superior carpet wool breeds.[23] However, the Banpala breed should have been classified under coarse carpet wool breed as the wool is coarse, As regards the Tibetan breed, (Plate 15) the sheep is of medium sized, mostly white with black or brown face, brown and white spots are spots are also found on the body. Both the sexes are horned. The ears are small, boad and dropping. The belly legs and faces are devoid of wool.

Compared to the Tibetan sheep, the Banpalas are tall, leggy and well built. The body colour ranges from completely white to completely black with a number or intermediary tones. The ears are small and tubular. Both the sexes are horned. The tail is thin and short. The belly and leg are devoid wool. The average body weight is about 35kg. which produces about 1kg of hairy wool per annum. The other breed which is very similar to that of Banpala breed is brown as "gharpala" or home reared. The exotic sheep breeds introduced in Sikkim for upgrading the local sheep are Russian Merinos, Corridale and Rambouillet etc.

As shown in Table 4.1 the two related wild sheep found in North sikkim are Bharal or Blue sheep (*Pseundois nayaur*) and Nayan or great Tibetan sheep (*Ovis ammon hodgsoni*). Both of these wild varieties have been classified under Schedule I of the wildlife (Protection) Act 1972.

Goat is a very popular domestic livestock with the farmers in Sikkim. It is reared mainly for meat. At Lhonak and Chho Lhamo Grazing grounds a local hairy pashmina Goat variety called "Chengra" in Bhutia language is reared in limited numbers. The goats in the sub-tropical zones are mostly stall fed and the important local breed is called "Singhali" in Nepali

23. Achary, R.M. Sheep production. In (Tata, S.N. and Lokeshwar, R.R. *eds*. Hand book of Animal Husbandry, New Delhi, *Indian Council of Agricultural Research*. 1990. p 43-118.

language. As compared to Black Bengal variety, it is generally bigger in size. The goats with considerable Black Bengal breed are also reared in the lower sub-tropical zone. The breeds introduced in Sikkim for upgrading the local goats include Jamunapari, Barbari, Beetal and pashmina goats imported from Ladahk. A photo of crossbred pashmina goat with local "Chengra stock could be seen in Plate 12.

4.2.3. Yak

Yak has a special place in the economy of people inhabiting areas with an altitude ranging from 2500m above sea level in North Sikkim. According to the classification of vertebrate animals the domesticated yaks fall in the bovidae family, the sub family being Bovinae. The scientific terminology is *Bos grunniens* or *Bos poiphagus*.[24] It has identical number of diploid chromosomes i.e. 60 (2m=60) like cattle.[25]

Yak is widely known for its ability to withstand low temperature, sure-footedness and capability to thriveon coarse fodder at sufficiently high altitude where no other large animal can survive. It is the only species which produces milk, meat and hair fibres etc. It is a very popular medium of transport in high, altitude areas (plate 13). Yak is an exceptionally hardy animal and is extremely popular with the tribes of Lepcha and Bhutia on account of its surefootedness and ability to thrive even in severe winter with snow environment. Yaks hoofs are as big as those of a camel and can obtain a very secure foothold in glaciers and rocks. "It can graze comfortably in places where cattle and horses would find footing only with great difficulty" - FAO (1949) and can also dig through snow for fodder. Thus yak is called the "camel of the snow". There are three types of yaks found in sikkim which include Lhogyag, Bod-gyag and A-Yu. Lho-gyags are generally large animals as compared to Bod-gyag and A-Yu.

24. Hoffparuir, R. India's other Bovine. A Cultural Geography of the water buffalo. The university of Wisconsin, USA. 1974. p 45-46.

25. Zuitin, A.I. New data on the cromosome number in Yak (*Poephagus grunniens L*). Doke, Akad, Nauk. NS. 19. 1938. p 201-202.

Plate 12. Pashmina goat introduced from Ladakh-good prospect in North Sikkim.

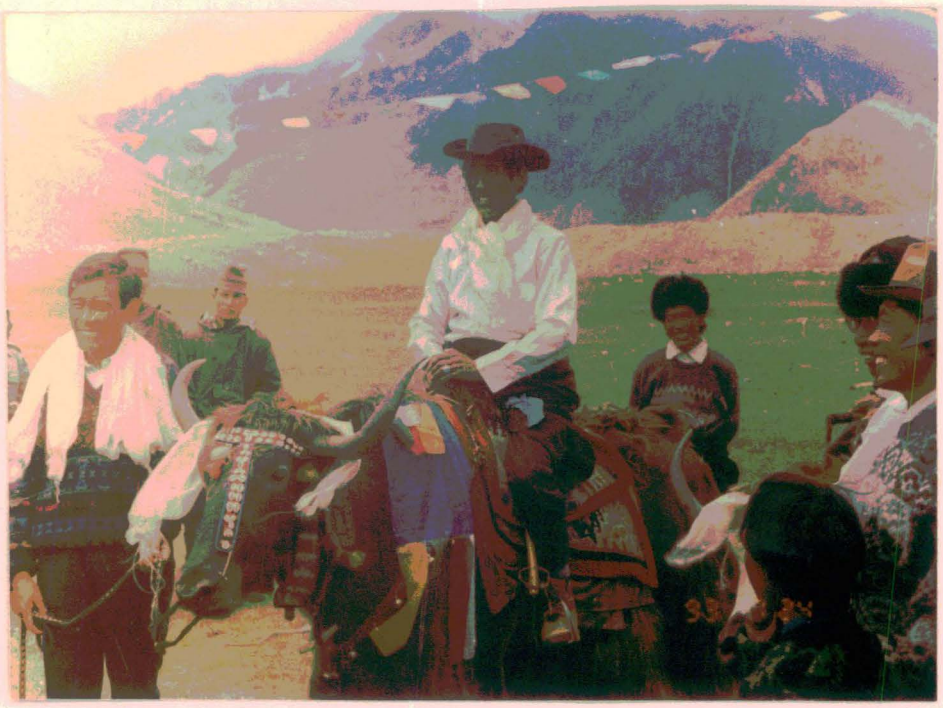


Plate 13. Yak is used for riding in the Dry High Zone of Lhonak & Chho Lhamo areas.

The A-Yu yaks are normally pooled yaks. Out of the above three yaks "Lho-gyags" are supposed to be the best Yaks in Sikkim.[26] Crossbreeding between Yak and local cows is practised in sikkim on a limited scale. The cross-bred progeny between Yak bull and local female cows is called "Dzo". The male "Dzo" is sterile. The female "Dzo" normally yields more milk (3-4 litres) per day. They seem to be hardier and can tolerate high temperatures at lower altitude. Whereas the pure Yaks cannot thrive at lower altitudes. The crossbred male "Dzo" is widely used in North Sikkim as drought power and is best suited in the hill terrain of the region specifically for transportation.

4.2.4. Piggery

The pigs are reared by the farmers especially in the sub-tropical zone (Table 4.1). The indigenous and the small black swine varieties were contributing substantially to the pig production untill 1970 in North Sikkim. Improved breeds like saddle Back, Yorkshire, Hampshire and large white are being used at present for upgrading indigenous local varieties. The farmers in North Sikkim usually prefer black colour pigs which are varieties such as Hampshire and saddle Back breeds like the other very much popular in North Sikkim. Wild pig (sus-scrofa) too are found in the forests of sub-tropical zone in North Sikkim. These are mainly hunted and trapped for supplementing the protein requirements of the people.

Ponies are indigenous "Bhutia" breed found in North Sikkim. However, the mules are used for transportation purposes in the region (Plate 14) where road transport by other means is rather difficult.

26. White, J.C. Agriculture in Sikhim. In (Gazetteer of Sikhim. Calcutta, 1894. Reprinted by Sikkim Nature Conservation Foundation, Gangtok. 1989. p 74-79.

4.2.5. Poultry

The poultry breeds in North Sikkim are mostly local and non-descript. The two types of local indigenous breeds include Frezzle fowls and Naked neck fowl. The improved breeds available with the farmers in North Sikkim are Black Austrolop cross, Rhode Island Red crosses and white leg horn crosses rearing of commercial hybrid broiler and layers are also being popularized by the department of AH & VS. There are two types of wild fowl i.e. Red Jungle fowl (*Gallus gallus*) and Kaliz (*Laphura Leucomelamura*) which are generally found in the jungles of subtropical zones in North Sikkim. These birds are also hunted and traped for meat to supplement the food requirements of the people in the region.

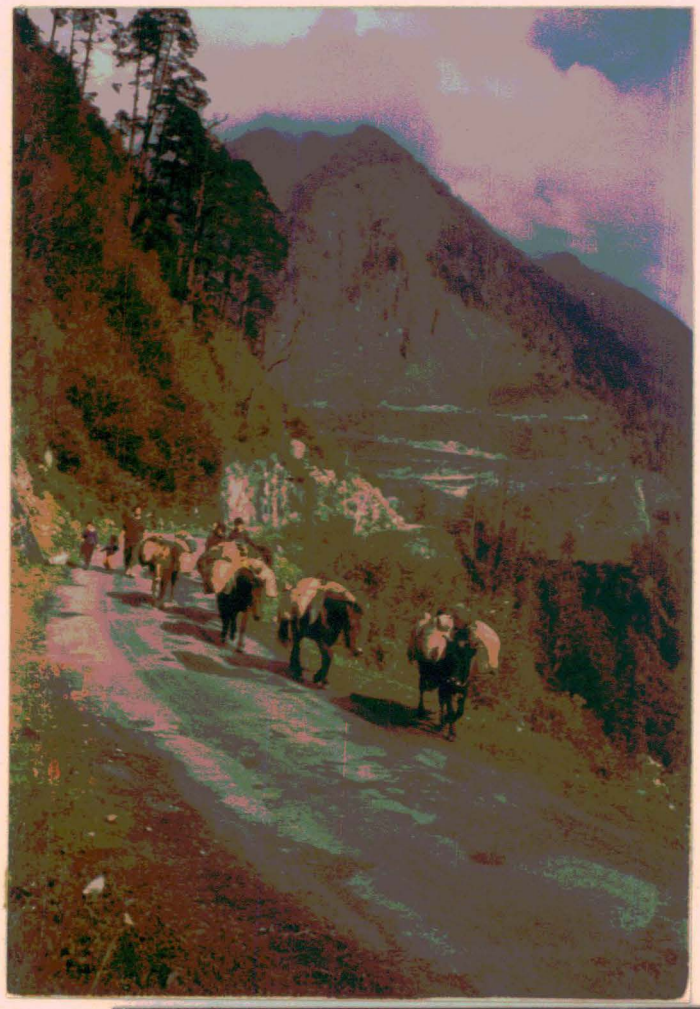


Plate 14.
Horses mules are still being used for transporting goods in North Sikkim. Background- Zema state A.H. fodder demons. centre.

Plate 15. Tibetan Sheep grazing in the Lhonak pastureland.

Table - 4.2

COMPOSTION OF LIVESTOCK IN NORTH SIKKIM

SL.No.	TYPE OF ANIMAL	1977 No.	1977 % age to total	1982 No.	1982 % age to total	1987 No.	1987 % age to total	% age of change over 1977 to 1987
1.	Cattle							
	(a) Adult male	4531	8.22	3128	4.82	3199	4.50	-29.40
	(b) Adult female	5618	10.20	4571	7.05	5074	7.14	-9.68
	(c) Young stock	4096	7.44	5804	8.95	6314	8.89	54.15
	Total cattle	**14245**	**25.86**	**13503**	**20.82**	**1458**	**20.53**	**2.40**
2.	Buffalo							
	(a) Adult male	44	0.80	16	0.20	1	0.00	-97.73
	(b) Adult female	108	0.20	58	0.09	5	0.001	-95.37
	(c) Young stock	79	0.14	53	0.80	4	0.01	-94.94
	Total Buffalo	**231**	**0.42**	**127**	**0.20**	**10**	**0.01**	**-95.67**
3.	Yaks							
	(a) Adult male	447	0.81	736	1.14	1104	1.55	146.98
	(b) Adult female	1102	2.00	1100	1.70	2027	2.85	83.94
	(c) Young stock	791	1.44	825	1.27	1734	2.44	119.22
	Total Yaks	**2340**	**4.25**	**2661**	**4.10**	**4865**	**6.85**	**107.91**
4.	Sheep	3977	7.22	2556	3.94	3627	5.10	-8.80
5.	Goat	8864	16.09	11638	17.95	11871	16.71	33.92
6.	Other animal	725	1.32	804	1.24	1186	1.67	63.59
7.	Pigs	1520	2.76	3269	5.04	3958	5.57	160.59
8.	Poultry	23287	42.09	30283	46.70	30947	43.56	33.46
	Grand Total	**55089**	**100.00**	**64841**	**100.00**	**71051**	**100.00**	**28.97**

4.3. Population Dynamics and compositional change of livestocks including poultry in North Sikkim.

Keeping the above discourse concerning the genetic characteristics and the varieties of livestocks found in North Sikkim in view, it will be meaningful to throw light on the population dynamics and compositional change of the livestocks and poultry in this region. Table 4.2 shows the poultry and livestock population in different census years in Sikkim.

It will thus be seen from Table 4.2 that the number of total poultry and livestock in North district has increased by about 2887. As far as the composition of the total livestock population is concerned it could be seen that in North sikkim the proportion of poultry in the total livestock population has been recorded to be the highest in 1987 as against 42.09 percent in 1977. During 1977 to 1987 the poultry population shows an increasing trend registering a growth rate of about 33.46 percent. Next to poultry comes cattle which occupies the second highest position in the total livestock population of North Sikkim. Cattle accounted for as much as 20.53 percent in 1987 as against 25.86 percent in 1977. During 1977 to 1987 the population of cattle has thus increased by about 2.40 percent only. There is a decreasing trend in adult male and adult female cattle population during the same period i.e. from 1977 to 1987 showing a negative growth rate i.e.-29.40 percent over the decade. Similarly, there has been a negative growth rate of adult female cattles, the percentage growth rate being -9.68 percent over the decade i.e. 1977-1987. However, during the same period there has been a substantial increase in Young stock cattles accounting for 54.95 percent growth rate.

From the above situation, it could be infered that the negative growth rate in case of adult male and female cattles may

be largely due to gradual phasing out of the indigenous varieties and introduction to high mortality or culling rate among the adult cattles which need further research and investigation. In order to explain this compositional change, the growth rate on cattle population was further analyzed on the basis of breed. the details in this regard are presented in Table 4.3.

Table 4.3

Trend of growth rate of Cattle Population in North Sikkim Types of Cattle Population

Year	Cross Bred Cattle No.	%age	Indigenous cattle No.	% age
1977	Not available	-	14,245	100.00
1982	1852	12.06	13,503	87.93
1987	2930	20.05	11,684	79.95
Total Growth rate -		598.27	-	(-) 79.47
Annual growth rate -		11.67	-	(-) 2.69

It is to be noted that direct information on the number of crossbred cattles in the state was not available till 1982 livestock census. From 1982 onwards, the livestock census conducted at five year intervals has been recording information of cattle by crossbred and indigenous categeries. The results of the livestock census for 1982 and 1987 on cattle population presented in Table 4.3 reveal that the proportions of crossbred cattle population to the total cattle population in North Sikkim were 12.06 percent and 20.05 percent for 1982 and 1987

respectively. During the period 1982-87 the crossbred population has increased by 58.25 percent. Such rise in crossbred cattle population in North Sikkim may be attributed to a number of factors. The factors include the extensive cross-breeding programme under-taken by the department of AH and VS, the distribution of crossbred heifers cows under Tribal Development programme, integrated rural development programme through the commercial banks and last but not the least the facility provided by Sikkim Livestock Development Corporation for procurement of milk in early eighties from the rural areas to be distributed in Mangan town after its processing by simple method of heating and cooling. The above factors gave a big push for the diffusion of crossbreeding since the early eighties and have resulted in significant increase in percentage of crossbred cattle population. It is also sidely observed that the farmers are doing away with the local unproductive cattles and are going in for high producing cattles particularly crossbreds. The crossbred cows not only produce more milk but their growth rate and breeding efficiency are much better than that of the local indigenous cows.

Next to cattle, goat rearing is becoming popular in North Sikkim. The proportions of goat population to the total livestock population were 16.09 percent 17.95 percent and 16.71 percent for 1977, 1982 respectively. The goat rearing is generally discouraged by the state Forest Department as these animals cause considerable damage to the vegetation cover.However, despite this, the population of goats has increased considerably from 16.09 percent to 33.92 percent during a period 10 years i.e.from 1977 to 1987. The main reason of increase of goat population is that the goats do not just provide their owners with milk, meat and other products, but also serve other important economic investment and security and also fulfilling many other social obligations. [27]

27. Peacock, C. Improving goat production in the Tropics. In (A manual for development workers, Africa Oxfarm. 1994. 35p).

The proportion of Yak population to the total livestock population was 4.25 percent in 1977. However, this proportion has decreased to 4.10 percent in 1982, the figure has more than doubled the growth rate being 107.91 percent during the period 1977 to 87. The main reason for such an increase in yak population in the state could be attributed to high degree of awareness among the farmers regarding yak health care and timely vaccinations undertaken by the department of animal Husbandry and veterinary services.

The pig population registered the highest increase during 1977 to 1987 by about 160.59 percent even though its proportion to the total livestock population only 2.76 percent in 1977, 5.04 percent in 1982 and 5.57 percent in 1987. There has been a decreasing trend in buffaloe population the percentage growth rate being (-) 95.67 percent during the period 1977 to 1987, it is a heavy animal and is generally suitable for grazing in the steep slope of North Sikkim.

Next to buffalo, sheep population is also observed to be having a negative trend of growth, the growth rate being - 8.80 percent during 1977 to 1987. It may be seen from the Table 4.2 that the proportion of sheep population to the total livestock population shows an increasing trend during 1982-1987. The figure was 3.94 percentage 1982 and has increased to 5.10 percent in 1987. It could also be seen from the said table that the proportion significantly dropped from 7.22 percent in 1977 to as much as 3.92 percent in 1982. Owing to high rainfall and high humidity prevalent almost throughout the year, the exotic sheep have failed to perform well in the state and more over with the closure of All India co-ordinated sheep project in Sikkim the number of crossbred sheep population has declined dramatically.

As far as the other categories of animals are concerned these mostly include horses, mules, ponies and donkies. During sixties these animals formed the major proportion of livestocks in the number of these valuable eco-friendly animals have gradually gone down. The animals are still used for transporting goods in North Sikkim (plate 14). The proportion of the other animal to the total livesock population was 1.32 percent in 1977, 1.24 percent in 1982 and 1.67 percent in 1987. The percentage change in population of these animals is found to be 63.59 percent during 1977 to 1987.

4.4 SAMPLE SURVEY OF LIVESTOCK POPULATION IN NORTH SIKKIM.

This chapter primarily deals with the varieties of poultry and livestock along with their composition and population dynamics. However, data on the zone wise distribution of livestiock are not available. As per the design of the study indicated in chapter-I a sample survey was conducted to determine the livestock population and their distribution pattern in the three identified ecological zones in North Sikkim. In this survey a total households of 827 were covered in the three eco-zones of North Sikkim, the altitudes ranging between 800 m. to 5500m. above the sea level. The results of the survey that incorporate the zoanwise details of households covered, types of livestocks along with their population concentration etc. have been presented in Table 4.4. It will be seen from the appendix Table 4.1 that in the dry high Sikkim as many as three types of livestock species are reared including yak, sheep and pashmina type of goat. Out of the two identified regions in this zone, As far as the total number of livestock in this zone are concerned, i.e. 4497 heads Lhonak alone accounts for as much as 71.27 percent or 3205 numbers out of total 4497 livestock.

Switching over to the continental zone, it is well observed that almost all livestock species belonging to different categories are found here. In this zone, there is substantial variation in livestock population between Lachen and Lachung. Out of the total livestock of 4959 in this zone 3380 which accounts for 68.16 percent of the total have been recorded in Lachen and the rest i.e. 31.84 percent are found in Lachen. In case of poultry population there is not much difference between the regions.

In the sub-tropicl humid zone, the important livestock species reared are cattle, goat, pigs and poultry. The highest number or livestock populations in the sample survey have been recorded for Kabi village with 897 numbers. The Tingda with 646 numbers and Chungthang with 621 numbers respectively. In the Dzongu area Hee-Gyathang has the highest livestock population with 547 numbers.

As far as the population of poulry birds are concerned 88.56 percent of the total poultry is found in this zone alone. This is in view of the fact that the climate is warm and very congenial for poultry production. The highest poultry population is found in Kabi which possesses 20.40 percent of the total followed by 12.36 percent for Lingthem (Dzongu) and 11.34 percent for Chungthang.

4.4.1 SPATIAL DISTRIBUTION OF VARIOUS SPECIES OF LIVE STOCK.

In order to determine the spatial distribution of various livestock species in north Sikkim the number of each species of livestock were converted into percentages which have been pre-

sented in Appendix IX. The following picture emerges from the spatial variation of the percentages of different livestock species in the study area.

4.4.1.1 YAK POPULATION.

It has been said earlier that the yaks are mostly found in the dry high and continental upper zones of North Sikkim. Table 4.4 and Fig. 10 presents the distribution of yak population in North Sikkim.

Table 4.4

Distribution of yak population North Sikkim.

SI. No.	Percentage Interval.	Class Category	No.of Blocks.	Name of Blocks.
1.	15 - 20	Low	1	Lachung
2.	20 - 25	Moderately low	1	Chho-Lhamo
3.	25 - 30	Moderate	1	Lhonak
4.	30 - 35	High	1	Lachen

It may be seen from the Appendix IX. yak population in the region varies between as low as 17.97 percent to the total yak population to as high as 34.33 percent for Lachung and Lachen respectively. Such high percentage of yak population in Lachen may be attributed to favourable climatic and environmental conditions for the survival of this animal. As far as the special distribution of yaks in north sikkim is concerned it will be seen from the table 4.6 that only one developmental block i.e Lachung comes under the arbitrary class interval varying between 15 to 20

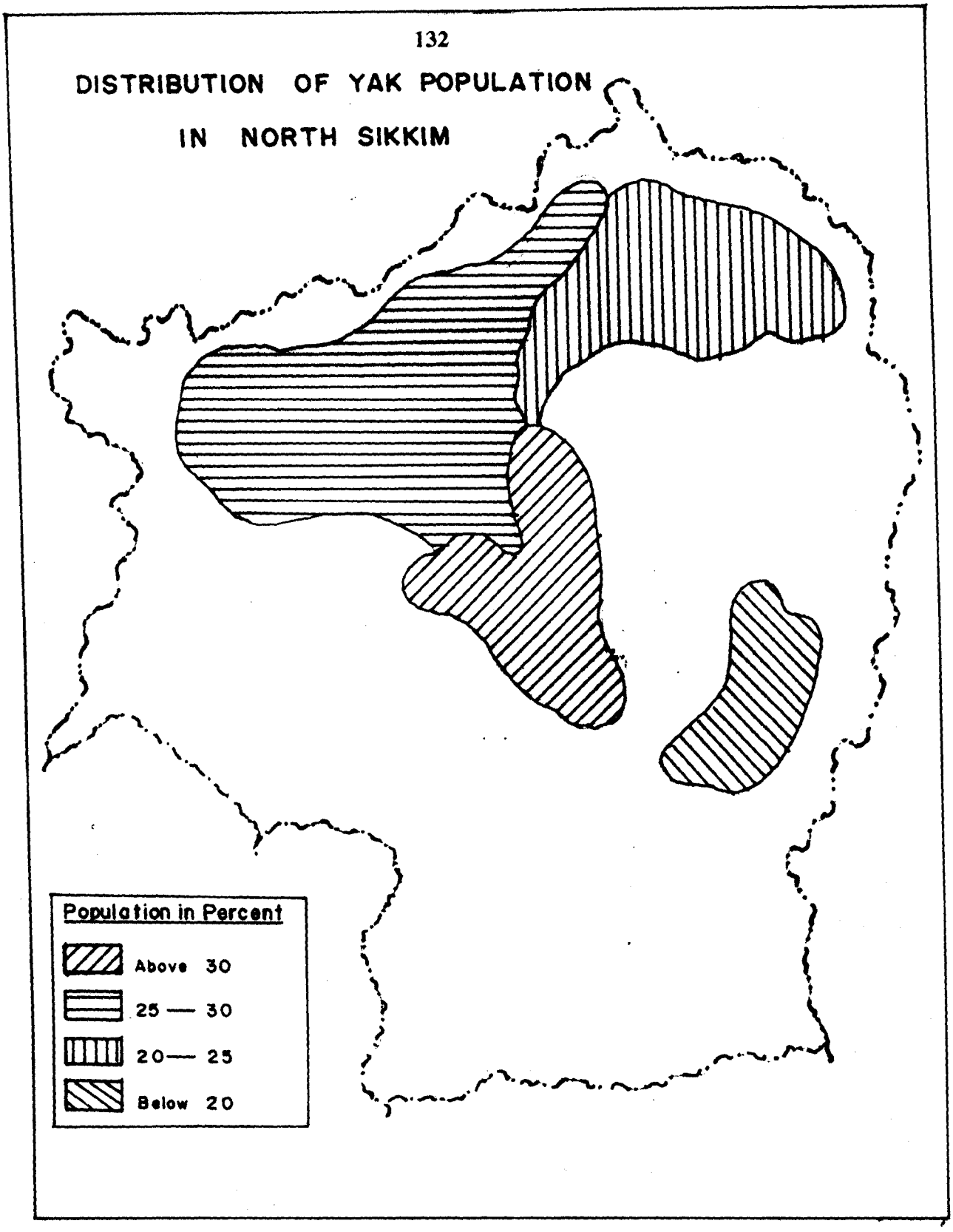

DISTRIBUTION OF YAK POPULATION
IN NORTH SIKKIM
Population in Percent
Above 30
25 — 30
20 — 25
Below 20

Fig 10.

percent that exibits low percentage of yak population. Such low percentage of yaks could be due to multiple reasons including environmental, econmic and so on and so forth. As yak is a high altitude animal environmental factors are deemed to be the most important for the survival of these animals. Lachung being situated 2633 metres altitude supports very few yaks because of the fact that their grazing grounds are not as extensive as that of Lachen and people of Lachung cultivate off season vegetables like cabbage and other continental vegetables compared to Lachen.

Next to Lachung comes Chho-Lhamo which has a moderately low percentage share of yak population the percentage being 20.66 percent. Lhonak in north Sikkim possesses a moderate share of yak population i.e. 26.74 percent to the total yak population in the entire region. There is only one development block i.e. Lachen which has the highest percentage share of yaks in the entire region. As has been explained earlier, such high percentage of yaks in Lachen may be largely due to favourable environmental conditions that stand responsible for the high populations growth of these animals.

4.4.1.2. CATTLE POPULATION

Cattle is the most important livestock in North Sikkim as far as the economic significance of this animal is concerned Table 4.5 4.2 percents the distribution of cattle in North Sikkim. The distribution of cattle population in North Sikkim is shown in Fig. 11.

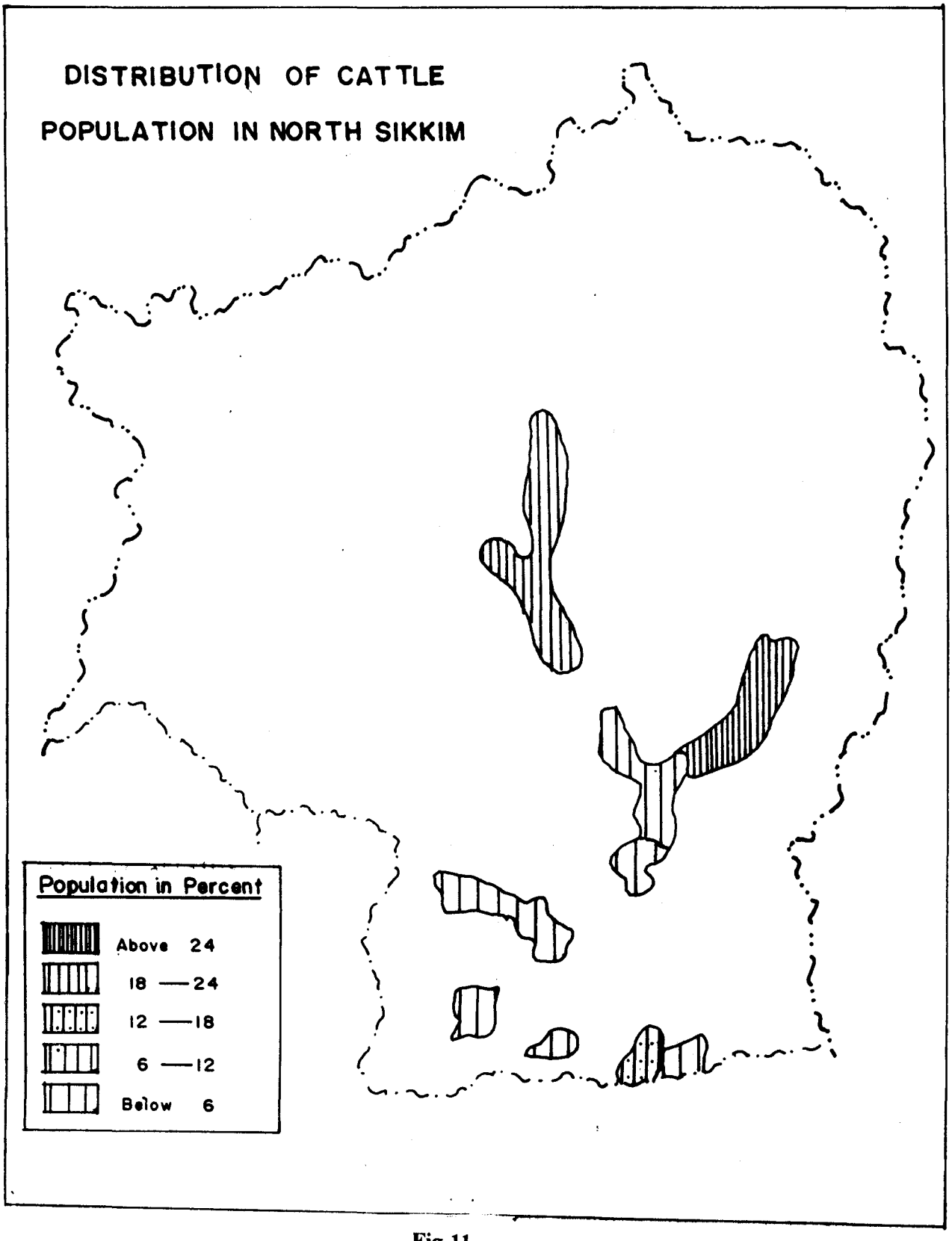

DISTRIBUTION OF CATTLE
POPULATION IN NORTH SIKKIM
Population in Percent
Above 24
18 — 24
12 — 18
6 — 12
Below 6

Fig.11.

Table - 4.5

Distribtion of cattle population in north Sikkim.

SI. No.	Percentage Class interval.	Category	No. of birds.	Name of Blocks.
1.	Less than 6	very low	11	Shipgear, Naga, Namgor, Pakshep, Kazor, Singhik, Hee-Gyathang, lingthem, Gnon-Samdong, Tingda, Ramthang Mangan. lingthem.
2.	6 -12	low	1	Chungthang
3.	12 -18	Moderate	1	Kabi
4.	18 -24	high	1	Lachen
5.	24 and above	Very high	1	Lachung

In north district majority of the blocks located in the sub-tropical zone have cattle population the percentage share being less than 6 pecent. The block falling in the very low category of cattle population include shipgear, Naga Namgor, Pakshep, Kazor, singhik, Hee-gyathang, Lingthem, Gnon-Sandong, Ramthang, Tingda and Mangan. However, Chungthang block has low concentration of cattles population the percentage being 7.63 percent to the total cattle population. Similarly the Kabi block with moderate concentration of cattles possesses 12.01 percent of the total cattle population in the entire north Sikkim. the very high percentage of cattles in Lachung is followed by high percentage at Lachen. As far as the distribution of cattles in north Sikkim in different areasare concerned, it could

be infered that as many as 12 blocks have low percentage share of cattles to the total cattle population in the region. Only one block i.e. Kabi could be termed as having medium share of cattle population. However, only two blocks such as lachen and lachung have high cattle concentrations in the entire region. Such high percentage share of cattles to the total livestock in these blocks could be attributed to favourable environemental & socioeconomic conditions such as availability of large expenses of pastures, resources of water, moderate temperature conditions etc. incentives to farmers, good extension services, services from financial institutions in terms of loans, subsidy from the state government etc.

4.4.1.3. GOAT POPULATION

Goat is the only animal found all over north Sikkim from dry high zone to sub-tropical zone. The percentage distribution of goat is given in Table 4.6.

Table- 4.6

Distribution of goats in North Sikkim

SI. No.	Percentage Class interval	Category	No.of villages.	Name of the villages.
1.	Less than 5	Very	8	Chho-Lhamo, Lachung shipgear, Pakshep, Gnon-Sandong, Kazor Naga Namgor, Ramthang.
2	5 -10	low	6	Lhonak, Chungthang, Lingthem, Mangan.
3.	10 -15	Moderate	2	Kabi, Lachen
4.	15 and above	high	1	Tingda.

It may be seen from the Table 4.8 that 47 percent of the samplevillages fall in the low category of goat population the percentage share being less than 5 percent. Similarly as much as 35.29 of the total sample villages have low goat population the percentage shares ranging between 5 to 10 percent. Only one village i.e. Tingda has high goat population of which comes under the percentage interval of 10 to 15 percent. A glance at table 4.8 reveals that there are as many as 14 village which have low goat populations. However, only one village has the highest percentage share of goats. Such high goat population in this village may be due to favourable socio-economic and environmental conditons factor may be high profitability in terms of cash return in case of this animal. The distribution of goat population and the sample villages in north Sikkim is shown in Fig 12.

4.4.1.4. SHEEP POPULATION

The percentage distribution of sheep population is presented in Table 4.7 and Fig. 13. The very high percentage of sheep population i.e above 27 percent is found in only one block i.e Lhonak. This is followed by Lachen with high sheep population the percentage shares varying between 18 to 27 percent. Chho-Lhamo could be termed as having moderate sheep population the percentage share to the total sheep population following under the percentage class interval varying between 9 to 18 percent. However, Lachung has the lowest sheep population having below 9 percent of the total sheep population in the region.

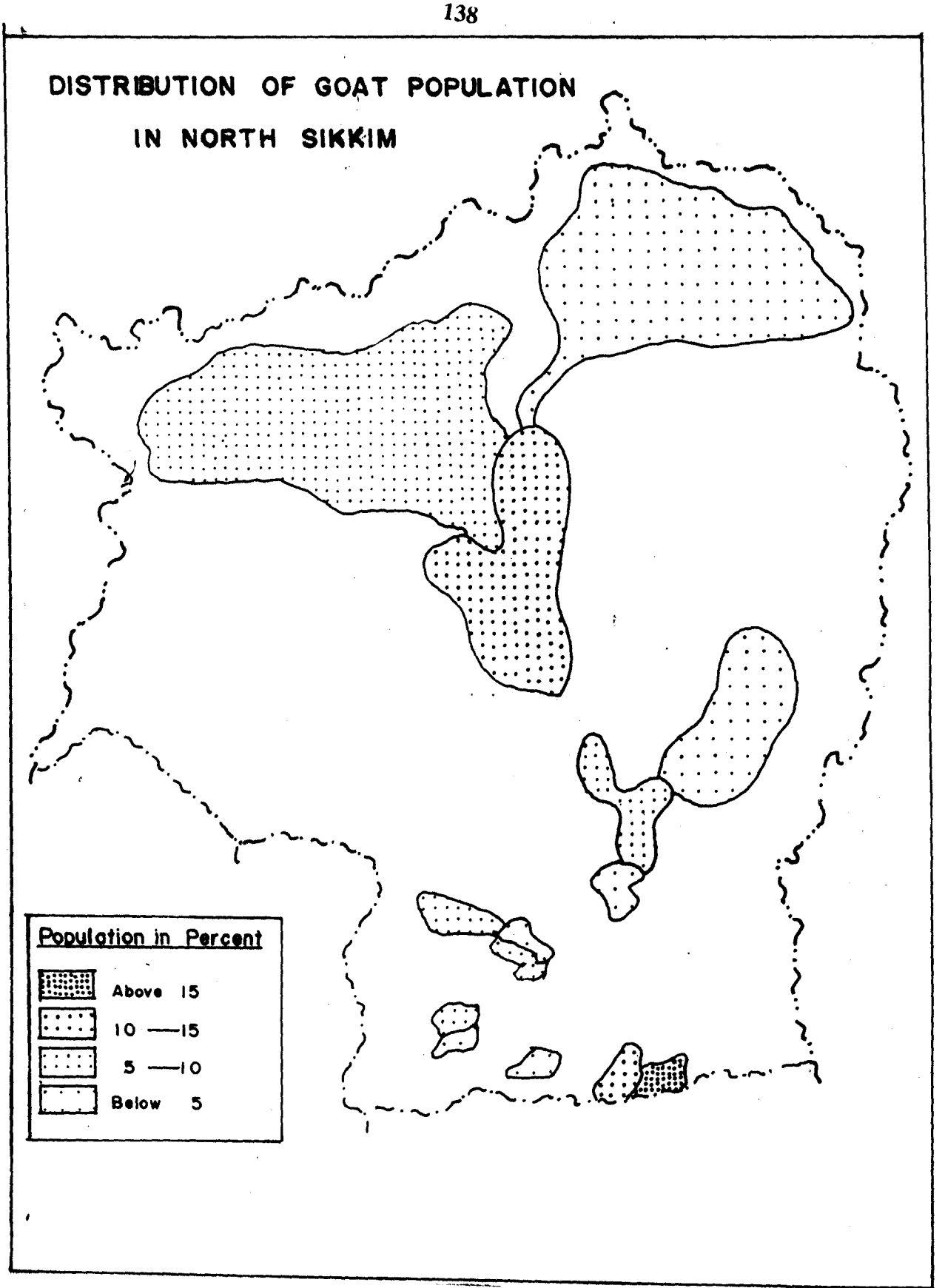

DISTRIBUTION OF GOAT POPULATION
IN NORTH SIKKIM
Population in Percent
Above 15
10 —15
5 —10
Below 5

Fig 12.

Table - 4.7

Distribution of sheep in North Sikkim.

SI. No.	Percentage Class interval.	Category	No.of villages.	Name of the Villages
1.	Below 9	low	1	Lachung
2	9 -18	Moderate	1	Chho-Lhamo
3.	18 -27	High	1	Lachen
4.	Above 27	very high	1	Lhonak

Thus the above table reveals that sheep rearing appears to be very popular in two villages such as Lachen and Lhonak. Though Lachung and Chho-Lhamo have relatively low sheep population never the less sheep rearing is no less important in these villages. as these animals live in extensive grass lands Lachen and Lhonak have the right ecological conditions. Moreover, better economic conditions of the sheep farmers in these villages have boosted the enterprise of sheep rearing in these villages.

4.4.1.5. PIGGERY POPULATION

The distribution of piggery population villagewise in different percentage categories in North Sikkim has been given in table 4.8 and Fig 14.

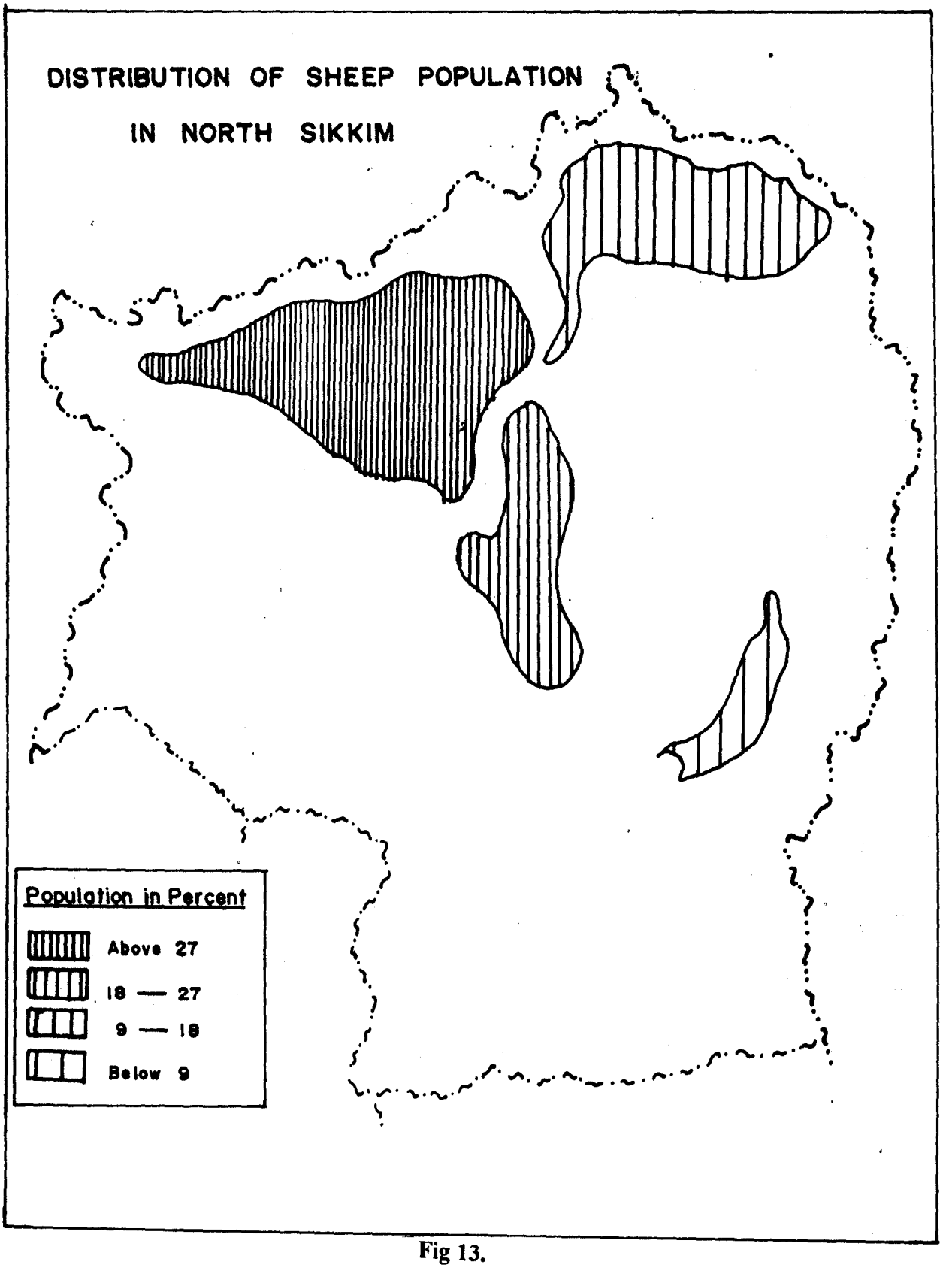

DISTRIBUTION OF SHEEP POPULATION
IN NORTH SIKKIM
Population in Percent
Above 27
18 — 27
9 — 18
Below 9

Fig 13.

Fig 14

DISTRIBUTION OF PIG POPULATION IN NORTH SIKKIM

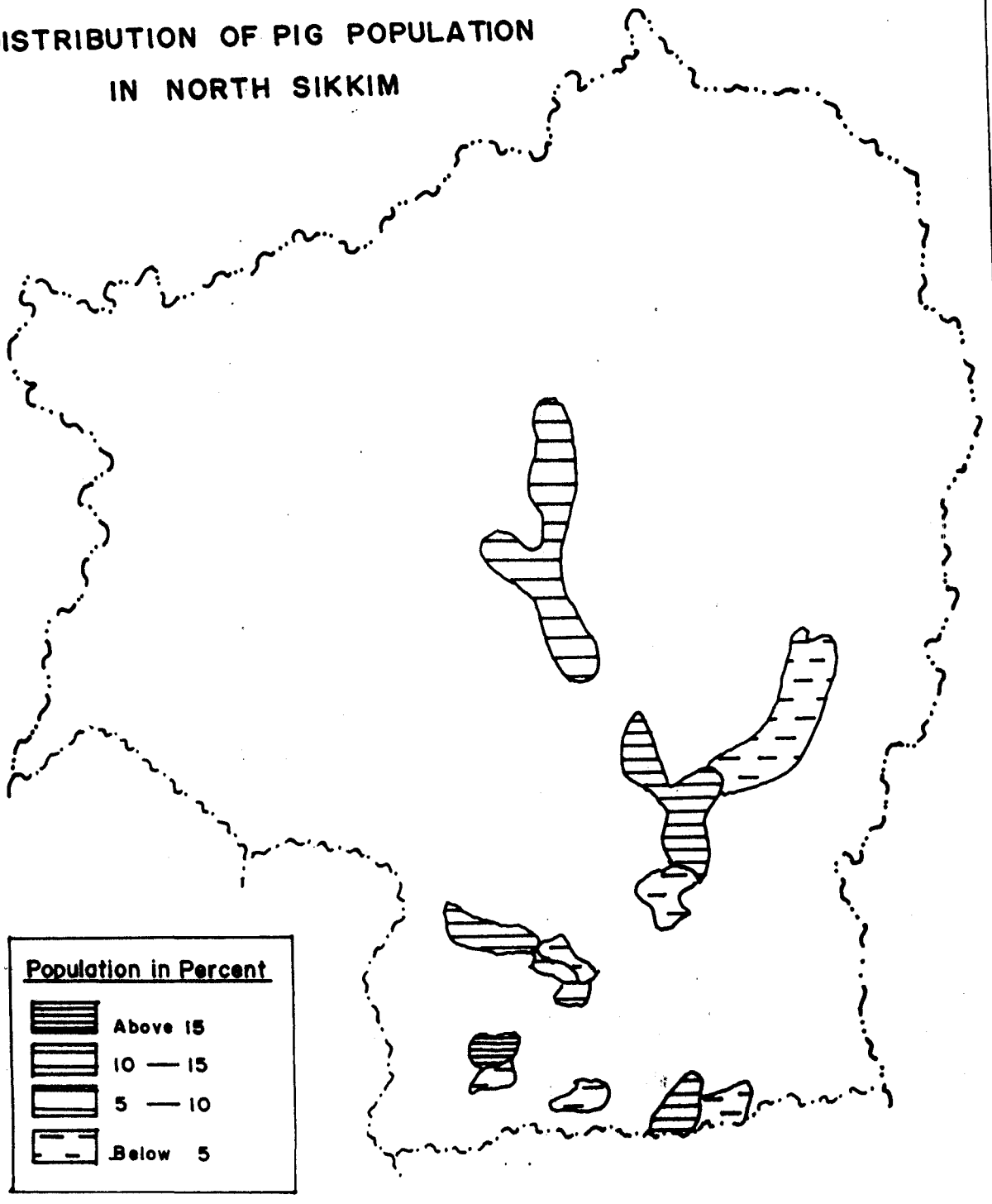


Table 4.8
Distribution of Pigs in North Sikkim.

SI. No.	Percentage Class interval	Category	No.of villages.	Name of the villages.
1.	0 -5	Very low	8	Lachung, Shipgear, Kazor, Naga Namgor, Pakshep, Gnon-Sandong, Tingda Ramthang.
2.	5 -10	low	3	Lachen, Mangan,Singhik.
3.	10 -15	Moderate	3	Kabi, Lingthem,Chungthang
4.	15 -20	high	1	Hee-Gyathang.

Majority of the sample village accounting for as much as 53 percent of the total sample village have low pig population i.e below 5 percent. There is only one village which has the pig population in the region the percentage share being 15.89 percent come under the category of 15 to 20 percent. There are three villages namely Kabi Lingthen and Chungthang have pig populations that come under the arbitrary percentage class interval ranging between 10 to 15 percent. Similarly there are another three villages nemely Mangan, Lachen and Singhik which could be termed as having low piggery population their percentage share varying between 5 to 10 percent. Such low piggery population in these villages may be largely due to harsh environmental conditions and other socio-economic conditions. Similarly, high pig population in Hee-gyathang village could be attributed to suitable geographical conditions required for pig farming and commercial ventures taken up by the farmers.

4.4.1.6. POULTRY POPULATION

The number of villages and various degrees of poultry population in North Sikkim are presenteed in Table 4.9. The distribution of poultry population in sample villages is shown in Fig 15.

Table 4.9

Distribution of poultry population in North Sikkim.

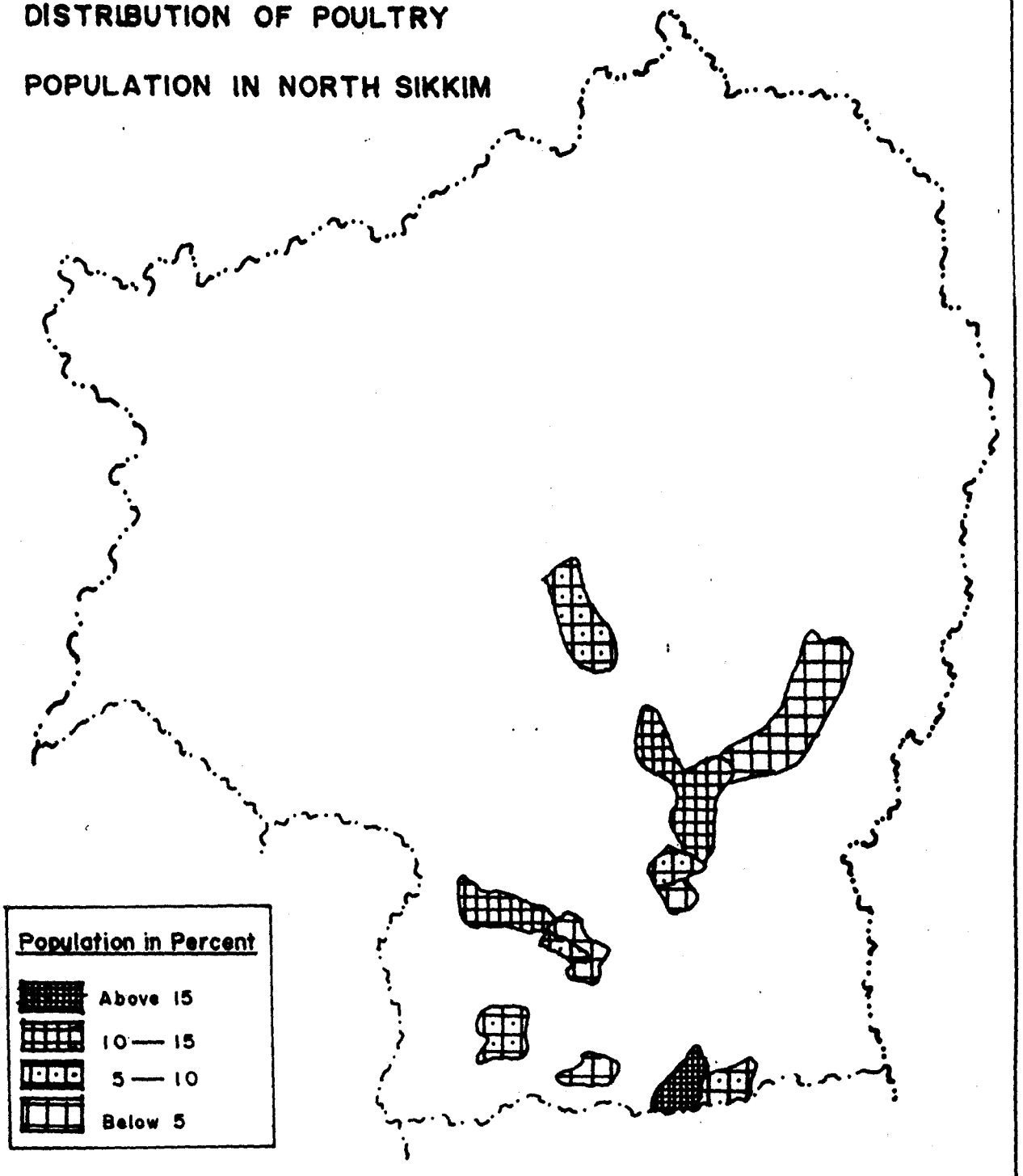
SI. No.	Percentage Class interval	Category	No.of villages.	Name of the villages.
1.	0 -5	Low	6	Lachung, Kazor, Pakshep, Naga Namgor,Ramthang, Mangan.
2.	5 -10	Moderately low	6	Tingda, Gnon-Sandong, Hee-Gyathang, Singhik, Shipgear and Lachen.
3.	10 -15	Moderate	2	Lingthem, Chungthang.
4.	15 -20	high	1	Kabi.

As much as 40 percent of the sample villages have poultry population below 5 percent. Similarly another 40 percent or 6 villages have poultry population ranging between 5 to 10 percent. Only two villages namely Lengthem and Chungthang have poultry population ranging between 10 to 15 percent. Out of 15 villages only one village i.e Kabi has poultry population ranging between 15 to 20 percent which comes under high category of poultry population in the region.

Fig 15.

DISTRIBUTION OF POULTRY

POPULATION IN NORTH SIKKIM



Though poultry is a profitable commercial enterprise in North Sikkim atleast 80 percent of the villages surveyed exhibit a very dismal figure of population in terms percentages to the total livestocks in the region. The percentage shares of poultry in these villages appear to be below 10 percent of the total livestocks in the region. However, only two villages have moderate share of poultry. The high poultry share in Kabi could be largely attributed to profitability of this farming and good incentives given to the farmers.

CHAPTER V

DIFFUSION OF MODERN INNOVATIONS IN LIVESTOCK FARMING IN NORTH SIKKIM

Adoption of modern innovations in various economic enterprises is a phenomenon which has considerably helped boost the level of farm productivity. At the same time the farm income has also gone up many fold due to this technological break through in the production process. As far as agriculture and animal husbandry is concerned, application of modern technology is though a relatively recent phenomenon in india, but in many developed countries of the world,the same has revolutionised the production scenario thereby generating huge surpluses for a progressive market economy. As has been said earlier, animal husbandry or livestock rearing being an important economic sector and an integral part of indias' rural economy contributes significantly to our national income. However, the productivity of the country's millions of livestock has not been very satisfactory over the decades despite the fact that there has been a concerted effort in raising the productivity level of the animals by bringing in to its fold particularly in the rural country side. It is quite surprising to note that the receptivity to modern technology by the rural farmers is considerably low. This has largely been attributed to numerous social cultural and economic factors. Besides, Phisico-geographical factors also stand on the way of the diffusion of modern innovations in a spatial context. As spatial diffusion of modern innovation as a dimension of study is beyond the scope of the present exercise, it will be pertinent to highlight as to how socio-cultural factors have influenced the decision making process of the farmers to go in for modern technology in the study area. It is in this context that certain socio-cultural indicators such as the educational background of the farmers and the level

of their exposure to modern technology, sources of communication of knowledge about new innovations such as different electronic media like Radio & T.V., tradition of rearing livestock etc. have been decidedly taken in to consideration to know the level of receptivity of the farmers to new innovations at farm level. Therefore, with a view to understanding such socio-cultural status of the farmers at present and their attitude towards modern innovations in North Sikkim first hand informations have been collected during the household survey. The analysis of the data and information so procured are presented item-wise as follows:

5.1 Educational Background of the Farmers of North Sikkim.

Education is supposed to be the most important attribute for socio-economic change. Before going into the details of the diffussion in livestock farming in the region, it would be meaningful to throw light on the educational background of the farmers of North Sikkim. The following table illustrates the percentage share of the farmers areawise as far as their educational background is concerned.

Table 5.1

Educational Background and Occupation of the farmers of North Sikkim.

SI. NO.	PARTICULARS	ZONES						TOTAL	
		DRY HIGH ZONE		CONTINENTAL ZONE		SUB-TROPICAL ZONE		NORTH SIKKIM	
		NO	%	NO	%	NO	%	NO	%
1.	Literate.	00	00	93	38.75	293	52.60	386	46.67
2.	Illiterate.	30	100	147	61.25	264	47.40	441	53.33
3.	Farming.	30	100	180	75.00	445	79.89	655	79.20
4.	Service.	00	00	32	13.33	90	16.16	122	14.75
5.	Business.	00	00	28	11.67	50	6.05	50	6.05
6.	Family size								
	Per household	5.17	-	5.10	-	5.41	-	5.31	-

It will be seen from the Table 5.1 that in the Dry High zone out of 30 house holds surveyed all are found to be illeterates. In the continental zone out of 240 households surveyed 147 or 61.25 percent respondents who are heads of the households were illiterate and 38.75 percent were literate. Also in the same zone 75 percent respondents belong to the farming community where as 13.33 percent and 11.67 percent belong to service and business communities respectively. In the lower sub-tropical zone the total number of household surveyed is 557. Out of the 557 households in this zone 50 percent of respondents are literates and 50 percent illeterates. From the above household survey in the region, the farming community constitutes a staggering 79.89 percent of the total households followed by 16.16 percent in service and 3.95 percent in business and commerce. The above findings indicate that out of 827 farmers surveyed for the purpose as much as 46.67 percent are found to be literates and educated whereas more than 50% of the farmers are illiterates the percentage being 53.33 percent. As far as the occupational status of the households is concerned it is noticed that a substantial proportion of the rural households constitutes of farming community which accounts of 79.20 percent of the total households surveyed. The rest of the people are either serving in various government departments or are businessmen who account for 14.75 percent and 6.05 percent respectively. It can however be concluded that the educational status of the people of the rural households in North Sikkim is gradually improving and majority of them are farmers who appear to be educationally enlightened and are found receptive to new innovations particularly at their occupation level which is predominated by livestock farming.

5.2 Source of communication of Knowledge

In the present study as many as 240 households in the continental zones and 557 households in the sub-tropical humid zone were surveyed to ascertain their sources of information regarding modern livestock rearing. The farmers were accordingly asked to indicate whether they came to know about the modern technology in livestock farming through programmes of Krishi Darshan show in T.V. or through any other media. Similarly they were asked to indicate whether they have participated in calfrally or Livestock show etc. and if they did participate in such rallies whether it was found educative for them or not. The findings have been presented in Table 5.2. It has been observed that out of 797 households as much as 30 perecnt of farmers use radio as their main source of information for modern livestock rearing and only 12.55 percent watch T.V. for programmes on livestock rearing where as about 57.34 percent of the households neither listen to radio nor do they watch T.V. As many as 164 farmers accounting for 20.58 percent of the total respondents indicated that they have watched or heard of Krishi Darshan on radio and T.V. It is interesting to note that a substantial percentage of the farmers accounting for more than three quarters of the total respondents i.e. 79.42 percent do not have any opportunity to hear the Krishi Darshan programme in T.V. and radio and thus appear to be quite unaware of modern livestock rearing. It will be seen from table 5.2 that out of 797 households as many as 126 accounting for 16 percent of the farmers have attanded livestock show and from amongst them 109 farmers i.e. 86.51 percent found the show quite educative whereas as 17 farmers i.e. 13.49 percent did not find the show useful which could be attributed to their low educational standard or poor grasping of the scientific aspect of the programme.

Table 5.2

Source of communication of knowledge in north Sikkim

Sl. No.	Source of Information		Continental Zone		Sub-tropical Zone		Total North Sikkim	
			No.	%	No.	%	No.	%
1.	Radio		86	10.79	154	19.23	240	30.11
2.	T.V.		14	1.76	86	10.79	100	12.55
3.	Nither listen to Radio nor watch T.V.		140	17.57	317	39.77	457	57.34
4.	Aware of Krishi Darshan.	Yes	17	2.13	147	18.44	164	20.58
		No	223	27.98	410	51.44	633	79.44
5.	Participation in Livestock Show/Calf Rallies.	Yes	3	0.33	123	15.43	126	15.81
		No	237	29.74	434	54.45	671	84.19
6.	Whether found Livestock Educative	Yes	-	-	109	86.51	109	86.51
		No	3	2.38	14	11.11	17	13.49

From the foregoing discussion it could be concluded that though the main sources of information for modern livestock farming are the electronic media such as radio and T.V. in

North Sikkim, nevertheless these media are not very effective in propagating the message of modern technology and new innovations in these remote and isolated region of the country. It is quite evident from the above discussion that a large number of farmers are evidently unaware of programmes on modern livestock rearing and related aspects that are being covered on electronic media. It is also observed that a very few farmers attend to livestock extension programmes such as livestock shows of exotic high yielding varieties. As a matter of fact, there is a considerable information gap among the rural farmers about the modern innovations of livestock rearing. These may however be attributed to the fact that either the farmers are not properly motivated or they do not have financial viability to go in for T.V. sets or they are simply indifferent to programmes on agriculture and livestock on radio etc. or the region is not served with right infrastructural facilities for bridging the above communication gap amongst the farmers. All these need further research and investigation which will be of immense use for the postering particularly the planners and policy makers at both the State and the national levels. From the above findings it could also be inferred that even though a smaller proportion of the farmers listen to radio and still an insignificant share of them watch T.V. on modern livestock technology. In these hilly and remote areas of northern Sikkim, there is wider scope in livestock development in this region which could be achieved through a co-ordinated effort involving various agencies such as government, the non government organisations, the voluntary agencies and so on with the building up of adequate infrastructures etc.

5.3. Mobility of the farmers

Direct contact and self observation of the fruits of science and technology sometimes help in acquiring first hand informa-

tion and upto-date knowledge on recent advancement on various fields thereby leading to easy receptivity and acceptance to new ideas and introduction of modern innovations. As far as livestock farming is concerned visits of farmers to the centres of technology leads to the creation of awareness amongst them who would prepare themselves for adoption of this new technology in the process of diffusion of modern innovations at large.

Keeping the above fact in view it would be meaningful to throw light on the level of exposure of the farmers in terms of their frequency of visits and contact with advance farmers and mobility to relative advanced places in understanding the technological innovation in livestock farming. Unless the farmers have direct observation it will be difficult for them to accept the new techonology. With a view to understanding the level of exposure of the farmers concerning modern technology in livestock farming data and information were collected with the help of structure questionnaire schedules through direct interview with the farmers. From the data and the information gathered from the field survey the following picture emerged besides other nearby places of livestock development the farmers were put questions to indicate their number of visits to Gangtok which is an important centre for livestock production and other allied activities relating to modern livestock raising and training facilities and has a central veterinary hospital and a liquid nitrogen plant for the preservation of frozen semen (plate 16 & 17). Table 5.3 presents the number of visits of the farmers to Gangtok in a year.

Table - 5.3

Farmers of North Sikkim visiting Gangtok in a year.

SI. No.	Details No. of visit	No. of farmers	Cumulative Frequency	Percentage %	Cumulative percentage	Level of Exposure
1.	ZeroVisit.	24	24	3	3	Nil
2.	1-2 times.	308	332	38.65	41.65	Low
3.	3-6 times.	250	582	31.37	73.02	moderate
4.	7-12 times.	84	666	10.54	83.56	high
5.	Above 12 times.	131	797	16.44	100.00	Very high

From Table 5.3 it will be seen that as much as 97 percent of the farmers out of the total respondent recorded during the field survey visit Gangtok though the frequency of their visit varies from place to place. The rest of the farmers who constitute of as little as 3 percent of the total refrained from doing so.

A glance at Table 5.3 reveals that there are a very few farmers who do not have any exposusre to modern livestock farming as they do not pay any visit to the livestock production centres such as Gangtok concerning modern livestock farming. A substantial percentage of the farmers constituting of 38.6 percent of the total respondents are said to be having low exposure to new innovations in livestock farming. Similarly 31.37 percent of the farmers have moderate exposure to new innovations whose visit to Gangtok varies between atleast 3 to 6 times a year. It will be further seen from the above table that more than 10 percent of the farmers have fairly high exposure to modern technology in livestock farming varies between 7 to 12 times a year. It is interesting to note that an appreciable share of the farmers i.e. 16.44

Plate 16.
Liquid nitrogen plant at Gangtok (East Sikkim).

Plate 17.
Stockman with 2 litres liquid nitrogen container-ready for insemination.

percent seem to be highly exposed to modern livestock farming as evident from their frequency of visits to Gangtok regarding modern innovation in livestock farming.

5.4. Livestock Rearing Tradition

Duration of livestock rearing is an important criteria for successful adoption of modern cross breeding technology. The farmer must be familiar with the rearing of livestock otherwise his venture for adoption of new technology will fail.In order to have an understanding about the tradition of rearing of livestock in the region data an information were collected through structured questionaries during the household survey and frequency tables were prepared to classify households according to their period of rearing of livestock. The following table represents zonewise distribution of households according to period of rearing of livestock.

Table 5.4

Distribution of households according to period of rearing livestock.

Sl. No.	Duration of rearing livestock	Dry high Zone		Continental Zone		Sub-tropical Zone		Total	
		No.	%	No.	%	No.	%	No.	%
1.	Below 1 year	Nil	Nil	1	0.12	9	1.09	10	1.21
2.	1-2 years	Nil	Nil	9	1.09	52	6.29	61	7.38
3.	2-5 years	Nil	Nil	20	2.42	71	8.59	91	11.00
4.	5-10 years	Nil	Nil	41	4.96	103	12.46	144	17.41
5.	Above 10 years	30	3.63	164	19.83	320	38.69	514	62.15
6.	Not aware	Nil	-	5	0.61	2	0.24	7	0.85
	TOTAL	30	3.63	240	29.02	557	67.35	827	100.00

A glance at Table 5.4 reveals that all the farmers of Dry mountain zone i.e. Lhonak, Muguthang and Chho-Lhamo grazing grounds under dry high zone have been rearing livestock for over 10 years period even though they constitute only 3.63 percent of the total household. Similarly in the continental upper zone out of 240 households 164 households or 68.33 percent of the farmers have been rearing for over 10 years even though they form only 19.83 percent of the total household surveyed.

As far as the sub-tropical Humid Zone is concerned the number of farmers rearing livestock for the past 10 years is 320 out of 557 or 57.45 percent. However it constitutes only 38.69 percent out of the total household surveyed. From the above findings based on sample household survey it could be observed that a substantial share of farmers that account for as high as 62.15 percent of the respondents have been rearing livestock for over 10 years.

5.5. PREFERENCE FOR CROSS BREED LIVESTOCK

Cross breed of livestock have always been prefered for higher yield of milk, meat and wool vis a vis the local varieties. The department of Animal Husbandry and Veterinary Services of the Government of Sikkim have been emphasizing on the cross breeding of the local livestock with exotic cattle, sheep, goats of Jamunapari breed, exotic pigs like Saddle Back, Landrace, Yorkshire etc. and improved strains of poultry birds. In view of the economic significance of the cross breed animals it will be worthwhile to discuss the level of adoption of these livestock in the study area. Though there are different types of livestocks reared by the farmers, cattle is an important livestock in north sikkim and is found to be reared by almost all the livestock farmers in the region particularly the upper continental zone and

the humid sub-tropical zone. Therefore, cattle should be given main emphasis as it is widely reared as said above. The department of Animal Husbandry have started frozen semen technology by opening numbers net work of artificial insemination centres in this part of north Sikkim for quickening the process of cross breeding.

In order to know the rate of adoption of cross breed cows the farmers and the reasons of such preference a direct interview with the farmers was conducted and the data and informations were collected through structured questionaries the following picture emerges. The reasons of preference were divided into four points as follows. The first point was that the crossbred cows would give 100 percent more milk than local cows-followed by second and a third points which respectively referred to the facts that same cows would give 50 percent and 25 percent more milk than the local cows. As far as the fourth point is concerned the crossbred cows would give the same quantity of milk as the local cows.[28] The distribution of households according to the preference for different types of cattles along with the reasons that could be attributed to such preference has been given in Table 5.5. It will be seen from the Table 5.5 that a substantial share of the total number of farm households accounting for as high as 83 percent indicating their preference for croosbred cows. However as little as 17% of the farmers preferred for local cows only. In the upper continental zone a large number of farmers opted for Holstein Frisean the percentage being 76.67. About 30 percent of them opted for Jersey. In the lower sub-tropical zone 70 percent preferred Jersey cow and only 23 percent showed preference for Holstein Frisean cows.

28. Similar methodology was adopted in Kerala by George, P.S. and Nair, K.H. In (Livestock economy of Kerala, Trivandrum. 1990. p 137-167).

Table - 5.5

Distribution of house-holds according to preference of cattle and the reasons there of

Sl. No.	Zone and Revenue Blocks	No. of House-hold Surveyed	Local		Jersey		Hols.-Fri.		Cross-breeds' milk Production more than that of local						Cross-breeds' milk Production same as local	
									100 %		50 %		25 %			
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
A. DRY HIGH ZONE																
1.	Lhonak	15	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2.	Chho-Lhamo	15	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total (A)		30	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
B. CONTINENTAL UPPER ZONE																
1.	LACHEN	122	7	6.36	92	13.98	23	76.67	25	20.49	61	50.00	29	23.77	0	0.00
2.	LACHUNG	118	12	10.91	106	16.11	0	0.00	4	3.39	93	78.81	9	7.63	0	0.00
Total (B)		240	13	17.27	198	30.09	23	79.31	29	12.08	154	64.17	38	15.83	0	0.00
C. SUB-TROPICAL HUMID ZONE																
1.	Chungthang	108	3	2.73	105	15.96	0	0.00	98	90.74	6	5.56	0	0.00	1	0.93
2.	Ship-ger	29	4	3.64	25	3.80	0	0.00	0	0.00	20	68.97	5	17.24	0	0.00
3.	Naga Namgor	20	0	0.00	20	3.04	0	0.00	0	0.00	13	65.00	7	35.00	0	0.00
4.	Pakshep	14	0	0.00	14	2.13	0	0.00	13	92.86	1	7.14	0	0.00	0	0.00
5.	Kazor	23	5	4.55	18	2.74	0	0.00	15	65.22	3	13.04	0	0.00	0	0.00
6.	Singhik	59	8	7.27	51	7.75	0	0.00	38	64.41	13	22.03	0	0.00	0	0.00
7.	Hee Gyathang	61	2	1.82	54	8.21	5	16.67	22	36.07	37	60.66	0	0.00	0	0.00
8.	Lingthen	49	20	18.18	28	4.26	1	3.33	27	55.10	1	2.04	1	2.04	0	0.00
9.	Gnon Sangdong	16	1	0.00	15	2.28	0	0.00	8	50.00	7	0.00	0	0.00	0	0.00
10.	Ramthang	19	18	16.36	1	0.15	0	0.00	1	5.26	0	0.00	0	0.00	0	0.00
11.	Kabi	83	19	17.27	64	9.73	0	0.00	29	34.94	24	28.92	9	10.84	2	2.41
12.	Tingda	32	9	8.18	23	3.50	0	0.00	0	0.00	15	46.88	7	21.88	1	3.13
13.	Mangan	44	2	1.82	42	6.38	0	0.00	8	18.18	24	54.55	10	22.73	0	0.00
Total (c)		557	91	82.73	460	69.91	6	20.69	259	46.50	164	29.62	39	7.00	4	0.72
Grand Total		797	110	100.00	658	100.00	29	100.00	288	34.82	318	38.57	77	9.31	4	0.48

As regards the reasons for preference for crossbred cows, 64 percent of the farmers of Lachung and Lachen however indicated that crossbred cows would give 50% more than the local cows. As much as 12 percent of the farmers indicated that crossbred cows would give 100 percent i.e. double the local varieties. About 16 percent of the farmers were of the view that these cows would yield only 25 percent more milk than the local cows. Strickingly over to the sub-tropical zone of the study area it is observed that an appreciable share of the farmers constituting 47 percent of the total number of farm households of this zone opted that the cross breed cows would give 100 percent more than the local cows. Only 30 percent of the farmers indicated that milk yield would be 50 percent more than the local cows. As low as 7 percent of the farmers were of the openion that the crossbred cows would yield only 25 percent more than the local varieties. Less than one percent of the farmers indicated that milk yield of the crossbreds cows are same as local cows. From the above analysis it could be infered that the farmers in the region have a general urge for the cross breed cows as most of the farmers go in for these varieties for receiving relatively higher yield as compared to the local varieties of cows (Plates 18,19,20 and 21).

5.6. Preference for Breeding Cows

Scientific breeding of livestock is a step ahead in the process of modern innovations in the field of livestock management and development worldwide. In view of favourable enverionmental conditions in North sikkim, there is great scope for breeding different kinds of livestock for higher yield. In regard to the preference of breeding of animal out of 797 households surveyed 206 i.e. 25.85 percent preferred for artificial insemination and 480 farmers or 60.23 percent

Plate 18. A Lepcha farmer with his prized Holstein Friesian cow at Lingthem village, Dzongu Block (North Sikkim).

Plate 19. A Tribal woman with her crossbred Holstein Friesian cow in North Sikkim.

Plate 20. A Bhutia woman with her Jersey female calves at Singhik in North Sikkim.

preferred for natural services. However, 111 households accounting to 13.93 percent neither preferred A.I. nor did they go in for natural service. Table 5.6 presents the preference for breeding of livestock zonewise. Plate 22 shows a well maintaind breeding bull (Jersey breed) at Rabum A.H. farm in North Sikkim.

Table - 5.6

Preference for Breeding facilities in North Sikkim

Sl. no. Preference	Continental zone		Sub-tropical zone		Total	
	No.	percent	No.	percent	No.	percent
1. Preference for A.I. facilities	29	3.64	177	22.20	206	25.85
2. Preference for Natural Service.	197	24.72	283	35.51	480	60.23
3. Neither prefer A.I. nor N.S.	14	1.76	97	12.17	111	13.93

5.7. Animal Health Care

Proper Animal Health care is an important component in maintaining exotic crossbred animals which are more susceptible to various diseases than the local livestock. In north Sikkim as crossbred animals are increasingly becoming popular outbreak of the different animal diseases has caused a serious concern for the livestock farmers and the government as well. As for instance it has been discovered that in north Sikkim with the postings of the Indian army in the extreme border areas an animal disease known as foot and mouth disease keeps on

Plate 21. A good Jersey herd at Singhik in North Sikkim.

occuring every year especially near the army slaughter points. The infected sheep and goats are procured by the army and are slaughtered in various slaughtering points in North Sikkim thereby spreading the diseases far and wide. In the past not a single farmer would take up vaccination and would rather go in for the Lama's holy water for cure. It took a lot of time and extension work to convience the farmers. But at present they have been properly motivated to go in for scientific health care offered by the concern department and this change is coming from within. Vaccination of animals thus has become a commmon phenomenon in the rural areas of the hill region. The farmers are becoming more receptive to new innovations and the rate of adoption of modern innovations seems to be increasing at a faster rate. Out of 797 households surveyed, 527 families i.e. 66.12 percent vaccinated their livestocks against various infectious diseases including foot and mouth disease. Table 5.7 presents livestock vaccinated against various diseases.

Table 5.7

No. of households vaccinating their livestock

Zones	No. of households vaccinating their livestock	No. of households not vaccinating their livestock.	Total
Continental Zones	166	74	240
Sub-tropical Zones	361	196	557
TOTAL	527	270	797
PERCENTAGE	66.12	33.88	100

A photograph of Mangan veterinary hospital along with veterinary officers and para-vets is shown in Plat 23.

Plate 22. Jersey Breeding Bull at Government Farm Rabum (North Sikkim).

Plate 23. Veterinary Hospital at Mangan (North Sikkim).

CHAPTER VI

ECONOMICS OF LIVESTOCK PRODUCTION IN NORTH SIKKIM

6.1 Introduction.

Livestock rearing is an age old and integral part of India's rural economy. Agriculture and livestock go side by side and are deemed as the most dominant features of rural India which provide substantial employment to millions of our rural population. Thus there is an immense significance of livestocks in India's rural economy. The various livestock products such as meat, milk, skins, wool. pashmina hairs and bones etc. carry high economic values and contribute substantially to national income. Animal by-products of various kinds such as offals and blood obtained from animal, dung and urine etc. do also possess high commercial values thereby adding to gross national product. Livestock accounts for as much as 10 percent of our Gross National Product (GNP), the cash equivalent being approximately Rs. 15,000 crores or more[29]. As far as the details of the contributions of livestocks to the national income are concerned, it has also been found out that cattle and buffaloes being the most important components of the total livestocks contribute significantly to the gross National Product, the share of which stands at a staggering 80 percent of the total livestock products in the country. The rest of the livestocks that contribute about 20 percent to the GNP include mostly poultry birds, sheep and goats and other livestocks. The energy component of the livstocks in the form of dung as a source of fuel and draught power derived from cattles and buffaloes is a very significant contribution to various agricultural operations in the rural areas of the country. It has been worked out that 193 millions of cattle population in the country produce as much as 37,000 mega

29 Anonymous. Processing and Marketing of Meat, Milk and Milk product. Paper presented at (Conference of State Ministers of Animal Husbandry and Dairying. Department of Agriculture and cooperation and Indian Council of Agricultural Research, New Delhi, November 27-28, 1986. p 114 - 118).

watts of power for agricultrual production[30]. The overall draught power is assessed at Rs. 5000 crores.

6.2. Organization & Characteristics of Sikkimese Economy: A Historical Profile.

As the present chapter deals with the economics of livestock rearing and production in North Sikkim, it will be pertinent to draw up a brief history of Sikkimese economy in general and its rural economy in particular prior to going into the details of the study. As far as the past economic scenario of the state is concerned, there is hardly any written document that exists to date. Therefore, very little is known regarding the past economic scenario of this tiny Himalayan state. In view of a typical geographical setting in the Himalayas though pastoralism has historically been an element of Sikkim's rural economy and domestication and rearing of animals are the primordial occupation of the people nevertheless, its economic organization at different time period is found to be characteristically different which could well be split up into distinct phases while drawing up a brief historical profile of Sikkimese economy. The various aspects under review thus, incorporate the history of Sikkimese economy, the Sikkimese economy in transition, the economic scenario of the state prior to its merger with Indian union, the present status of livestock economy in Sikkim in general, the details of fund allocation under different plans and the physical achievements under State Animal Husbandry sector during 1954 to 1974, the post merger economic scene, the subsequent fund allocation and the role of animal Husbandry in the economic development of the state and finally the contribution of animal Husbandry sector to the State's gross income. The economic history of Sikkim could therefore be divided into five distinct periods which incorporate the periods of the Lepchas, the Bhutias, the British and

30. Bhat P.N. An overview of cattle productivity paper presented at (National Symposium on Animal productivity. Hindustan Lever Research Foundation. Bombay, April 17-18, 1987. p. 19-20).

the Indian protectorate and lastly the period starting from Sikkim's merger with Indian Union to become the 22nd State untill now.

There is no definite account of the Lepchas of sikkim in earlier writings except that Lepcha society was semi-nomadic and tribal in character due to the primitive mode of acquisition of food.[31] The domestic animals played an important role in the lives of the Lepches. The animals especially oxen were killed during socio-religious celebrations of birth, marriage and death and were sacrificed in almost all the religious ceremonies of the community known as "mun". The cattles were considered as the chief sign of wealth and a person with 20 herds of cattles was considered a rich man[32]. Thus, their main food consisted of domesticated as well as wild animals that they could kill or find dead. They also ate a great variety of forest produce chiefly tubers of different wild yams and various bamboo shoots and neetle leaves etc. During this period the inevitable rule of the Lepcha economy was from each according to his ability, to each according to his work. The Lepcha period ended in 1642 and there was no change in the social set up till then.

From the year 1642 Bhutias started coming in and they brought with them the Tibetan ideas and customs. They introduced feudal society with a monarch as its head and the land was the main pillar of socio-economic structure. It is interesting to note that the Tibetans brought with them the domestic animals like yaks, sheep, pashmina type of goats which became sources of food and woolen clothing for the people living in high altitudes. The agricultural production during this period was quite meagre and thus, there was no significant change in the economy of Sikkim till the year 1889.

31. Debnath J.C. Evaluation of the Sikkimese Economy during the British period. Indian Journal of Hill Economy. Vol2 1992, p. 20-37.

32. Gorger,G. The Lepchas of Sikkim. New Delhi, Cultural Publishing House, 1984.p.83-111

Sikkim's economy began after the establishment of British control after 1889[31]. Proper taxation, revenue and budgetary systems were established subsequently. This helped the State in improving communication system which greatly contributed to the Indo-Tibetan trade in later years. The concept of private property evolved in the process thus sowing the seed of capitalist elements. Gradually the introduction of Indian rupee started modernising the economy in Sikkim. Side by side, there was the existence of primitive media of exchange like pigs, hens and other livestocks. Another major event which changed the Sikkimese economy was the influx of Nepalis in 19th century. "Sikkim's economy during British period can thus be termed as a feudal economy with increasing capitalist elements". The British control over Sikkim came to an end in 1947[31].

The Indian government after signing the Indo-Sikkim Treaty of 1950 started taking interest towards the development of Sikkim and following the visit of Late shree Jawaharlal Nehru the then Prime Minister of India in April 1952, the First Seven-year Development plan of Sikkim (1954-60) was introduced under the chairmanship of Chogyal Late Palden Thondup Namgyal. It was he who laid the foundation of Development plans of Sikkim. Prior to first plan there was no organized effort to develope animal husbandry scheme in the State though the state enjoys all appropriate natural conditions and has enormous potentiality/scope for developing such a promising and economically viable sector as has already been pointed out. The details of fund allocation under differ ent plans and the physical achievements under Animal Husbandry sector are given in the next page.

31. Debnath J.C. Evaluation of the Sikkimese Economy during the British period. Indian Journal of Hill Economy. Vol2 1992, p. 20-37.

Details of plan	Fund allocation (Rs.)	physical achievement
1st plan (1954-61)	2.90 lakhs	Tadong livestock farm was established and 16 Australian Jereys alongwith 6 nos. of large white yorkshire pigs were introduced. Poultry section was started with the introduction of exotic breed like Rhode Island Red and white leg horn to produce chicks for improving the local stock A Veterinary Hospital at Deorali and a dispensary at Namchi was opened to look after the health of animals.
2nd plan (1961-66)	24.00 lakhs	Cattle strength at Tadong farm was increased to 35 cows and Landrace pig breed was introduced. The poultry section was improved with a breeding cum rearing shed and incubators were installed. The strength of the veterinary hospital at Deorali was further expanded by adding a reserach cell for disease investigation. Pure Jersey and Sindhi bulls were distributed to the progressive dairy farmer for breeding. A sheep breeding. Farm was started at Dentam.

3rd plan (1966-71)	18.80 lakhs	The third plan period carried on the schemes of the second plan without much difference.
4th plan (1971-76)	31.00 lakhs	The Tadong livestock farm was further expanded.

Source: Compiled by self from Annual plan of A.H.& V.S. Department. Government of Sikkim.

After the creation of a separate Deartment of Animal Husbandry and Veterinary services in 1974, various scientifically based livestock production schemes were launched to suit the peculiar agro-climatic conditions, geographical profile, cultural traditions and the food habits of people of the region. The basic aim was largely to encourage the farmers to take up these schemes as sources of their livelihood. The financial and physical targets achieved during Vth, VIth, VIIth, and VIIIth Five year plan periods are given in the next page.

A. Financial Target and Achievements. (Rs. in lakhs).

Animal Husbandry	Dairy Dev. & Vety. Services.	Dairy Dev	Total
1. Vth Five year plan (1976-80)Actual.	235.54	27.81	263.35
2. VIth Five year plan (1985-90) Actual.	511.46	87.10	598.56
3. VIIth Five year plan 1980-90 Actual.	878.16	96.71	974.87
4. VIIIth Five year plan 1992-1997 Target.	1200.00	150.00	1350.00

Period from 1990 to 1992 was treated as rolling or plan holiday period.

B. Physical Target and Achievement in important sectors only.

SI. No. Five year plans.	Milk production (in tons)	Egg production (in millions)	wool production (in Lakh kgs.)
1. Vth Five year plan (1976-80)Actual.	10.95	1.25	0.23
2. VIth Five year plan (1985-90) Actual.	19.00	3.50	0.26
3. VIIth Five year plan 1980-90 Actual.	27.00	12.00	0.30
4. VIIIth Five year plan 1992-1997 Target.	35.00	18.00	0.36

Source: Department of A.H.& V.S. Department. Government of Sikkim.1994.

As indicated earlier, with the creation of an independent Animal Husbandry and Veterinary services Department in 1974 a number of livestock farms and veterinary hospitals were established. Primary importance was given to the animal health sector which was complementary to the extension wings like the development of cattle, poultry piggery,sheep and goat and other livestocks on one hand and the development of feed, fodder and dairy on the other. In addition, the department is running a training centre for stockman, a disease investigation laboratory and a feed analysis laboratory. Today the staff consists of 72 gazetted officers, 156 para-veterinarians and 246 other supporting staff. Presently animal Husbandry and Veterinary services department avails the following infrastructure.

Table 6.1
Details of Animal Health Centres in North Sikkim.

INSTITUTIONS	All Sikkim (Hospital)	North Sikkim
Viterinary institutions.	11	3
Dispensaries	25	6
Stockman Centre	55	6
Livestock Farms	9	2
Disease Check posts	4	nil

Source: Prepared by self

Thus Animal Husbandry and Veterinary services department is well established in the State.

6.3. Contribution of animal husbandry sector to state's gross income.

The survey report on the state's income conducted by the Bureau of Economics of Sikkim reveals that the relative share of the primary sector in real terms comprising agriculture and its allied activities i.e. Animal Husbandry, Forestry, Fishery and Mines and Geology, accounts for 51.60 percent of the total net domestic product of the state during 1980-81 and it has increased upto 53.44 per cent during 1982-83. However, the contribution of livestocks to the NDSP started declining from 1983-84 and reached 50.96 per cent during 1986-87. The trend and share of contribution of the agriculture and allied sector to NDSP from 1987-88 onwards and the share of contribution of Animal Husbandry alone to the NDSP are presented in Table 6.6. As regards the contribution of the Animal Husbandry sector to the

NDSP, the share was 9.18 percent in 1988-89 which has de clined to 4.73 per cent in 1991-92 over a period of 3 years.

Table 6.2

Contribution of Total Agriculture sector vis-a-vis the Animal Husbandry sector to the State's Income

Year	Current Price	
	Total Agriculture sector (% share)	Animal Husbandry sector alone (% share)
1987-88	49.80	5.81
1988-89	48.80	9.18
1989-90	49.70	6.99
1990-91	46.51	5.88
1992-92	45.26	4.73

Source: Sikkim State Bureau of Economics and Statistics.1993.

It will be seen from Table 6.2 that the decline in the share of contribution of Animal Husbandry to states income has been 2.19 per cent during 1988-89 to 1989-90, 1.11 per cent during 1989-90 to 1990-91 and 1.15 per cent during 1990-91 to 1991-92. However, there is no separate figure available for North sikkim. It could be inferred from the above Table that there is a declining trend in the contribution of income derived from Animal Husbandry to the total income of agricultural sector in a period of 3 years. The economic census conducted by the State Bureau of Economics and Statistics in 1990 revealed that the number of identified enterprises (agricultural and non-agricultural taken together) was 10686 employing as many as 47296 persons. Of these, agricultural enterprises are in account for

numbers which 689 or 6.45 percent of the total enterprises. On the employment side, agricultural enterprises employ 2587 persons or 4 percent of total employed in all enterprises. The distribution of enterprises and employment in agriculture and non-agricultural sectors in North Sikkim is presented in Table 6.3.

Table 6.3

Enterprises and employment in North Sikkim

Enterprises			Employment		
Agricultural	Non-Agricultural	Total	Agricultural	Non-Agricultural	Total
25	856	875	29	3262	3291

Source: Economic Census Report Vol.I Bureau of Economics and Statistics, Govt. of Sikkim, 1990.

Thus out of the total 689 agricultrual enterprises, 25 numbers or 3.63 per cent are found in north sikkim. As far as employment scenario is concerned, out of 1927 persons 29 (i.e. 1.50 percent) are employed in North Sikkim.

The total agricultural enterprises and employment in terms of percentage in the State are presented in Table 6.4.

Table 6.4
Distribution of enterprises at three digit level of National Industrial Classification.

Industrial Group	Description	Percentage share of total Enterprises (%)	Agricutural Enterprises Employment (%)
020	Cattle breeding, rearing production of milk	75.62	63.07
039	Agricultural Services	10.01	19.88
058	Forestry & logging	5.08	3.60 and 059

Source: Report on Economic Census, Vol. I Bureau of Economics & Statistics Govt. of sikkim.1990.

Table 6.4 indicates that as much as 75.62 percent of total agricultural enterprises are found in Animal Hsbandry sector i.e. in cattle breeding rearing and production of milk. The districtwise data relating to the contribution of Animal Husbandry to the total agricultural sector in terms of percentages are not available. As far as the generation of employment is concerned, animal husbandry employs a substantial percentage of the total employment in agriculture and animal husbandry together the percentage being 63.07 percent.

Keeping the above discourses in view, the objective of the present Chapter is to throw light on the economics of livestock farming in North Sikkim which is traditionally known for its age old pastoral economy.

The first part of the chapter deals primarily with the economics of livestock production in India with special emphasis on their productivity and growth pattern and the contri-

bution of the same to the national income. The second part, while highlighting the significance of livestocks in the economy of North Sikkim discusses the economics of livestock farming in the region. The analysis is based on data and information procured during field investigation in the area under study. The last part of the Chapter, being the concluding remarks however, emphasises the ways and means in stepping up the livestock production in this formidable hill region in a commercial scale.

As has been said earlier the data and information for the present study have been procured both from primary and secondary sources. The data so procured have been analysed with the help of small statistical tables.

6.4. ECONOMICS OF LIVESTOCK PRODUCTION IN INDIA

6.4.1. Productivity of Indian Livestocks.

India has about 14 per cent of world's cattle and 50 percent of world's buffalo population. In terms of global milk production, buffaloes and cattles have special significance which contribute as much as 65 percent and 3.16 per cent respectively to the total world milk production. An extensive crossbreeding programme in dairy cattle with exotic semen has been lauched by the National Dairy Research Institute Karnal through All India Co-ordinated Research Project (AICRP), Indo-swiss and Indo-Danish Projects, Military dairy Farms and other Re-search Institutes. The results indicate that out of the exotic breed namely, Friesian, Brown Swiss and Jersey etc. the Friesian Crosses give the best results irrespective of indigenous breed and the prevailing agro-climatic conditions. In addition, the National Dairy Research Institute (Karnal) has produced two breeds of cattle

namely "Karen Swiss" and "Karen Fries" which give 3,200 litres and 3500 litres of milk per lactation respectively. As compared to the aforesaid cow varieties, the indigenous milch cow called Sahiwal gives an appreciable quantity of milk that amounts to as much as 1,600 litres per lactation. The work carried out by the Kerala Livesock Development and Milk Marketing Board under the Indo-Swiss project has been assessed by N. D. R. I, Karnel 1975. The results of the survey undertaken by National Dairy Research Institute, Karnal (1975) in Kerala on the performance of the Brown-Swiss crosbreed cows vis-a-vis the indigenous local Keralean cows under field conditions has been shown in Table 6.5.

Table 6.5

Performance of Brown swiss and Indigenous Cross Cows of Kerala

SI.No.	Economic Trait	Brown Swiss Crossbred cow	Indigenous cow
1.	Age at first calving	31 months	54 months
2.	Calving interval	466 days	542 days
3.	Lactation yield	1727 litres	600 litres
4.	Production cost per litre of milk	Rs. 1.26	Rs. 2.38

Source: Indo-swiss project, Kerala (1984).

A glance at Table 6.5 reveals that the crossbred Brown-Swiss cow is more economical than that of the local cow. It not only calves at a young age of 31 months, but calving interval is also shorter than that of the local cows. It may thus be noted that the calving intervals for crossbred Brown Swiss cow and the local cows in terms of days are 466 and 542 days respectively. Mereover, the milk yield per lactation is found to be more

than that of local cows. At the same time, the unit cost of production per litre of milk in case of the former is almost 50 percent less than the latter. Under similar conditions elsewhere in the country, particulaly where the environment is congenial the cross breeding results well indicate that the Holstein-Friesian crosses, perform the best, followed by Brown Swiss/ Red Dane and Jersey Crosses. A comparative statement of performances of exotic, superior Indian cows, crossbred cows and buffaloes etc. is presented in Table 6.6

Table 6.6

Performances of Exotic Superior, Indigenous and Crossbred Cows and Buffaloes.

SI.No.	parameter	Exotic (Holstein)	Native (Sahiwal)	Crossbred Cows	Murrah Buffaloes
1.	Age at first calving (months)	30	40	29	41
2.	First lactation milk production (Ltr.)	3,900	1,800	2,900	1,744
3.	Cost of milk production per litre (Rs.)	1.60	1.95	1.26	1.49

Source : Chatterjee, A.K. & Acharya, R.M.[33]

It will be seen from Table 6.6 that the crossbred cows not only calve at an early age of 29 months, but its milk yield in first lactation is over one and half times more than superior Indian

33. Chatterjee A.K. and Acarya R.M. Heading 21st Century. In (Gupta P.R.and Mathur, R.K. eds Dairy India 1992 Delhi. Devararsons Stylish Press, 1992. p. 4-24.

not only calve at an early age of 29 months, but its milk yield in first lactation is over one and half times more than superior Indian Sahiwal milch breed cow and Murrah buffaloes. The cost of milk production per litre of milk is also found to be relatively less in case of crossbred cows than the other varieties such as exotic Holstein and native Sahiwal etc.

The above findings indicate that since the peformance of the crossbred cows is relatively better than that of the other varieties, the cross breeding programme with exotic animal can successfully improve the genetic breed of the milch cattles in the prevailing agro-climatic conditions of the region. The adoption of such scientific innovations can thus enhance the prospects of milk production in the region thereby improving the economic conditions of the rural farmers. As for as sheep and wool development programme is concerned the Central Sheep and Wool Resarch Institute has, however developed breeds known as "Avikalin" for superior carpet manufacturing with annual wool production of 2 kg. and "Avivastra" for apparel wool with annual greasy wool production of 2.5 kg. The all India Coordinated Research Project on sheep breeding has also developed breeds capable of producing 30 kgs. live weight at six months of age. In so far as goats are concerned, the National Dairy Research Institute, Karnal has developed a goat breed that is capable of yielding as high as 300 litres of milk per lactation. These findings in the field of livestock breeding indicate that the tremendous economic potential livestock farming possesses in India through the genetic improvement of indigenous livestock breeds needs further research and investigation in a broader perspective. This would help the country dispose off the unproductive lots of livetock within a specified time frame. As per the survey carried out by Prasad (1990) it has been found that India possesses about 100 million do-

mestic animals with an annual maintenance cost of Rs. 1,800 crores and out of these only a meagre 16 million breedable cows will be required to yield an estimated 6.5. million metric tonnes (MMT) of milk by the turn of the century[30].

6.4.2. Economics of Livestock Production.

Before setting up a livestock farm, at the very outset, a proper assesment of the techno-economic feasibility survey of the project is deemed very essential. As livestock products are highly perishable, the backward and forward linkages for the supply of input services and marketing etc. have to be established on priority basis. A study conducted by All India coordinated Project on Economics of milk production under Intensive Dairy farming conditions (1972-1976) found that under Indian conditions, mixed farming system consisting of various components such as forage, milk and cash crop productions has to be recommended to the farmers instead of Dairy farming alone. Under Intensive dairy farming system, Indias milk production thus began to rise after 1970. By crossing almost 30 million tonnes mark in 1980 it reached as high as 57.7 million tonnes in 1991 with the development of chilling and processing technologies all over the country at the instance of National Dairy Development board under the Operation Flood programmes.

A number od dairy activities have thus emerged as commercial ventures all over the country. These include high producing cattles and buffloes under intensive feeding, production of quality animals feed and fodder, animal health care centres and so on. Work carried out in Bangalore for the past 11 years to compare the profitability of Dairy farming and crop farming has reported that the overall profit is much higher in

30. Bhat P.N. An overview of cattle productivity paper presented at (National Symposium on Animal productivity. Hindustan Lever Research Foundation. Bombay, April 17-18, 1987. p. 19-20).

case of dairy farmer than that of crop husbandry. Table 6.7 presents a comprehensive and comparative picture of the income and profit and loss account of the crop farming and animal farming over a period of 11 years. The study has, however, been undertaken by scientists as referred below.

Table 6.7

Income and profit/loss account from dairy/crop production by four categories of farmers in Banglore District over 11 years.

Cotegories of Farmers		Dairy Farming	Crop Farming
Marginal :	Income	4,734	2,216
	Profit/Less(is Rs.)	196	-1,726
Samall :	Income	5,748	3,618
	Profit/Loss (in Rs.)	1,702	-181
Medium :	Income	8,194	7,160
	Profit/Loss (in Rs.)	3,715	-710
Large:	Income	11,337	21,255
	Profit/Loss (in Rs.)	3,728	6,228
Overall:	Income	6,983	6,693
	Profit/Loss (in Rs.)	2,226	178

(-) sign signifis loss.

Source: Chatterjee, A.K. & Acharya, R. M.[33]

It will be seen from Table 6.3. that crop farming does

33. Chatterjee A.K. and Acarya R.M. Heading 21st Century. In (Gupta P.R.and Mathur, R.K. eds Dairy India 1992 Delhi. Devararsons Stylish Press, 1992. p. 4-24.

not appear to be productive particularly in case of marginal, small and medium farmers. These farmers have not derived any profit from crop farming, rather the loss incurred by them in crop farming varies in terms of rupees between as low as 181 to as high as 1726 for small ad marginal farmers respectively. It is thus observed that except large farmers who normally can carry the risks of weather etc. and go in for commercial farming, all other categories of farmers have incurred loss. The reason of such loss may be attributed to the fact that the above categories of farmers have not carried any risk. As capital investment and the introduction of modren innovations are pre requisites to achieve better yield in crop farming, small and marginal farmers do not find such farming as economically viable in view of their socio-economic conditions despite the fact that introduction of modern technology at farm level is neutral to scale. However, the large farmers in view of their social status and better economic conditions have made crop farming a commercial venture and therefore introduction of modern technology has been profitable for them. As far as dairy farming is concerned, the marginal, small and medium farmers have not incurred any significant losses as compared to crop farming. The profit in case of Dairy farming varies between as low as Rs. 196 to as high as Rs. 3728 for marginal and large farmers respectively. As a matter of fact, the income of medium and small farmers also seem to be much better. The income from dairy farming varies between as low as Rs. 4734 /- to as high as Rs. 11,337 /- for marginal and large farmers respectively. The over all profit devided from dairy farming appears to be quite significant when compared with crop farming. Similar kind of studies have also been conducted by the Punjab Agricultural University where satisfactory returns from cow yielding have been obtained, the quantity of milk being 5000 litres per lactation along with a suitable cropping combination i.e. wheat,

rice and sugarcane adopted in the region. The findings have been presented in Table 6.8. Which include returns from dairy and crop farming in terms of rupees per hectare.

Table 6.8

Return from Commercial Crops and Dairy Farming

SI. No.	Type of farming	Return per hectare (in Rs.)
1.	Dairy farming with 5,000 litres per lactation producing cow prices Rs. 2.00 per litre	13,700.00
2.	Using best strain of wheat rice with optimum fertiliser dose	9,600.00
3.	With sugarcane farming	8, 250.00

Source: Annual report, Punjab Agricultural University (1992).

A glance at Table 6.8 shows that dairy farming appears to be almost one and half times more profitable in terms of cash than commercial crop farming where wheat and rice make the best crop combination with optimum fertiliser application as a scientific method. As far as sugarcane farming is concerned, it will be seen from the above table that the return from sugarcane farming amounts to Rs. 8250.00 only per hectare whereas the return from dairy farming is Rs. 13,700.00 per hectare which is more than one and half times the return from sugarcane. It could however be infered that dairy farming with the introduction of modern techology is more profitable than that of crop farming.

With the encouraging results achieved in milk production by the introduction of frozen semen technology and embryo transfer technology in India, the goal to achieve the production target of 5,000 litre per lactation would not be far away when livestock farming in India would emerge as a full fledged agro-based business like other developed countries such as U.S.A., Australia and New Zealand where livestock farming is considered profitably as the most important commercial enterprise.

6.4.3. Milk Marketing and Processing System.

With a view to providing employment to the rural population and enhancing the production of milk, the National Diary Development Board was created in 1965 to transfer the spirit of "Anand" from Gujarat to other Satates of India. The unique system of 'Anand' pattern is that the milk is produced, collected, processed and marketed by the producers themselves. The National Dairy Development Board launched a mammoth Operation Flood project on Anand pattern in 1970 and the third phase of the project is in operation at present. The most significant contribution of the Co-operative dairying is to link the village farmers producing milk to the urban consumers through the National Milk Grid. The milk is collected from the villages, processed and moved to cities in insulated trucks and rail tankers like other developed countries such as U.S.A., Australia and New Zealand etc. The Operation Flood projects over the last two decades, have engaged over 7 million dairy farmers in 60,000 milk producers co-operatives and have earned an income to the tune of Rs.1,200/- crores from dairy sector[34]. By the end of the third phase of the Operation completed in 1994, it is proposed that over 8 million farm producer families will be engaged in this economic pursuit.[33]

33. Chatterjee A.K. and Acarya R.M. Heading 21st Century. In (Gupta P.R.and Mathur, R.K. eds Dairy India 1992 Delhi. Devararsons Stylish Press, 1992. p. 4-24.
34. Patel, A. Twentyfive years of National diary Developments Board. In (Gupta P.R. and Mathur, R. K. eds. Dairy India 1992 Delhi. Devararsons Stylish Press, 1992. p. 49-50.

6.5. ECONOMICS OF LIVESTOCK PRODUCTION IN NORTH SIKKIM.

As has already been said that promotion of livestock carries immense economic siginificance in the state, it will be meaningful to carry out an emperical investigation concerning the economics of livestock production in the area under study.

North Sikkim being a part of the high Himalayam range enjoys the appropriate geographycal conditions for the growth and development of livestock. These is tremandous scope for developing livestock an commercial scales thereby generating both employment and income. As commercial farming has to be economically sound and viable, what needs to be done in North Sikkim is to develop a sound infrastructural base such as improved accountability and terms of adequate transpart and commnication;institutional development, such as banking and cooperative and so on. Introduction of modern innovation is also another aspect of livestock development programmes in the region. Because crossbreeding programmes as a technological beak through has revolution use the productionery pattern of livestocks in the country. As for instance the crossbred animals i.e. crosses between superior Indian livestock with that of related exotic livestock are found to be not only superior in productivity of such items as milk, meat and wool but also cost effective in terms of production of these items The cost of production of the said items is supposed to be far lower than that of the indigenous livestocks. Thus, as per current statistics livestock accounts for as much as 10 percent of the country's gross national product under the prevailing socio-economic and physical conditions. The main findings in chapter indicate that the technological advancement is livestock sector in this part of Sikkim is still at a very lowebb. However, if an appropriate strategy for

raising the level of production of livestock in the region is evolved, the prospect of this livestock farming as a commercial venture could be definately bright in future.

Keeping the above discourse in view, this second part of the chapter is a modest attempt to throw light on the overall economics of livestock farming in North Sikkim. The study is primarily based on field investigations carried out in the area at different points of time. As has already been explained in chapter I the field investigations have been carried out by direct interview with the farmers through structured questionnaires. The principal objectives of the study are as follows:

1. To economically assess the farmers depending on live stock for their sustenance as livestock is their main source of income
2. To ascertain the concentration of such farmers in differenct eco-logical zones of the area with a view to studying their pattern of distribution..
3. To study the main economic traits of three different livestocks i.e. yak, local cattle and crossbred cattle giving milk.
4. To study the relative cost of production of milk of the above animals such as yak, local cattle and crossbred cattle giving milk.
5. To attempt a comparative analysis between livestock farming and agricultural farming in Lachung Valley.
6. To high light the distributional pattern of income and expenditure of the farmers of Dry High Zone in the region as a case study.

6.5.1. Generation and distribution of Income from Livestock farming.

As indicated in chapter I, 25 percent of the total villages and 25 percent of the households in north sikkim were covered to in the household survey at random to determine the impact of livestock farmings on the overall economy of the people of north sikkim. Out of the total 827 households covered in the survey as many as 594 accounting for 71.83 per cent of the total receive income mainly from livestock rearing and the rest i.e. 233 households or 28.17 percent do not receive any income from such economic enterprise (Table 6.9).

Table 6.9

Distribution of households depending on livestock as the main source of income in North Sikkim.

Zone	Households depending on livestock for sustenance		Households not depending on livestock for sustenance		Total.	
	No.	%	No.	%	No.	%
Dry High Zone	30	100	-	-	30	100
Continental Zone	205	85.42	35	14.85	240	100
Subtropical Zone.	359	64.45	198	35.55	557	100
TOTAL	594	71.83	233	28.17	827	100

It will be seen from table 6.9 that as the altitude from subtropical zone to dry High Zone increases the percentage of dependence on livestock farming for economic sustenance of the

people also increases steadily. Thus in the sub-tropical zone as much as 64.45 percent of the farmers depend on livestock for sustenance; as one goes higher up in the continental zone it is found that more than 85 percent of the total household teke out their living from livestock farming. Similarly in the Dry High zone the dependence on livestock for economic sustenance of the household is 100 percent.

Distribution of Income.

As far as generation and distribution of income from livestock farming are concerned data and information relating to expenditure incurred on different heads such as rearing of livestock, marketing and sale of livestock products etc. were gathered with the help of structured questionaries through direct interview with the farmers. The total expenditure on livestocks for each household was calculated by adding expenses on different heads such as feed and foulder, medicines, depreciation cost of the animals, rent on area devoted to farming, daily wages of the labours engaged in the farming and so on. Similarly, the total market value of the various products derived from livestocks was calculated for each household on annual basis. The total annual income/profit /loss derived from livestock farming was thus worked out by finding out, the difference between the total expenditure and the total market value of the products. Unit cost of production of milk etc. and the unit sale price of the same have also been found out to gain an understanding about the relative profit/loss of the livestock products in north Sikkim.

An analysis of distribution of income of the households thus derived has been presented zonewise. Table 6.10 presents distribution of income from livestocks zonewise For the purpose, arbitrary class intervals of income varying from Rs. 1000 to above

Rs. 10,000/- from livestock farming has been prepared as is shown in table 6.10. The following picture emerges as regards the levels of income of the farm households.

Table 6.10

Distribution of household according to different levels of family income from livestock farming in north sikkim.

Family Income per annum.	Distribution in three zones. Dry High Zone		Continental upper Zone		Sub-tropical Zone		Total No. of household		Level of income
	No.	%	No.	%	No.	%	No.	%	
< Rs. 1000	00	00	14	6.83	64	17.83	78	13.13	Low
Rs. 1001 to Rs. 5000	00	00	50	24.39	168	46.79	218	36.70	moderate
Rs. 5001 to Rs. 10.000	00	00	58	28.29	77	21.45	135	22.73	high
>Rs. 10,001	30	100	83	40.48	50	13.93	163	27.44	very high
TOTAL :	30	100	205	100	359	100	594	100	

It will be seen from table 6.10 that out of 594 from households surveyed covering the three important climatic zones in north Sikkim such as subtropical zone continental zone and dry high zone, a substantial percent age share derive moderate income (Rs.1001-5000) from livestock farming. accounting for as much as 36.70 percent of the total households followed by house-

holds having very high (10,001) and high income (5001 to 10,000). These households account for 27.44 percent and 22.73 percent respectively. However, as low as 13.13 percent of the households receive low income from livestock rearing. These households earn income from livestock farming which is below Rs. 1000 per annum. Keeping the above distributional pattern of income among the farm households in north Sikkim in view, it will be interesting to throw light on the zonewise distribution of income among the households.

1. Dry High Zone.

In the dry high zone of Lhonak, Muguthang and Chho-Lhamo region, all the 30 households surveyed depend exclusively on livestock for their livelihood and receive income invariably above Rs. 10,000/- per annum.

2. Continental Upper zone.

Out of the 205 households having livestock farming in this zone 122 are from Lachen and 83 from Lachung. As far as Lachen is concerned all the households depend on livestock for sustenance. The entire area is rugged and steep, hence there is hardly any flat land available for cultivation. The major source of income of the inhabitants is livestock. It will be seen from table 6.10 that the percentage of farmers earning income between Rs. 100/- to Rs. 5000/- accounts for 24.39%. Similarly the share of farmers receaving income between Rs. 5000/- and Rs. 10.000/- stands at as much as 28.29%. It is interesting to note that a large number of farm households earn income normally above Rs. 10,000/-. These farmers constitute of as much as 40.48% of the total households.

In Lachung area such farm secnario appears to be some what different. Out of the 118 households surveyed, 35 households or 29.66% were not found to be depending on livestock. for their economic sustanance. It will therefore beworthwile to discuss the distribution pattern of income of the rest 83 households with reference to the above arbitrary class interval of income in rupees. The following table presents the distribution of income from livestocks in Lachung area. It will be seen from table that as much as 11.86 percent of the households receive income i.e less than Rs. 1000/-. The proportions of households receiving income ranging between Rs. 1000/- to Rs. 5000/-, Rs. 5000/- to Rs. 10,000/- and above Rs. 10000/- are 27.97%, 21.19% and 9.32% percent respectively. It is quite interesting to note that in this area as the range of income keeps increasing the corresponding share of households in terms of percentege decreases. Meaning there by relatively less number of households have high income from livestocks. A substantial share of households have only moderate farm income from livestocks [27.97%]. The annual income ranges between Rs. 1000/- to 5000/-. It could be largely be attributed to the fact that as compared to Lachen, Lachung is relatively less undulating and flat. Therefore cultivation of off season vegetables namely cabbage and potatoes etc. are very popular in this area and hence people are found to be more dependent on agriculture farming than livestock farming. As a matter fact, agriculture and livestock go hand in hand in this particular area.

3. Sub-tropical Humid zone.

In the sub-tropical humid zone as many as 13 villages covering 557 households were surveyed. And it was found that as many as198 households accounting for as much as 35.55 percent receive no income from livestock. Relatively higher concentra-

tion of households receiving no income from livestocks are from village kazor, Ramthang, Gnon-Samdong and Singhik, the percentages being 73.19, 73.68, 56.25 and 55.93 respectively. However, all the 44households surveyed at Mangan receive income from livestock farming only.

A glance at table 6.10 and Appendix X reveals that the share of households receiving income below Rs. 1000/- from livestock farm constitutes of as much as 17.83 percent of the total. Maximum farm households are from Chungthang accounting for 27.78 percent of the total followed by Kabi with 24.10 percent. Thus these households could be termed as having low income from livestock. Similerly, the households receiving income in the range of Rs. 1000/- to 5000/- are 168 in number and from 30.16% of the total. The highest number of farmers are however, from Tingda and Naga Namgor villages. Therefore, the level of income for these households could be termed as moderate.Then comes the range of income varying between Rs. 5000 to Rs. 10,000. As many as 77 households accounting for percent of the total fall in this category. Relatively higher percentages of farm households are from village Pak shep followed by Kabi. So the households earning income between Rs. 5000/- to Rs. 10,000/- could be termed as high incme group farmers. As far as the highest categary of income ie. Rs. 10,000above is concerned, thire are as many as 50 households accounting for percent of the total. It is further observed that maximum number of households in this income bracked are from Mangan accounting for 68.18% of the total. This is followed by Singhik from where 13.56 percent of the households have been interisewed. From the above analysis it could be in fered that the low percentage of the farmers depending on livestock farming for their economic sustenance in this zone could be mainly attributed to the fact that a relatively higher propor-

diverted for growing cereal crops like paddy, maize and millet etc. and also for growing high value cash crops like cardamom and ginger etc. from which the cash return is always high. It has been thus estimated that more than 50 percent of the cultivable land is under cardamom farming in North Sikkim. The livestocks in this zone are there fore mainly reared for supplementing family income by selling the products and also for supplying manure & bullock power etc.

6.5.2. STUDY OF ECONOMIC TRAITS OF DAIRY ANIMALS IN NORTH SIKKIM.

Ever since the marger of sikkim with India in 1975 measures have been taken and necessary conditions/infrastructures have been developed for diffusion of modern innovations in animal husbandry sector with a view to augmenting animal productivity by introducing such programmes as cross breeding etc. in the north district of the state. The infrastructure so developed in animal husbandry sector in the state therefore consists of mostly bull rearing centres, animal health care centres, a net work of artificial insemination centres and commissioning of five litre liquid nitrogen plant for storing frozen semen that was established in 1987 etc. Such development in crossbreeding programmes have brought in significant changes in cattle breeding practices and have contributed significantly in strengthening the breed composition of cattles in the region. This has been very aptly discussed in Chapter 3, The modern trend of technology in the region indicates that the introduction of cross breeding programme in particular has made significant impact on the overall economy of the region. Thus the farmers are gradually going in for adoption of improved cattle breeding practices.

Keeping the above discourse in view it will be meaningful to examine the economic traits of livestocks that are reared for production of milk as such traity have great commercial implications such as achieving higher productivity in milk and milk product etc. which are the direct source of cash return to the farmers. perticularly therefore, milk giving stage is considered as one of the most important selection traits.

The other traits largely incorporate the reproduction capacity of the animals, the growth vitality and disease resistance capacityof the animals and over and above the capacity of the animal to tolerate cold condition.

PROCEDURE.

With a view to determining the economic production traits of the existig livestocks in north Sikkim, three different important milk giving livestocks have been selected. These animals include yak, local seri cow and crossbred cows. Data and information concerning the economic production traits of the animals have been collected during field investigation in the area. With the help of structured questionraire schedules through direct interview with the farmers the following economic trait parameters have been taken into consideration while interviewing the farmers.

1. Age at Pubrety- The earliest age at which a yak or cow is capable of reproduction or the age at first oestrus.
2. Age at first calving.
3. Gestation period -This is the period spanning between the date of suc cessful service and the subsequent calving date.
4. Service period - This is the period that starts from the date of calving and ends at the date of successful service.

5. Lactation Length - This has been calculated as the length of time starting from the date of calving till the date of drying.
6. Dry Period - This is the period between the date of drying and the subsequent date of calving.
7. Calving Interval - This is the duration between two successive calvings.
8. Number of days taken to reach peak yield.
9. Total milk yield per lactation.

Based on survey data, the above parameters of yak, local cow and crossbred Jersey cows have been assessed and estimated. The findings are as follows.

RESULTS.

1. Economic Traits of yaks.

The economic traits of yaks that largely incorporate the age of maturity or puberty, age at first calving, service period, lactation length, dry period, calving interval, number of days taken to reach peak yield, total milk yield per lactation, hair yield, life span and climatic adaptation of yaks have been presented in Table 6.11

Table 6.11

Economic traits of yak under local rearing condition in north Sikkim.

SI. No.	Economic Traits of Yak	Range	Average
1.	Age at Puberty (days)	1095 -1460	1277.5
2.	Age at first calving (days)	1365 -1730	1537.5
3.	Gestation period (days)	260 - 270	265.0
4.	Service period (days)	155 - 450	302.5
5.	Lactation Length (days)	225 -233	229.0
6.	Dry period (days)	235 -300	268.0
7.	Calving interval (days)	450 -720	480.0
8.	No. of days taken to reach peak yield	10 -12	11.0
9.	Total milk yield per lactation (ltrs.)	650 (-) 680	665
10.	Hair yield in (kg.)	0.500 -1.00	0.750
11.	Life Span	16-18	17
12.	Adaptation	High altitude	

It will be seen from the table 6.11 that yak normally reaches the age of puberty within a range varying between 1095 to 1460 days. Therefore it has been calculated that the average number of days taken by the animal to reach puberty are 1277.5 days or three and half years to reach puberty. The average gestation period as has been recorded during the survey spans for 265 days haveing a range varying between 260 to 270 days. Similarly, gestation period of 260 days have also been recorded for the yaks of Nepal Himalays.[35] However, gestation period spanning as long

35. Joshi, D.D., YAK and Chauri Husbandry in Napal. Tankleswar Tahachal: Kathmandu, K.D. Joshi, 1982. p. 67-83.

as 285(-) 11days for the yaks of east Sikkim [36] and 252 days for Indian yaks in general [37] have been recorded.

SERVICE PERIOD.

The service period i.e. the period from the date of calving to the date of successful service, ranges between 155 days to 450 days i.e. between 5 months to 15 months with an average of ten months. It implies that most of the yaks are conceived after approximately ten months or one year of calving. According to local people, service in the same year is normally avoided owing to two important reasons. First, there is a great scarcity of feed and fodder coupled with environmental problems during winter and second the yaks usually stop giving milk after four months of pregnancy. The oestrus cycle of 21 days with 16 hours oestrus duration has been recorded in yaks of Nepal[35] and oestrus cycle of 17 days in yaks of India.[37]

LACTATION LENGTH.

The lactation length or the period of milk production commences from the date of calving and continues till the date of drying. In North Sikkim, as per the data and information gathered during field survey (Table - 6.11) the average lactation length is found to be of 229 days, with a narrow range varying between 225 to 233 days. The lactation length of 180 days and 171 days have however been recorded in yaks of Nepal and India respectively. From the above, it could be concluded that yaks of sikkim give milk for a longer duration than that of Nepal[35] and other parts of India[37].

35. Joshi, D.D., YAK and Chauri Husbandry in Napal. Tankleswar Tahachal: Kathmandu, K.D. Joshi, 1982. p. 67-83.
36. Sinha, S.b. and Bhutea, D.N. Yak breeding in Sikkim Sikkim Veterenary Journal Vol.1(2), 1983. p. 9-11.
37. Narang, M.P. and Deoddori: D. YAK of Ma[illegible]

DRY PERIOD.

Dry period is the period starting from the date of drying to subsequent calving. This period usually commences from the date of ceassation of lactation length. It will be seen from table that dry period in yaks of North Sikkim ranges between 235 to 300 days with an average of 268 days or nine and half months.

CALVING INTERVAL.

A glance at table 6.11 reveals that calving interval or the duration between two successive calving in the yaks of north sikkim ranges between 450 days to 720 days with an average of 480 or 16 months. similar calving interval of 14 months and 22.17 months have been recorded in yaks of India[37] and Nepal.[35]

No. of days taken to reach peak yield.

According to data and information gathered from field investigations in verious parts of North Sikkim, it has been found that yaks in the region normally take 10 to 12 days to reach peak yield after calving.

Milk yield per lactation.

It will be observed from table 6.11that yaks in the study area give milk varying between as much as 650 litres to 680 litres with an average of 665 litres per lactation. Average milk yield as low as 200 litres in Indian yaks [37] and as high as 720 litres in yaks of Nepal[35] have been recorded. In North Sikkim milking is done once a day at dawn.

35. Joshi, D.D., YAK and Chauri Husbandry in Napal. Tankleswar Tahachal: Kathmandu, K.D. Joshi, 1982. p. 67-83.

37. Narang, M.P. and Deoddorj; D. YAK of Mangalia and India Asian Livestock Vol. 15 (2) 1990.p.

HAIR YIELD.

As far as the hair of the animal is concerned, the hair of this animal has immence economic value and fetches good price from the market. It will be seen from table 6.11that the production of hair per yak per annum ranges between half a kilogram to one kilogram. While interviewing the farmers in the selected village of the study area it has been confirmed that normally two types of hairs are collected from the body of a live yak i.e. the inner fine hair which is locally known as "Khulo" and the long rough hair Known as "Chupa". While the former is normally used for blanket weaving the latter is used for making yak tent and ropes etc.

Economic traits of local and crossbred cows in North Sikkim.

The economic traits which largely include the age at puberty, the age at first calving, gestation period, service period, lactation length, dry period, calving interval, number of days taken to reach peak yield and total milk production per lactation are deemed as the most important indicators achieving higher object far as as the milk giving livestocks are concern. Therefore it is felt imperative that the above economic traits of milk giving animals such as cows, and yaks are studied in greater details with special emphasis on the natural habitat of the area and the availability of feed, fodder and other requirements of the animals. For the purpose, field investigations have been conducted in the study area to procure information on the above aspect the data and information so gathered with the help of structured questionairs through direct interview with the farmers have been processed and analised. The following table illustrates the economic traits of local and Jersey cross bred cows under local rearing conditions in the area.

Table 6.12

Economic traits of Local and Jersey Crossbred cows under local rearing condition in north Sikkim.

SI. No.	Economic Traits	Local Cow		Crossbred Cow	
		Range	Average	Range	Average
1.	Age at Puberty (days)	870-1470	1170	630-960	795
2.	Age at first calving (days)	1170-1770	1470	930-1290	1110
3.	Gestation period (days)	270-280	275	270- 280	275
4.	Service period (days)	105-180	142.5	90-150	120
5.	Lactation length (days)	210-300	255	240-290	265
6.	Dry period (days)	125-210	167.5	60-120	90
7.	Calving interval (days)	335-510	422.5	300-410	355
8.	No. of days taken to reach peak yield	6-7	6.5	10-24	17
9.	Total milk yield per lactation (ltrs.)	850-1100	975	1440-2900	2170

Source : Prepared by self from field data.

AGE AT PUBERTY.

It will be seen from the Table 6.12 that the age at puberty or maturity of local ows ranges between 870 to 1470 days with an average of 1170 days which account for more than to almost three years.Thus the local cows take almost three years to reach the puberty age. However, in case of crossbred cows the age of maturity varies between 630 to 960 days with an average of 795 days which exceed 2 years. The age of puberty is therefore lower by almost one year in case of crossbreds than that of local cows.

AGE AT FIRST CALVING.

The age at first calving in case of local cows ranges between 1170 to 1770 days with an average of 1470 days or 4 years. The average age at first calving in case of crossbred heifers is 1110 days or 3 years. It is concluded that the crossbred heifers produce the first calf at age of 3 years where as the local cows produce the calf at the age of 4 years.

GESTATION PERIOD.

Gestation period as indicated earlier is the period starting from the date of successful service to the subsequent calving date. It is a species specific trait which can neither be influenced by environmental nor nutritional factors. In North Sikkim as per field survey, it is observed that there is no difference in gestation period of local and crossbred cows. The range of such period however, varies between 270 to 280 days with an average duration of 275 days. The gestation period of Sahiwal (Indian indigenous milk cow) has been recorded to be 286 days and that of Holstien Friesian 275 days.[38]

SERVICE PERIOD.

Service period is the period that extends the date of calving to the date of successful service or conception. The importance of service period in dairy farming is enormous in view of the fact that as most of the economic traits are dependent on this single factor i.e. as to how soon the cow is conceived after calving. It has been found from the field survey (Table 6.12) that the average service periods are 142.5 days and 120 days in local and crossbred cows respectively. The

38. Thomas, C.K. and Sastry, H.R.S. Dairy Farm Management. In (Dai Thomas C.K. and Sastry, N.R.S. Dairy Bovine production. New Delhi. Kalyani publishers, 1991. p. 42-93.

range of period varies between 105 to 180 days in case of local cows and 90 to 150 days in case of crossbred cows. It can be infered from the above that the local cows normally take longer time to conceive than that of the crossbred cows.

Lactation length.

Lactation length or period is another important economic trait which considerably influences the milk yield. The field survey result presented in Table 6.12 ranges between 210 to 300 days averaging at 255 days or eight and half months. In case of crossbred cows the range is between 240 to 290 days with an average of 265 days or approximately nine months. Thus, as far as this economic trait is concerned crossbred cows are found to be more productive and hence give milk for a longer period than that of local cows. The lactation length as reported in case of pure Jersey is between 287 to 417 days and in case of Indian cow (Tharparkar) the same varies between 274 to 286 days. Similarly lactation length of 9.22 months in local cows and 11.25 months in crossbred cows have been reported in Kerala.[39]

Dry period.

The unproductive phase of the cattles otherwise called the dry period is the period that usually starts from the date of drying to date of successive calving. Normally a farmer would like to avoid this period which means additional expenditure for feeding and maintenance of the animals. In north Sikkim, the dry period of local cow varies between as many as 125 days to 210 days with an average of 167.5 days or approximately 6 months. However a range varying between 60 to 120 days with an average of 90 days is found in respect of cross-

39. George P.S. and Nair, K.N. Breding and Economic Traits of milch cattle. In (George P.S. and Nair K.N. eds. Livestock Economy of Kerala. Trivandrum, Centre for development Studies.

bred cows. The above findings indicate that the dry period in case of orossbred cows is shorter by almost 3 months than that of the local cows.

CALVING INTERVAL.

As has been said earlier the calving interval is the duration between two successive calvings.As per the data procured through field investigation the calving interval in local cattle ranges between 335 to 510 days and in crossbred cattle the range is between 300 to 410 days. The average number of days are calculated to be 422.5 or 14 months and 355 or approximately 12 months for local cow and crossbred cows respectively. The duration of calving interval appears to be shorter in case of crossbred cows by about two months than local cows. In the State of Kerala the calving interval of 19.80 months in local cows and 16.89 months in crossbred cows have been reported[38]. Similarly, calving interval between 439 to 580 days and 392 to 453 days have been reported in indigenous cattle Sahiwal and pure exotic Jersey cows respectively[38].

NO OF DAYS TAKEN TO REACH PEAK YIELD.

Number of days taken to reach peak yield is also an important economic trait in dairy animals. It has been found that the local cows normally take 6 to 7 days after calving to reach the peak yield. In case of crossbred animals, the time taken is still longer and the number of days varies between 10 to 24 days.

38. Thomas, C.K. and Sastry, H.R.S. Dairy Bovine Reproduction. New Delhi. Kalyani publishers, 1991. p. 42-93.

TOTAL MILK YIELD PER LACTATION.

It has been mentioned earlier that the total milk yield per lactation is the most important economic trait in a dairy enterprise as it is the direct source of ecomomic return. Hence, profitability of dairy farming is mostly influenced by milk production per cow per lactation. The result of the field survey carried out in north Sikkim which is presented in Table 6.12 reveale that the milk production in crossbred cows ranges between 1440 litres to 2900 litres per lactation, while the milk production of local cows ranges between 850 to 1100 litres. In terms of average production per lactation the figure is 975 litres and 2170 litres for local cow and crossbred cows respectively. In terms of percentage, the yield of crossbred cow is over 220 percent higher than the local cows. Milk yield of 2162 to 2979 kgs. per lactation of Jersey crosses have also been reported[38].

From the above analyis it could be said that the milk yield of crossbred cows in north sikkim are well comparable with all India figures.

6.5.3. ECONOMICS OF LIVESTOCK PRODUCTION.

From the field survey conducted in the study area it has been confirmed that a staggering 71.83 percent of the total farm house holds directly depend on livestock rearing for their economic sustenance while the rest 28.17 percent do not earn any income from livestock raising. Livestock farming is therefore the main source of income of more than 70 percent of the people inhabiting the region Similarly from the studies on the economic traits of livestocks it has been concluded that the animals with exotic blood inheritance are superior not only in production of

38. Thomas, C.K. and Sastry, H.R.S. Dairy Bovine Re-production. New Delhi. Kalyani publishers, 1991. p. 380-396.

milk but their lacta tion period is also longer. However, dry period and calving intervals of these animals are progressively shorter than the local cattles in the area. As the milk giving livistocks such as local and exotic crossbread cows and yaks etc. contribute substantially to the family income of the farmers it will be meaningful to attempt a comparative analysis of the cost of production and the relative profit structure of the above livestocks.

Keeping this objective in view it was proposed to carry out a comprehensive study on the economics of setting up of one cow unit of yak, local cow and crossbred cows each and compare the economics of production of the animals in terms of cost of production of milk in particular. The financial aspects thus covered pertain to the capital investment on various heads including cattle and yak sheds and cost the of the animals. The recurring expenditures incorporate the fund required to run the day to day affairs of farming i.e. purchase of feed and fodder, labour costs etc. The farm return or income so derived is generally from the sale of products such as milk, milk products, manure and also from the sale of calves. Finally the cost of production of various items has been worked out taking the figures relating to expenditures incurred on different items into account.

Methodology.

As has been discussed in chapter-I, data and informations concerning the expenditure and cash return from livestock farming have been collected with the help of structured questionnairs from the farm households. After selecting the different parameters of cost of milk production, the cost and return in terms of cash have been estimated as follows.

A. CAPTIAL INVESTMENT.

As regards the capital investment, it was observed that the farmers generally start their cattle farming on a modest scale in the beginning and then expand their enterprise. The capital investment of such farmers was of two folds i.e. construction of cattle shed and purchase of animals. The zone wise details are given below.

DRY HIGH ZONE AND CONTINENTAL ZONE.

The yaks reared in these two zones are normaly not provided with any housing facilities except the young animals which are housed in tents made of yak hair. The cost of these tents ranges between Rs. 9,000 to 11,000 and normally such tent is purchased for a herd of above 10 yaks. An average amount of Rs. 10,000/- has been assumed to be the cost of the in trents while embarking on a cost/benefit analysis. The cost of one yak ranges between Rs. 4,000/- to Rs. 6,000/- with an average cost of Rs. 5,000/- per animal.

The cost of one young yak male or female yak varies between Rs. 900 to Rs. 1,100/-. Therefore an average amount of Rs. 1,000/- per calf of five to six months age has been taken into consideration in this present cost analysis.

SUB-TROPICAL ZONE.

As far as the sample households falling under subtropical zone are concerned, it will be observed that the capital investment in the farms is primarily on animal housing and purchase of animals. The cost of cattle housing per animal ranges between Rs. 1300 to 1500 with an average cost of Rs. 1400 per

local animal. However, the cost of housing for a crossbred cow is slightly more than that of the local. The cost of the shed veries between Rs. 1400/- to Rs. 1600. The average cost could thus be estimated at Rs. 1500 per animal. Switching over to the tune of capital investment on the purchase of local and crossbred animals, the prices vary between Rs. 3000 to 5000 and Rs. 8000\- to Rs. 10,000/- for the former and the latter respectively. The average cost of local and crossbred cows particularly Jersey crosses stand at Rs. 4,000/- and Rs. 9000/- respectively. These average figures have however, been taken into consideration for cost analysis here.

B. RECURRING COST/EXPENDITURE.

As the farm expenditures on different heads are a continuous process, there are a number of recurring expenditures which include largely, the feeding costs, labour wages, depreciation cost and interest on capital etc. The details concerning the cost of feed and fodder are presented below.

COST OF FEED AND FODDER.

The animal feeds according to the data collected from the field survey incorporate mainly different types of concentrates whether home grown or purchased from outside. The data on home grown concentrates were tabulated household wise and were valued at the existing market price. The cost of fodder included the cost of hays or dried fodder and green fodder. The following discussion high light the cost componants of fodders.

As has been said earlier in chapter-III the feed and fodder alone constitute between 60 to 70 percent of the cost of production of various livestok products. However, the data

and information collected during field survey in the area reveal that the pratice of feeding balance feed to the livestocks is not at all adopted by the farmers of North Sikkim and many of the farmers are not even aware of the balance feed. The types of feed ingredients fed to the livestock at different ecozones and their transportation cost could be summerised as follows:

1. Dry High Zone.

In the dry high zone all the feed ingredients are transported from either Lachung or Lachen. Only lactating yaks are fed with concentrates and dry fodder and the rest of the animals are served with salt only. Howerver, during heavy snowfall, the animals are normally given dry fodder. The quantity, the types and rates of the various feed ingredients fed to the livestocks are presented in Table 6.13

Table 6.13

Types of feed ingredients, quantity and the relative costs of the feed given to a lactating yak in dry high zone of north Sikkim.

Typeof feed ingredients	Total quantity fed per annum in kg.	Proportion of feeding	Rate per quantal (Rs.)	Total cost in Rs.
1. Atta-wheat flour	80	30.78	800	640
2. Maize crushed	80	30.77	00	560
3. Mustard cake	80	30.77	650	520
4. Salt	20	7.68	400	80

As far as the feeding of fodder is concerned it is observed that fooder is given to the lactating yak at the rate of 3 kg. per day only during the winter months i.e. for a period of 4 to 6 months. Similar feeding schedule is also adopted by the farmers of the continental zone. As regards the feeding ingredients of farmers of sub-tropical zone, the main ingredients fed to the cows include maize, crushed mustard cake and salt. The rate per kg. of these feeds works out to be Rs. 5.50. Switching over to the feeding schedule of the livestocks in this zone, one can observe the following procedures adopted by the farmers.

The crossbred cows are fed at the rate of 3 kg. of feed per day for 6 months and 2 kg. per day for next 3 months. So the total amount spent on feed could be calculated as follows for one cross bread cow for the whole year (3x6x30x50+2x3x30x5.50=Rs. 3960). The local "Seri" cows are given at the rate 1 kg. per day for 6 months per lactation and then the feeding schedule is changed to 0.5 kg. of feed per day for next 2.5 months of lactation. Hence, the total amount spent on feed is (1x6x30x5.50+2.5x0.5x30x5.50 = Rs. 1196.25) per annum. In regard to dry fodder, both the animals i.e. crossbreds and local cows are fed with paddy straw during winter for 3 months. The cost of paddy straw is estimated at Rs. 1.50 per kg. The remainig months are fed with crop and jungle mixed dry fodder the value of which is estimated at 0.60 per kg. Hence the cost of dry fodder for crossbreds is Rs.1215 i.e. (3x30x5x1.5+ 5x30x5x0.60). Similarly, for local cow the dry fodder requirement works out to be Rs.1170 i.e. (5x30x3x1.5+ 5.5x30x5x0.60). Green fodder in the sub-tropcial zone is fed usually at the rate of 20kg. per animal per day irrespective of breed. The rate per kg. is estimated at Rs. 0.50. The main sources are forest and cultivated lands. The estimated cost of green fodder per crossbred cow is Rs. 2650 i.e.(20x265x0.50).

Similarly for local cow the cost of feeding green fodder is Rs. 2550 i.e. (20x255x0.50).

LABOUR COST.

The labour cost was determined on the basis of actual time spent by the labourer looking after the animals and the cost so recorded was worked out on the basis of actual wages paid. In case of animals looked after by the family members, the cost of labour was also determined on the basis of prevalent wage rate paid to the permanent labour. The details are given below:

In the dry high zone and contenental zone, the yaks are mostly grazed in the lust alpine pasture and one adult labour usually looks after a group of above 10 yaks. The wages he is paid vary between Rs. 1455 to Rs. 3055 per annum and the average figure taken for consideration in this cost analysis is Rs. 2255/- per annum or Rs. 225.50 per yak per annum.

In the sub-tropical zone, the wages per animal works out to be Rs. 410.85 for local and Rs. 550.42 for crossbred animals.

DEPRECIATION ON ANIMALS.

As far as the depreciation cost on animals is concerned, the same has been calculated with the help of the the commonly used method known as straight line method. It is therefore, assumed that the value of an animal appreciates upto the age of 5 years in the proportions i.e. 1; 3; 7 and 10. Thus if an animal is valued at Rs. 500/- at the age of one year, its value in the second, third, fourth and and fifth years would be Rs. 1.500/-, Rs. 2,500/-, Rs. 3.500/- and Rs. 5,000/- respectively.

In the above cost analysis depreciation of 12.5 percent on the value of animal has been assumed and the same works out to be Rs. 500/- for local animal and Rs. 1080/- for crossbred animal. As regards interest on the capital investment of animals, the prevalent rate of 12 percent per annum has been assumed.

Depreciation of cattle shed has been calculated on the value of the cattle sheds i.e. at the rate of 2 percent for permanent sheds and 5 percent for temporary sheds.

Interest on capital is charged on the fixed capital assets at the rate of 12 percent per annum. In case of animals giving milk, no interest is charged on the working capital because the farmer derives regular income from the sale of milk.

Miscellaneous cost of 10 percent was charged on the total recurring expenditure to cover the unforseen expenses.

C. RETURNS.

The returns from the animals surveyed were in terms of quantity of milk, farm yard manures, calves and yak hairs. The following existing sale prices were adopted to work out the total cash returns.

In the dry high zone the yak milk is sold to the army @ Rs. 7/- per litre. In Lachung, the yak milk is sold at the rate of Rs. 8/- per ltre. The yak milk yield per lactation has been assumed to be 665 litrs. In the sub-tropical zone the milk of both local and crossbred cows is sold at the rate of Rs. 7.50 per litre. Regarding the sale of calf, the assumed value per calf was Rs 1000 for crossbred and Rs. 500/- for local calf. The following analysis highlights the results of the above cost analysis. Concerning the expenditure incurred and cash returns on livestock products.

Most of the farmers especially in the dry high and continental zones are well aware of the cost principles involved in livestock farming i.e. the relationship between cost of production and the receipt of revenue interms of loss/profit to work out real income. It was also observed that the farmers of the region normally increase their income from livestock farming in two ways i.e. First by increasing production and second by reducing cost of production. The cost here by and large refers to the outlay of fund used in the production of livestock products e.g. milk, meat & eggs etc. In the field study it was initially proposed to cover milk only. While carrying out the field investigation, it was observed that the costs involved at the dairy farming at the initial stage are of two main categories i.e fixed and recurring costs. Once the farm is established the farmers is the more concerned about the income from the farm. Therefore, a modest attempt has been made here to analyse the various costs and cash returns in establishing one unit each of yak, local cattle and crossbred cattle during the production period of one lactation in the study area. The second aspect of the study is to analyse the economics of production of one litre of yak, local and crossbred cow milk. The results of the findings of the above study in case of yak rearing in the dry high zone and the continental zone have been presented in Table 6.14 and 6.15 respectively. The zonewise details of the cost analysis are presented below:

DRY HIGH ZONE:

The following analysis highlights the economics of establishment of one yak unit in terms of expenditures and returns under local condition in dry high zone taking Lhonak and Chho-Lhamo areas in to consideration. Table 6.14 presents the details of expenditure average costs involved and

the cash returns in establishing one unit of yak in the dry high zone of North Sikkim in one lactation period.

Table 6.14

Economics of Establishment of one unit of yak in the dry high zone of North Sikkim in one lactation period.

SI.No.	Details of expenditure	Average cost (in Rs.)
A. CAPITAL INVESTMENT.		
1.	Procurement of yak	5,000
2.	Transportation costs (including labour charges)	400
3.	Cost of Mobile shed for attendent	350
4.	Utensils	75
5.10	percent contingencies	582.50
	Total	6.407.50
B. OPERATING COST.		
	1. Dry fodder or hay for 4 months @ of 3 kg. per day @ Rs. 3/- per kg.	1,080.00
2.	Cost of medicines and vaccines supplied free of cost by the Department - say	10.00
3.	Feeding of concentrates-260kg. @ Rs. 6.92	1,799.20
4.	Labour cost.	225.50
5.	Contingencies 10 percent.	311.47
	Total	3,426.17

C. RETURNS:

1.	Sale of milk - 665 @ Rs. 7/- per ltr.	4,655
2.	Sale of calf -1/2 to 1year old	1,000
3.	Sale of yak hair - 0.750 kg.	37.50
Total		5,692.50

Net return (Rs.5,692.50 - 3426.17) = Rs. 2,266.33

It will be seen from the Table 6.14 that the initial capital investment to establish one yak unit could be to the tune of Rs. 6,407.50 The operating cost worked out per yak per lactation based on the local management is calculatedto be Rs. 3426.17. The return per yak by the sale of milk, calf and yak hair comes out to be Rs. 5,692.50. The milk so produced in the area is normally sold to the army who are stationed in the area and most of the unsold milk is converted into various products like yak, butter, hard and soft cheese and curd etc. The net return per yak works out to be Rs. 2,266.33 per lactation period.

CONTINENTAL ZONE.

In the continental zone the three different types of milk producing animals reared are yak, local siri cow, and cross-bred cows. The details of the cost of production of these animals are enumerated below.

1. Yaks - The economics of establishment of one unit of yak in this zone is almost same as that of the dry high zone except that

the cost of feed is slightly lower. The details of investment and returns are presented in Table 6.15.

Table 6.15

Economics of establishment of one yak unit in the continental zone of North Sikkim in one lactation.

A.	Capital Investment	Investment Cost in (Rs.)
1.	Procurement of yak	5,000
2.	Transportation cost (including labour charges)	400
3.	mobile shed for attendent.	350
4.	Utensils	75
5.	10 percent contignencies	582.50
TOTAL:		Rs. 6,407.50
B. OPERATING COST.		
1.	Dry fodder or hay for 3 months @ 3 kg per day @ Rs. 2 per kg.	540.00
2.	Cost of medicines and vaccine (fee) token amount	10.00
3.	Feeding of concentrates - 260 kg. @ Rs. 6.08 per kg.	1,580.00
4.	Labour cost.	225.50
5.	Contingencies 10%	235.55
	TOTAL:	Rs. 2,591.05

C. RETURNS

1. Sale of milk 665 ltrs. @ Rs. 8.00 per ltr.	5,320.00
2. sale of calf (1/2 to 1 year old)	1,000.00
3. sale of yak hair 0.750 kg. @ Rs. 50/ per kg.	37.50
TOTAL:	Rs. 6,357.50
Net return (6,357.50-2,591.05)	Rs. 3,766.45

In the continental zone the capital cost involved in establishing one yak unit is estimated to be Rs. 6,407.50 with the recurring expenditure of Rs. 2,591.05 per lactation. The return per yak per lactation on the sale of milk, calf and yak hair is worked out to be Rs. 6,357.50. The net return per yak per lactation is however calculated to be Rs. 3,766.45 (Table 6.15).

SUB-TROPICAL ZONE.

From the economics of establishment of one cow unit of local seri" cow and crossbred cow in the subtropical zone of North Sikkim in one lactation period, the following picture emerges. Table 6.16 illustrates the economics of establishment of one cow unit.

Table 6.16

Economic for establishment of One Cow Unit of Local Seri and Cross-bred cow in the sub-tropical zone of North Sikkim in one lactation period.

A. Captial Investment:	Local Cows (Rs.)	Crossbred Cows (Rs.)
1. Construction of cattle shed 3.5 sq.m. floor space	1400.00	1500.00
2. Purchase of animal	4000.00	9000.00
TOTAL CAPTIAL COST:	5400.00	10500.00
B. Operating cost.		
1. Cost of feed.	1196.25	3960.00
2. Cost of dry fodder	1170.00	1215.00
3. Green fodder @ 20kg. per day. @ Rs. 0.50 per kg.	2550.00	2650.00
4. Imputed value of labour @ Rs. 6/- per day.	410.85	550.42
5. Contingencies 10% insurance etc.	532.71	837.54
TOTAL OPERATING COST:	5859.81	9212.96
C. RETURNS:		
1. Sale of milk	7312.50	16275.00
2. Sale of calf & Manure	555.00	1055.00
TOTAL RETURN:	7867.50	17330.00
NET RETURNS PER ANIMAL:	2007.69	8117.04

In the sub-tropical zone of North Sikkim, almost all the farmers rear cattle i.e. both the "Seri" or local cows and the crossbred cows. The economics of establishing one cow unit of local "Seri" and crossbred cow in this zone in one lactation period has been shown in Table 6.16. From the Table 6.16 it is quite clear that the capital investment in case of local cow is Rs. 5,400/- which is substantially less than that of the cross-bred cows for which the capital investment in terms of rupees appears to be almost double i.e. Rs 10,500/-. Similarly, the operating cost of Rs. 5,859.81 in case of local cow is reasonably lower than that of crossbred cows which is Rs. 9,212.96 per lactation. However, total cash return in case of crossbred cow of Rs. 17.330.00 is much higher than that of the local cow which stands at Rs. 7,867.50 only. From the above, it could be infered that rearing of crossbred cows in the area can always be profitable in terms of cash return in view of the fact that the net return per cross bred cow is substantially higher than that of the local indigarous cows. The cash returns being Rs. 20,000/- and Rs. 8,000/- for the former and the later respectively. On the other hand, the amount of capital investment and other operating costs for both types of animal vary substantially. In regard to local cows, the expenditure incurred on various heads is lower than the exotic varieties. As the return for crossbred animals is always higher, one can say that rearing exotic crossbred animals in the region can not only be economically viable but it can also raise the farm income of the households to a new high. Wide introduction of cross bred cows in the area can help in commercial production of milk and milk products.

6.5.4. Economics of Milk Production.

An attempt has been made in this Chapter to analyse the economics of cost of milk production for yak at different

climatic zones and for two different breeds of cattle i.e. local "Seri" breed and crossbred Jersey breed in north sikkim. The method of analysis of the different parameters of the cost of production is based on the techniques adopted by Joshi (1982) in case of yaks in Nepal and by Sastry et al (1979), Pandey (1980) Sastry and Pal (1982), George and Nair (1990) and Thomas and Sastry (1991) in case of cattle and buffaloes. The catogory wise cost of milk production and returns per yak in dry high zone and continental zone has been presented in Table 6.17. It will be seen from Table 6.17 that the feed and fodder alone account for a substantial portion of the total expenditure incurred, the percentages being as much as 60.51 percent for dry high zone and 54.03 percent for the continental zone. The second highest amount of expenditure is found to be incurred on the cost of replacement and depreciation followed by thepayment of interest on capital investment on animal. If the second and third cost components are combined together then the total expenditure on interest on investment on animal and replacement/depreciation cost of animal comes out to be Rs. 1225 i.e. 25.74 percent for dry high zone and Rs. 1125 i.e. 31.22 percent in the continental zone.

Table 6.17

Category-wise cost of milk production and returns per yak during an intercalving period in North sikkim.

SI. No.	Particulars of costs and returns.	Yak farming in Dry High Zone Rs.	Percentage to total expenditure	Yak farming in Continental zone Rs.	Precentage to total expenditure
A. EXPENDITURE.					
1.	Present value of animal	5000	-	5000	-

2. Interest on investment on animal	600	12.61	600	15.29
3. Replacement/depreciation cost of animal.	625	13.13	625	15.39
4. Interest and depreciation on fixed assets (yak tent)	120	2.52	120	3.06
5. Imputed value of labour at the rate of Rs. 7/- per man/days	225.50	4.74	225.50	5.75
6. Feed and fodder costs	2879.20	60.51	2120.00	54.03
7. Miscellaneous other costs	308.92	6.49	233.00	5.94
8. Total Expenditure	4758.62	100	3923.50	100
9. Total Expenditure excluding value of labour	4533.12	-	3698.00	
B. RETURNS.				
10. Average milk yield (litres)	665.00	-	665.00	
11. Returns from sale of milk	4655.00	-	5320.00	
12. Value of calf and manure	1000.00	-	1000.00	
13. Sale of yak hair	37.50	-	37.50	
14. Gross returns(10+11+12)	5692.50	-	6357.50	
15. Net returns:				
a. Excluding value of labour labour in total cost.	1159.38	-	2659.50	
b. Including value of labour in total cost.	933.88	-	2424.10	
16. Net cost (7-(11+12))	3721.12	-	2886.00	
17. Net cost per litre of milk	5.60	-	4.34	
18. Net return per litre of milk.	1.40	-	3.66	

As far as gross returns from yaks are concerned the various items include sale of milk, sale of calf and manure and sale of yak hair etc. The total return per yak per lactation comes out to be is Rs. 5692.50 in the dry high zone and 6357.50 in the continental zone. The net returns per yak excluding the value of labour in total cost are Rs. 1159.38 and Rs. 2659.50 in the dry high and continental zones. However, if the value of labour in total cost is included the returns per yak are Rs. 933.88 in the dry high zone and Rs. 2434.10 in the continental zone. The cost of production per litre of milk is worked out to be Rs. 5.60 in the dry high zone and Rs. 4.34 in the continental zone. Similarly the net return per litre of milk is Rs. 1.40 in the dry high zone and Rs. 3.66 in the continental zone. The reasons for high cost of production of yak milk in dry high zone as compared to that of the continental zone may be attributed to high transport cost of feed and fodder. The farmers are also not given any transport subsidy by the State government.

The category wise cost of milk production and returns per local Seri cow and crossbred cow in north sikkim is presented in Table 6.18. This table also indicates that the feed and fodder are the major items of expenditure which accounts for Rs. 4916.25 per local cow i.e. 69.02 percent of the total expenditure and Rs. 7825.00 per crossbred cow i.e. 66.08 per cent the total expenditure on recurring cost. Though the rearing cost of the local cow is cheaper by Rs. 4719.23 as compared to the crossbred cows never the less production per crossbred cow is higher by Rs. 9462.50. The net returns per local cow could be Rs. 744.89 (if the cost of labour is included in the total cost) and Rs. 1155.74 (if the cost of the labour is excluded from the total cost). In case of crossbred cow, the return per cow is calculated to be Rs. 6038.58, (if the value of the labour is excluded from the total cost) and Rs. 5488.16 (if

the value of the labour is included in the total cost). Consequently, the cost of production of one litre of milk is workedout to be Rs. 6.74 or nearly Rs. 7/- in case of local cows and Rs. 4.74 or Rs. 5.00 per litre for crossbred cow. The net return per litre of milk is found to be only Rs. 0.76 for local cow and Rs. 2.53 for the crossbred cows. It can thus be concluded that even though the rearing cost of local cows are lower than that of crossbred cows but the returns from the former are not very promising. Despite high rearing cost, the return per crossbred cow is much higher. Similarly, the cost of production of one litre of milk seems to be very high in case of local cow than that of the crossbred cows. But the return per litre of milk is much lower in case of local cow than that of the crossbred cows. From similar studies carried out in Kerala, it was reported that during the lactating period, the cost per litre of milk from crossbred and local cows was Rs. 2.41 and Rs. 3.16/- respectively and with the inclusion of dry period alongwith the lactating period the cost of production of milk thus reported was Rs. 5.24 for local cow and Rs. 3.70 for crossbred cows.[40]

Table 6.18

Category-wise cost of milk production and returns per local Siri and Crossbred cow during an intercalving period in North sikkim.

SI. No.	Particulars of expenditure and returns.	Local "Seri" cow in (Rs.)	Percentage to total cost	Crossbred cow in (Rs.)	percentage to total cost
	A. Present value of animal	4000.00	-	9000.00	-
1.	Interest on investment on animal	480.00	6.74	1080.00	9.12
2.	Replacement/depreciation cost of animal.	500.00	7.02	1125.00	9.50
3.	Interest and depreciation on fixed assets (yak tent)	168.00	2.36	180.00	1.52
4.	Imputed value of labour at the rate of Rs.7/- per man/days	410.85	5.77	550.42	4.65

40. George, P.S. and Nair, K.N. Livestock Economy of Kerala, Trivandaum. Center for Devlopment Studies. 1990, p. 105-115.

5. Feed and fodder costs	4916.25	69.02	7825.00	66.08
6. Miscellaneous other costs	647.51	9.09	1081.42	9.13
7. TOTAL COSTS	7122.61	100.00	11841.84	100.00
8. Total costs excluding value of labour	6711.76	-	11291.42	-
9. Average milk yield (litres)	975.00	-	2170.00	-
10. Returns from sale of milk	7312.50	-	16275.00	-
11. Value of calf and manure	555.00	-	1055.00	-
12. Gross returns (10+11)	7867.50	-	17330.00	-
13. Net returns:				
a. Excluding value of labour labour in total cost.	1155.74	-	6038.58	-
b. Including value of labour in total cost.	744.89	-	5488.16	-
14. Net cost (7-11)	6567.61	-	10786.84	-
15. Net cost per litre of milk	6.74	-	4.97	-
16. Net return per litre of milk.	0.76	-	2.53	-

It is important to note that the cost of production of milk depends on a number of factors such as breed of the animal, type of housing and localtion, season and herd size, and stage of lactation etc. Moreover, the sample animals should be sufficient in number and repeated observations over a period of time should be the main criteria. In the current study, as a matter of fact, it was not possible to cover the animals in different stages of lactation and the households were visited only once. Hence, in view of these difficulties the data on cost of production of milk yield should be considered as only indica-

tor of an overall pattern. A more systematic study has to be planned therefore, over a longer period of time.This kind of study, if under taken in future, will help us arrive at a clear picture concerning relative cost benefit out of livestock farming in the area. As regards the market sale price of milk, the same is found to be the highest in North Sikkim with cost per litre ranging beatween Rs. 7.50 to Rs. 8 per litre. For a comparative analysis the rate of sale price of milk in other states and in the rest of Sikim is given in Table 6.19.

Table 6.19

Procurement price of hilly milk unions

Name of the Milk Union	Contents	Average Price (4%ft+8.5%SNF)
1. Sikkim Milk union	Fat 65, SNF 40	Rs. 6.18
2. Simla (Himachal Pradesh)	Fat 47, SNF 35	Rs. 5.00
3. Srinagar (J. & K.)	Fat 55, SNF 36	Rs. 5.44
4. Kohima (Nagaland)	Fat 60, SNF 40	Rs. 5.97
5. Himul (West Bengal)	Fat 46, SNF 36	Rs. 4.90

It will be seen from table 6.19 that as far as the procurement price of milk for different milk unions particularly in the hills are concerned, the procurement price for the Sikkim milk Union has been quoted as the highest i.e. Rs. 6.18 per litre. The high procurement price for the milk produced in Sikkim needs further research and investigation as far as the cost components are concerned.

Presently, it seems that the dairy development programme is not well organized in north Sikkim. However, the Central Government has sanctioned an integrated Dairy Development

project for north Sikkim which is being implemented by the State Government. Once the milk processing and chilling plants are established then the milk marketing would be laid on firm footing and the procurement cost might go down.

6.5.5. LIVESTOCK FARMING VERSUS AGRICULTURAL FARMING IN LACHUNG VALLEY : A COMPARATIVE ANALYSIS.

In Lachung valley, the farmers largely depend on mixed farming i.e. livestock raising and agricultural farming. With a view to highlighting the significance of mixedfarming in this region it has been appropriately decided to undertake a special study on the productivity of agricultural farming vis-a vis livestock raising. In this study, as many as 142 households were covered by adopting random sampling method in the following five villages.

Villages and number of households covered in the survey

SI. No.	Name of village	No. of houshold covered
1.	Bichu	45
2.	Singring	13
3.	Thomchi	10
4.	Fokha	21
5.	Sharchok	53
	TOTAL:	142

The farmers were personally interviewed and the production of agricultural crops and land holdings etc. were recorded.

It was observed that the land holding or the farm size of the farmers in the area vary between below 1 acre to 5 acres and above. As flat and arable land in the area is inadequate, large farmers generally own about 5 acres of land or more. Keeping the scarcity of arable land in view, the operating land holdings of the farmers have been arbitrarily classified into as many as six categories namely marginal, small, low medium, medium, high medium and large. The informations were collected as per the survey proforma developed for Lachung Valley. The prices taken into consideration for determining the cost of various livestock and agricultural products were as per the existing market rates.

Analysis:

The number of farmers involved in livestock and agricultural farming in the Lachung valley has been presented in Table 6.20. It will be seen from Table 6.20 that only 5 households or 3.52 percent out of 142 depend exclusively on livestock farming whereas 68 households or 47.89 percent of the total depend mostly on agricultural farming for economic sustenance. However, as many as 57 households accounting for 40 percent of the total depend both on agricultural as well as livestock farming. Only 12 househlds i.e. 8.45 percent are agricultural workers. They, therefore, neither rear livestock nor do they take up agricultural farming.

Table 6.20

DISTRIBUTION OF FARMERS IN VARIOUS FARM SIZES IN LIVESTOCK & AGRICULTURAL FARMING (LACHUNG VALLEY)

Holding size.	No.of farmers depending exclusively on livestock farming.	No.of farmers depending on exclusively on Agricultural farming	No.of farmers depending on exclusively lvestock & Agriculture farming	No.of farmers
Below 1 acre	2	10	1	5
1-2 acres	3	34	17	6
2-3acres	nil	14	18	1
3-4acres	nil	9	12	nil
4-5 acres	nil	1	5	nil
Above 5 acres	nil	nil	4	nil
TOTAL:	5	68	57	12
Percentage :	3.52	47.89	40.14	8.45

It will be seen from table 6.20 that out of 130 households practising either livestock farming or agriculture farming or both as mixed farming. Majority of them i.e. 68 out of 130 depend on agriculture farming for their sustenance followed by 57 depending on a mixed type of farming constituting of both livestock and agriculture. The rest 5 households however, have livestock farming as their main occupation. As the sizes of the farms in terms of acreage have been arbitrarily classified, it

will be interesting to throw light on the distribution of farm households in various size classes. A glance at table 6.20 reveals that out of 5 households depending on only livestocks for their livelihood two have farms with less than one acre of land and the rest three accounting for 60 percent of the total have farm, sizes varying between 1 to 2 acres. The above farm households could be termed as marginal and small farmers respectively.

Switching over to the households parctising agricultural farming only, it is observed that marginal and small farmers alone constitute of more than 64 percent of the total. The rest of the farm households could be termed as medium farm households whose farmsize varies between as much as 2 to 3 acres to 4 to 5 acres of land. As far as these farm households are concerned, maximum fall in the category of small or marginal farming followed by an appreciable share of farmers who could be termed as medium farmers.

As far as the farm households depending on both agriculture and livestocks for their economic sustenance are concerned, it could well be observed that more than 31 percent of them are either marginal or small farmers in term of area devoted to such farming. It is interesting to note that a substantial share of the farmers belong to the medium category (i.e. 61.89 percent). As low as 7.02 percent of the farm households could be termed as large farmers possesing more than 5 acre of land.

From the above analysis it could be infered that in Lachung Vally the above three categories of farmers posses different farm sizes. The households practising mixed farming appear to be economically better off as more than 60 percent of the households are medium farmers. However, a very few

devote relatively more land for agriculture and livestock farming and could be termed as large farmers. Here agricultural farming appears to be more prominent than that of the livestocks. It could be substantiated from the above fact that out of 130 households surveyed at random more than 52 percent depend on agriculture for sustenance.

DISTRIBUTION OF INCOME GENERATED FROM LIVESTOCK AND AGRICULTURE FARMING ACCORDING TO FARM SIZE:

Keeping the distribution of farmers according to farm sizes in view, it will be worth while to discuss the pattern of distribution of income generated from livestock and agricultural farming according to various arbitrary farm sizes. For the purpose, the average income per household derived from livestock farming and agriculture farming have been worked out taking into account the various arbitrary sizes of holding. The average income from livestock and agricultural farming separately per household per annum has been presented in Table 6.21. It will be seen from table 6.21 that the farmers depending exclusively on livestock farming with holding below one acre earn Rs. 12,835/- per annum.

Table 6.21

INCOME FROM LIVESTOCK & AGRICULTURE FARMING (Lachung valley)

Holding size	Average Income from livestock farming per household per year (in Rs.)	Average Income from Agricultural farming per house-hold per year (in Rs.)	Average Income from Agriculture-cum livestock farming per household per year (in Rs.)
Below 1 acre	12,835	6,130.00	10,200.00
1-2 acres	18,440	6,912.88	20,345.88
2-3acres	nil	5,799.00	19,151.94
3-4acres	nil	5,776.00	18,534.00
4-5 acres	nil	9,600.00	21,816.00
Above 5 acres	nil	nil	17,422.50

and the farmers with the holding size between 1 to 2 acres earn Rs. 18,440 per annum. It could further be abserved that the income shows an increasing trend as the fermsize increases. It has been confirmed during field investigation that the farmers normally use government grazing lands round the year. Such high income may be atributed to low level of spending on grass and fooder due to free grazing.

As regards the income generated from agriculture farming it was found that the average income per household does not necessarily depend on the size of holding except that farmers with 4-5 acres of land have an average income of Rs. 9.600/- per annum which is more than the income received by the farmers having less than 1 acre of cultivated land. Switching

over to the average income generated from mixed farming i.e. agricultural cum livestock farming, it is observed that income from such farming ranges between Rs. 10,200/- per annum to as high as Rs. 21.816/- per annum. The farmer with land holding generally less than one acre earns asmuch as Rs. 10,200/- from mixed farming as compared to Rs. 6,130/- per annum from agricultural farming alone. It could thus be seen from table 6.21 that holding size generally above one acre of land gives relatively better return in terms of cash as far as mixed farming is concerned. From the above table it can also be seen that income from livestock farming is more than double as compared to that of income derived from agricultural farming alone. As a matter of fact the income derived from the mixed farming looks much more promising than that of agricultural farming alone. In the plains as per the study conducted by the Indian council of Agricultural Research over the period 1962-63 to 1967-68 concerning a comparative analysis on the economics of dairy farming versus mixed arable farming in Nasipur Patiala (Punjab) net returns per hectare of land in rupees are Rs. 1480/- Rs. 1348/- and Rs. 1107/- per annum for dairying, mixed and arable farming respectively.[41]

From the above analysis it could be infered that mixed farming in Lachung Valley has a better prospect in terms of cash return than that of agriculture alone through the area stands quite favourable for raising a number of agricultural crops.

6.5.6. Distributional pattern of expenditure and income of the farmers of Dry High Zone.

Unlike the other two climatic zones, the farmers of Dry High Zone depend largely on livestock farming for their economic sustenance. As indicated earlier, farmers in this zone

41. Chaula, N.K. and Khanna, R.S. Social Revolution throw Dairying. In (Dairying as an instrument of change. Proceedings of 19th International Dairy Congress. New Delhi; 1974. p. 136-139.

rear yaks, sheep and goats in large number for their livelihood. Due to their centuries of physical isolation in the mountain fastnesses the high landers in the region have built up their own tranditional ways of livestock rearing. With a view to studying the economic life of these people, a household survey has been conducted to know the dynamics of their economy that primarily centers around various kinds of livestock. In this zone, the farmers of Lhonak and Chho-Lhamo have been interviewed with the help of structured questionnaries. From the data and information so gathered, the distributional pattern of expenditure and income according to farm size has been analysed with the help of statistical tables.

Analysis:

The type and number of livestocks reared by each household play an important role in the generation of family income. The expenditure on various heads in rearing the animals also varies depending on their types and numbers. Table 6.22 illustrates the number of animals reared by each household and the average family size in each region such as chho-Lhamo and Lhonak.

Table 6.22

LIVESTOCK HOLDING AND FAMILY SIZE IN DRY HIGH ZONE OF NORTH SIKKIM.

	Chho-Lhamo	Lhonak
No. of yaks per household	50.00	39.0
No. of sheep per household.	146.00	39.0
No. of goat per household.	17.00	9.0
Average family size.	5.53	4.5

It will be seen from table 6.22 that the number of yaks, sheep and goats per household is substantially higher in Chho-Lhamo region than that of Lhonak. The average family size is also more in case of Chho-Lhamo i.e. 5.53 than Lhonak region where the same is 4.50.

From the sale price of livestock products such as wool and the milk products etc. and the prevailing market price of the said products, the following picture emerges. Table 6.23 presents the livestocks, livestock products and their sale price for the above two regions. As per data collected from field survey, the production and subsequent sale of livestocks from Chho-Lhamo as many as 33 yaks, 91 sheep and 23 goats per annum have been sold in the market. The total output of milk products per annum similarly amounts 212 kg. butter and 304 kg. of dry yak cheese. The wool production is however estimated at 1642.5 kg. per annum.

Table 6.23

Levestock, Livestock products and the sale prices for Lhonak and Chho-Lhamo regions of North Sikkim.

Livestock/livestock products	Chho-Lhamo		Lhonak	
	No.	Rate(Rs.)	No.	Rate(Rs.)
(A) 1. yaks	33	5000	74	5000
2. Sheep	91	1500	93	1500
3. Goat	23	1000	20	1000
Milk products.				
B. 1. Yak butter in kg.	212	120	420	120
2. Yak dry cheese in kg.	304	80	590	55
C. Wool production in kg.	1642.5	80	438.75	80

Similarly it will be seenfrom table 6,23 that as many as 74 yaks, 93 sheep and 20 goats are annually prodcuced and subsequently sold from Lhonak region. As far as out put of milk products is concerned as much as 420kg. of butter and 590 kg. of hard dry cheese are produced annually from the region. The wool production is only 438.75 kg. The existing cost of livestock, butter, wool etc. are similar in both the regions.

Based on Table 6.23 the annual income from sale of various categories of livestock, milk products and wool has been worked out. In order to find out the annual income, expenditure on various counts of the households under review has been cal-

culated from the survey data. the details of both these parameters such as expenditure and income are presented in Table 6.24. It will be seen from the said table that of the total expenditure the expenditure incurred on the purchase of livestock alone accounts for 37.64 percent for Chho-Lhamo and 24.23 percent for Lhonak region. The maximum expenditure incurred is on food which accounts for 49.22 percent and 40.81 percent of the total expenditure for Chho-Lhamo and Lhonak region respectively. Consequently, the average expenditure per house hold in Chho-Lhamo comes out to be Rs. 25330 which is much less than that of Lhoank region i.e. as much as Rs. 43,286.30. Such high in curring of expenditure on animal feed and purchase of the animals etc. in the Lhonak region could mainly.

Table 6.24

STATEMENT OF EXPENDITURE AND REVENUE IN RESPECT OF LIVESTOCK FARMING IN CHHO-LHAMO AND LHONAK AREAS OF DRY HIGH NORTH SIKKIM.

A. Heads of expenditure	Chho-Lhamo (Amt. in Rs.)	Percentage to total Expenditure	Lhonak (Amt. in Rs.)	Percentage to total Expenditure
1. Purchase of livestock	142995.00	(37.64)	157294.50	(24.23)
2. Expenditure on food.	187005.00	(49.22)	265005.00	40.81
3. Other expenses	49950.00	13.14	226995.00	34.96
Total expenditure:	379950.00	100.00	649294.50	100.00
Average expenditure per house hold	25330.00		43,286.30	

B. TOTAL REVENUE				
1. Sale of yak	1,65,000.00	33.13	3,70,000.00	57.15
2. Sale of sheep	1,36,500.00	27.41	1,39,500.00	21.55
3. Sale of goat	23,000.00	4.12	20,000.00	3.09
4. Sale of wool	1,31,400.00	26.38	25,100.00	5.42
5. Sale of butter	25,440.00	5.11	50.400.00	7.78
6. Sale of oheese	16.720.00	3.35	32.450.00	5.01
Total REVENUE Received:	4,98,060.00	100.00	6,47,450.00	100.00
Average REVENUE per household.	33,204.00		43, 163.33	
Net income : (+)	1,18,110.00		(-) 1844.50	
Net income per family. (+)	7,874.00		(-) 122.97	

be attributed to the high transport cost of the various items of food and feed ingredients which have to be transported either on foot or by yak back from Thangu onwards as the area is not connected with moterable roads. Moreover, the area as has been discussed earlier has diffcult terrain conditions and remains often and usually cut off from the mainland either due to landslide caused by heavy down pour in the lower region or owing to heavy snowfall in the higher region. On the other hand, Chho-Lhamo region is connected by roads and transportation of goods therefore is relatively cheaper. The over-all picture of the net return or income per family indicates that the return per family in the Chho-Lhamo region works out to be Rs. 7,874 per annum. The returns per household of the Lhonak region is however, on the negative side i.e. minus Rs. 122.97. Such a negative trends in returns in livestock farming

could largely be attributed to high transportation cost of the essential farm requirements and numerous other socio-economic and physical factors. It is high time that the state government should introduce some sort of trnasport subsidy for the Lhonak farmers to economically sustain in such harsh environmental conditions.

6.5.7. Conclusion.

In conclusion one can say that livestock rearing being the traditional occupation of the people in North Sikkim has a promising future in view of its enormous potentiality in the region. From the economic analysis of livestock farming it is quite interesting to note that high yielding cross breed animals are increasingly cost effective and the return is substantially higher than the local indigenous varieties. A comparative analysis of livestock versus crop farming in the region also indicates that the former is more productive than the later in terms of cash returns. What needs to be emphasized here is that the entire North district in Sikkim needs special attention for the development of livestock sector. The following suggestions in this regard will there fore go a long way in promoting this sector as economically the most vibrant that can generate employment and brost the economy of the region for a better future.

1. The infrastructural development be undertaken on which footing to make this enterprise commercially viable.

2. As the products are perishable quicker scientific disposal of the same be given priority.

3. For better income, a strategy should be chalked out for a wider marketing system.

4. Awareness among the farmers has to be created for adopting modern innovations.

5. For improving the investment capacity of the farmers, institutional network should be developed to extend loan facilities through banks and cooperatives to the farmers at lower rate of interest.

6. Adequate framing facilities should also be developed to motivate the farmers to go in for modern technology.

7. Over and above educational facilities in the region should be given priority as education is the only instrument to bring about a perceptible change in the out look of the farmers. Therefore educated farmers are always found to be more receptive to new technology than the uneducated ones.

CHAPTER VII

LIVESTOCK AND ENVIRONMENT

7.1. INTRODUCTION.

The existing livestocks in any geographic region are the overall reflections of the prevailing environment.Therefore, livestocks and environment are very closely associated and are almost complimentary to each other. The present chapter primarily deals with the typical livestocks adapted to the high Himalayan environment of North Sikkim.The study high lights the effect of the environment on livestok population in the region. For the purpose a number of environmental parameters have been chosen to establish a kind of relationship between then and the livestocks as far as the growth and divelopment of the latter are concerned. The data and information have been procured through extensive field work. The soil samples and other physical variable collected from the field have been analysed in the laboratories of the Depth of Animal husbandry and Veterinary and Agriculture of the Govt. of Sikkim. The results have been tabulated for subsequent analysis and interpretations. As far as the methodological issues of the analysis of variables are concerned, the same have been discussed in the text. The chapter is divided into three parts. The first part examines the present status of livestock farming and the environmental hazards along with the beneficial role played by livestock in conserving earths fragile ecosystem. The second part highlights the livestock and environment interaction in North Sikkim based on field studies. The details of fields studies carried out are as follows:(i). Analysis of soil in Chopta Lhonak Chho Lhamo region and micro-nutriant content in the soil of Lhonak region.

(ii). Assessment of the present system of management of livestock and the grazing grounds and assessment of productionity of the grassland of Lhonak and Chho Lhamo region.(iii). Analysis of micronutrient and its important role in the growth and productivity of different kinds of grasses and fodders on which livestock in the region largely depend on. (iv). Study the role of vegetation, grasses, fodder trees, tree fodder, poisonous plants and performance of exotic grasses and legumes in conserving the precious top soil and the environment of north Sikkim. The above findings are presented below after the review.

7.1.1. Livestock and Environment in India Today.

Domesticated animals have been playing historically a beneficial role in human economy for thousand of years in terms of providing food, fuel, fertilizer, transport and clothing. However, at present these animals have been highly commercialized and their numbers have so greatly increased for economic benefits that they have posed a major threat to our natural enivronment. The following points would give a clearer and better insight into the role of livestock and the present environmental hazards in India today.

Grazing by livestock is regarded as one of the major causes of deforestation and livestocks are thus the range land destroyers. Due to heavy grazing the soil is ultimately exposed for wind and water erosion. The goat particularly in addition to grazing are excellent browsers and their role in ecological degradtion and desertification is well known[42]. Large scale depletion of vegetation leading to heavy soil erosion has occured in the Kashmir valleys[43]. Similarly in the arid and semi arid regions of Rajastan heavy erosion of top soils is also a common phenomenon

42. Singh, R.V. Role of goat in Desertification. Preconference Proceedings plenary papers presented at (5th International conference on Goats, International Goat Association, New Delhi, March 2-8, 1992.p. 100-109)
43. Dhar, H. M. and Kaul, V. Forest vegetation in relation to varying anthropogenic Distrubances; A case study from Kashmir Himalaya. *In* (Pangtey, Y.P.S.and Joshi, S.C. *eds.* Western Himalaya Vol. II problems and Development.Nainital, Gyanodaya 1987 p. 623-638

under heavy grazing[44]. It is true therefore that uncontrolled livestock population and grazing in open space can be extremely harmful to the growth of vegetation especially where new reseedling or plantation have been done. However, with proper management of livestocks i.e. increasing or reducing the stocking rate on the basis of grass growth can go a long way in improving the productivity of the animals and fertility of the soil. Long term grazing/browsing experiments with sheep and goats conducted by the Central sheep & Wool Reserach Institute (C.S.W.R.I.) Avikanagar & Bikaner in Rajasthan on land unsuitable for crop production have shown that stocking rate of 3 sheeps or goats per hectare of land produced no deterioration in the physical and chemical properties of soil [45] and also it has been reported that intensity of grazing in terms of 2 to 4 goats per hectare of land had no effect in run off and soil loss in hot arid regions of India under normal rainfall years [46]. It has been found that by planting livestock fodder namely vetiver grass, the rainfall runoff would be reduced from 40 percent to 15 per cent and silt losses could be reduced from 15 tonnes per hectare to 6 tonnes per hectare [47]. The forest land converted into permanent pastures for the production of fodder serves as natural sinks for carbondioxide. The leguminous fodder crops grown along with the grasses in the pasture lands are capable of fixing atmosphere nitrogen in the soil, thereby reducing the requirement of nitrogenous fertilizer and the emmission of nitrous oxide in the air. One of the important issues concerning the global environment is the greenhouse effect of increased carbon dioxide, methane and other gasses caused by human activities. Of the above gases methane causes great conern to the livestock farmers as the same is produced by livestocks through the activity of anaerobic bacteria and breakding down of organic matters in the reuminants of the animals. It is estimated

44. Kumer A. Joshi, M.C. The effect of grazing on the sturcuture and productivity of vegetation near pilani, Rajastan. India J. Ecol. 60; p.665-675.1972.

45. Acharya, R.M., *et.al.* Relative productivity of sheep and goat on free range grazing/browsing management on semiaril range land of Rajistan Central sheep and wool Research Institute Annual Report. Avikanagar, 1980, p.60-75.

46. Prajapati, M.C. *et.al.* Effect on different intensities of grazing by goats an vegetation cover, run off and soil loss in a forest water shed in Yamuna ravines vis-a-vis animal production paper presented at (Third International Range land Congress. Janshi, 1980.p. 419-422.

47. Grimshaw, R.G. Vetiver grass. The Hedge against Erosion. Washington, D.C. The world [illegible]

that cattle and buffaloes emit 35 to 55 kg. of methane per annum per animal; goats,sheep and horses emit 5 to 15 kgs. of methane per animal per annum and pigs produce 1 kg. of methane per animal per annum. There are 1.2 billion numbers of ruminants emiting methane in the world today. It has been estimated that 18% of the global warming is attributed to methane and methane accumulation in the atmosphere has trippled over the last 300 years.Another major concern is that for every one litre of milk produced in the developing countries, 240 grams of methane are released into the atmoshere as compred to that of only 40 grams in the developed countries[48].The beneficial role of livestock farming in India today needs to be examined taking the envirommental factors into account. India today uses about 300 million tonnes of agricultural by products and cellulosic wastes as fodder for the livestock and in the developed countries these are being burnt resulting into accumulation of carbon dioxide in the atmosphere. Similarly the use of dung has reduced the use of fertilizer, thus again reduces the accumulation of the nitrous oxide in the air and i.e. finally the use of bullock power in India has reduced the fossil fuel consumption to a great extend. However, the mission of methane has to be reduced by 20% by 2005 as agreed upon in the Earth summit at Rio-de-Janeiro in 1992. This means the Indias cattle population of 460 million has to be drasticaly reduced by 2005 and it is estimated that only 16 million breedable cows are needed to produce 65 million metric tons of milk needed by the turn of the century along with 125 million bullocks for power production to obtain a food production target of 250 million matric tons [49] .

7.2. Livestock and Environment of North Sikkim.

As indicated earlier North Sikkim has 908.61 sq. km. or 90861 hectares of land under alpine schrub and pasture land. These

48.Aneja, R.P.Dairying and its impact on the environment.*Indian Dairyman* Vol 44(3),1992, p.177-120.
49. Bhat P.N. An overview of cattle productivity National Symposium on Animal Productvity organized by Hindustan Lever Foundation, Bombay, 1987, p.

areas are famous grazing grounds of Lhonak and Chho Lhamo highlands. The area provides employment to a large number of farmers especially for two highland communites i.e Lachenpas and Lachungpas. In order to formulate appropriate policies and prepare action plan based on scientific lines for further development of this sector in North Sikkim, there is a genuine and strong need for reliable studies on the biophysical and socio-economic factors. As the development of livestock is largely determined by favourable environmental conditions and extensive grazing land forms one of the most important componants of livestock rearing, it would be meaningful to make an attempt to study and assess the above grazing lands of north Sikkim in terms of their biophysical characteristices which mainly incoporates the nutrient and fertility status of the soil, the quality of the grasses and other forages in terms of nutrient and mineral content, the carrying capacity per hectare of the grazing lands on one hand and the present management and utilization systems of the same on the other.

7.2.1. Analysis of soil in Chopta, Lhonak and Chho-Lhamo regions

The objectives of the present study is to carry out field studies on the impact of livestock grazing on the soil. For the purpose soil samples have been collected to bring out an analysis of the physical properties of the soil in the region comprising Chopta, Lhonak and chho-Lhamo grazing grounds. The soil properties analyzed include the pH values. Organic matter, available nitrogen, available phosphorus and available potassium content of the soil. The micronutrients mainly copper, zine and iron of the soil of Lhonak were also analyzed.

7.2.1.1. MATERIALS AND METHODS.

As many as twenty soil samples were were collected from Lhonak Chho-Lhamo and Chopta, particularly from pasture lands and were later dried and processed in the laboratory for determining the ph values, content of orgenic matter, available phosphorous and potassium with the help of the methods described by Jackson (1967), The procedure of nitrogen was analyzed by the technique devised by Subbiah and Asija (1956).

The availabale micronutrients were determined by using DTPA extractant. Ten grams of soil was shaken for two hours with 25 ml. of STPA (Lindsay and Norwell 1978). The content of zn,cu were determined by using atomic absorption spectophotometer (PE 3100). As regards the study of soil erosion a numerical approach was designed and analysis based on the interpretation of the results has been incorporated subsequently in the present study.

7.2.1.2. RESULT AND DISCUSSION

The results are expressed as the ranges and mean values of ph organic matter in terms of percentage, p_2o_5 in parts per million, k_2o also in parts per million and nitrogen (N) in terms of kilograms per acre. The results were interpreted in a similar fashion as proposed by Tisdale *et. al.* (1985). The following table 7.1 presents a scale of contents of various nutrients of soil such as nitrogen phosphorus and potassium. pH values and organic matter.

Table 7.1
Content of Nutrients

Degree of content	Content of Nutrients				
	N	P_2O_5	K_2O	Ph	Organic matter
Low	<250	<10	<125	4	<2.47
Medium	250-500	10-25	125-250	5-6	2.74-6.00
High	>500	>25	>250	6.0	>6.00

As regards the contents of micro-nutrients in the soil, the values pertaining to critical levels such as 1.00 ppm and 4.55 ppm for zinc and iron respectively in the analysis were adopted[51]. However, in case of copper, the critical level of 0.66 ppm was taken into considertion [50]. The findings are discussed below:

7.2.1.2.1. Soil pH and Macro-nutrients.

The mean values and ranges of PH content of organic matter, available nitrogen, phosphorus and potassium of Lhonak and Chho-Lhamo regions have been presented in Table7.2 (Appendices XI, XII & XIII). The mean value of 5.4 ph was recorded for Chopta (near Thangu) whereas values for Lhonak and Chho-Lhamu regions were found to be 6.47 and 6.44 pH respectively. The pH in Lhonak region ranges from 5.7 to 8.9 and for Chho-Lhamo region the value ranges from 6 to 6.8.

50. Lindsay, W.L. and Norwell, W.A. Development of DTPA (Dietheline triamine Penta acedic acid) test for Zinc,Iron, Manganese and Copper. *Soil Science Society American Proceedings* Vol 42, 1978. p. 421-428.
51. Sakal R. *et. al.* Evaluation of camical extractent for predicting response of wheat grown in pots to see in sub-Himalayan Soils. *Journal of Agricultural Science* Vol (3), 1983. p. 659-666.

Table 7.2

Mean values and ranges of PH, Organic matter, Nitrogen, phosphorus and potassium in Dry High region of North Sikkim.

Name of the area	No. of samples collected	pH		Organic Matter%		Nitrogen(N) kg./acres		Phosphorus (P_2O_5 ppm)		Potssium (K_2O ppm)	
		Mean Value	Range	Mean Value	Range	Mean Value	Range	Mean Value	Range	Mean Value	Range
Chopta	1	5.4	-	2.90	-	168	-	18.2	-	60	-
Lhonak region	12	6.47	5.7-8.9	7.51	4.00-9.38	210	91-301	33.45	13.0-50.7	368.33	225-480
Chho-Lhamo region	7	6.44	6.68-6.8	3.25	1.79-5.93	181	112-28	21.36	11.7-65.0	295.71	75-475

In lower Sikkim the high pH values of 6 and above was obtained after intensive application limie.[52]

The highest mean valus of organic matter that accounts for 7.51 percent was observed in the soil samples of Lhonak region with a range varying between 4.0 percent to 9.38 percent. In case of Chho-Lhamo region the mean value of organic matter is 3.25 percent with a range that varies between 1.79 percent to 5.93 percent. As far as Chopta is concerned the mean value of organic matter was found to be 2.90 percent. Switching over to the content of organic matter in the soil it could be infered that the value is worked out to be high in case of Lhonak and low in case of Chho-Lhamo and Chopta.

The highest mean value of nitrogen in Lhonak was found to be 210 kg. per acrea. The nitrogen content of soil of Lhonak region ranges between 91 kgs per acre to 301 per acre. The mean value of nitrogen in terms of kg. per acre for Chho-Lhamo region was found to be 181 kgs. per acre with a range varying between 112 kgs. per acre to 280 kgs. per acre. As far as Chopta is concerned the value is worked out to be 168 kgs. per acre. From the

52. Bhutia, D.T. *et.al.* Soil Bulletim on fertility status of the soils of Skkim. Gangtok, Sikkim;Depertment of Agriculture, 1986. p. 10-11.

above analysis of the avilability of nitrogen content in soils of various grazing lands in North Sikkim it could be concluded that the over all position of nitrogen in the soil of Dry High Zone of Sikkim is not satisfactory bearing a few isolated parts as the content of this important soil nutrient is considerably low.

In case of Phosphorus content the highest mean was observed for Lhonak i.e. 33.45 ppm. The next mean value of 21.36 ppm was recorded for Chho- Lhamo with a range of variation between 11.7 ppm to 65 ppm. As far as Chopta is concerned the phosphorus content in terms of mean value of 18.2 percent was observed. It could be therefore be concluded that the phosphorus content in the soil of dry high Sikkim appears to be high. The lowest level of potassium content i.e. 60 ppm in the soil was observed for Chopta region indicating a low content of this nutrient in the soil. The highest content of k_2o was observed in the soils of Lhonak 368.33 ppm with a range of variation from 225 ppm to 480 ppm. The potassium content of the soil of Chho-Lhamo was 295.71 ppm the values ranging from between 75 ppm to 475 ppm. Thus the potassium content is found to be low in case of Chopta and high for both Lhonak and Chho-Lhamo.

7.2.1.2. Micro-Nutrient content in the soil of Lhonak.

Trace elements or micro-nutrients in the soil have a direct bearing on the growth and productivity of the plants. With a view to knowing the status of the micronutrients in the soils of the study area, soil samples were collected and analyzed. The following picture emerged from the result of the analysis. A glance Table 7.3 reveals that thr mean value of copper content is found to be 0.23 ppm. The values renge between as low as 0.1 as high as 0.5 ppm which are above the critical level. The mean value of zinc was found to be 2.13 ppm within a range variation between

0.4 ppm to 8.00 ppm which are above the critical leavel of 1.00 oom. Similarly in case of iron the recorded mean value was 13.83 ppm with a range of variation between 8 ppm to 18 ppm. As far as the iron content of Lhonak grazing ground is concerned the same is above the critical level of 4.55 ppm.

Table 7.3

Mean value and Ranges variation of copper, iron, and zinc in the soil of Lhonak region.

Sl.No.	Micro-nutrients	Contents in PPM	
		Mean Value	Range
1.	Copper	0.23	0.1- 0.5
2.	Zinc	2.13	0.4 - 8.00
3.	Iron	13.83	8 - 18

7.2.2. Assessment of Management of Grazing Ground and Livestock Population of Lhonak and Chho Lhamo.

As indicated earlier the loss of traditional grazing facilities available in forest lands etc. in view of numerous environmental hazards in North Sikkim would result in serious over grazing of the extensive and actual grasslands. The areas under the present study incorporate the famous grazing grounds of Lhonak and Chho-Lhamo regions. The objective of the present study are as follows:

(i) To study the present management systems of the grazing grounds and the livestocks dependent on them.

(ii) To make an assessment of productivity of the present grassland of Lhonak and Chho-Lhamo regions in terms of soil capability, external land features e.g. natural shope, vulnerability to erosion etc. and the environmental conditions prevailing in the region.

7.2.2.1. MATERIALS AND METHODS

In order to study the present management system of the grazing ground and livestocks dependent on them, the farmers of Lhonak and Chho-Lhamo were interviewed by visiting all the migration routes and halting points during winter and summer. Thus the data and information on the present management system have been gathered through direct interview. Regearding the study of productivity of the present grassland of Lhonak and Chho-Lhamo a numeral method has been proposed and the details are described in chapter one.

7.2.2.2. RESULTS.

The details of the findings are discussed below:

(a) The traditional management system of grazing grounds and the livestock of Lhonak and Chho-Lhamo region.

The grazing grounds of Lhonak and Chho-Lhamo fall under Dry High Sikkim. The average precipitation in these regions is less than 500 mm. during summer months from April to September. However, heavy precipitation occurs in the form of snow during winter. The dry temperate climate of North Sikkim has resulted in scanty vegetation and these are found mostly in the form of dwarf scrubby bushes and tufts.

7.2.2.3. Geographical location of Lhonak and Chho-Lhamo.

Chho-Lhamo and Lhonak are situatated north of the Central Himalayan range and both of these valleys are characterized by reddish brown mounds and hillocks with broad undulating valleys. The Lhonak region which falls in the eastern region is separated from Chho-Lhamo region by a huge granite ridge culminating in Chhomo Yummo peak in the north. the only passage connecting these two valleys is Lunak la (5035 m 27° 54′ N 88° 31′ E) situated over the ridge.

The Lhonak valley is bounded in the west by Tonsong peak (7440 m a.s.l., 27° 53′ N 88° E), Lhonak peak Kanchanjunga (8598 m) etc. in the north by Chorten Nymala. Nakula and in the south by Zemu Glacier and finally in the east by Lunak La. Apart from areas under grazing grounds the Lhonak has about 50 important glaciers of various slopes and sizes along with a number of tributary glaciers. The largest glacier among them is Zemu glacier. These glaciers are very important soures of water for river Tista. Compared to Lhonak valley the Chho-Lhamo is easily accessible from Thanggu (3890 m 27° 53′ N 88° 34′ E) by road to its almost eastern boundery i. e. Pauhunri glacier (27° 55′ N 88° 45′ E) near Dongkya La (7128 m). The northern sector of Chho-Lhamo is bounded by Kongra La, Bamtso La, Say Say La etc. and in the south by Dongkya La. The traditional management systems of grazing grounds and the lvestocks of these two regions have been discussed separately.

7.2.2.3.1. Lhonak Region.

Lhonak is thus a completely seperate region and unlike other areas of North Sikkim this region does not depend on the

lower and adjacent areas for grazing livestocks though its dependence on Tibetan (Chinese) grazing grounds was closed ever since 1962. In order to reach this region one has to cross Lunak La which is situated at 5035 m. altitude and is considered as most difficult pass or La to cross over. There is a separate route by the side of Zemu river from Lachen but it does not remain open round the year owing to difficult terrain conditions.

As far as the field work for the present study is concened the route from Lunak La was taken by the author to reach Lhonak valley. The region was surveyed twice in summer and another attempt was also made to conduct field survey in the area during winter. However, owing to heavy snowfall and strong winds for hours together prevaling at Lunak La, it was not possible to reach the area the third time in winter was dropped. There is no motorable route approaching the area and the existing mode of transport in this part of Sikkim is either by yak or footmarch.

The data on livestock population and production of milk, meat, wool and other milk products were collected through direct interview with the farmers with the help of structured questionnairs and were later analysed the details of which have been discussed in Chapter 6 i.e. Livestock and Economy in north Sikkim. During the entire field survey the following observations concerning the feeding and migration system of the livestock were made at the farm level and the details are presented as follows:

(a). Winter Feeding systems at Lhonak High land.

Every year the farmers of Lhonak highland use to set aside a protion of good grassland which is not allowed to be grazied by the livestock. The grass is harvested in the month of July and

August every year which is preserved in the form of hay. It was also observed that one person collects 2 bags of grass well packed per day. The height of the grass varies between 6" to 7" that are to mixed species. Each bag weighing 15 to 20 kg.

7.2.2.3.2. Migration of livestock and grazing pattern.

The livestock farmers practics rotation of grazing system and the movement of the livestock fron one area to another is decided by the village headman who is known as Lhonak "Pepon". On enquiry from the present Pepon, it was gathered that the factors influencing the movement of the livestocks include the growth of grasses the advent of winter and monsoon seasons. The usual migration pattern is given is Table 7.4

Table - 7.4
Migration pattern in Lhonak Highland

Months	Areas and Activities
January/Feb.	Controlled grazing Tomboy Area.
March	Controled grazing Sherong Area.
Apr./May/June/ July/August	From April to August the grazing is decontrolled.
Sept./Oct.	Controlled grazing Nakpula area.
Nov./Dec.	Controlled grazing Khora area.

Table 7.4 shows that these highlanders of Lhonak have adopted an excellent management system based on rotational grazing system. Fron January to March, the grazing is controlled and the movement of the animals is monitored by the village headman. The headman who has no background knowledge of grasses pickes up the knowledge of the mobility of the animals and the availability of the pasture through experience only. According to him the livestock should not be allowed to traverse extensively in the pasture particularly during such timings when the growth of the grasses is not up to the mark in view of the fact that the livestock keepes walking in the grass lead to extensively that cause considerable damage to the grass species at an early stage. Therefore, controlled grazing is recommended by the headman within a given area till the pasture is utilized to an optimum level without any destructions to the grasslands. Then the herds are allowed to be feed in the next pasture. From April to August the rain brings moisture to the soil and the grasses grow in plenty. The rotational grazing is decontrolled and the herdsman are left to themselves. The grazing and the movement of the animals are controlled from the month of September onwards. The unique system of rotational grazing which is in operation in North Sikkim should be preserved as far as possible as it is a eco-friendly proposition. The main problems of the farmers are that their stock strength is governed by the availability of hay and feed during winter as most of the area remains snow coverd. According to the farmers of Lhoank the yaks during winter consume the grass roots by licking the ground. This could be one of the reasons as to why yaks survive in such difficult areas of north Sikkim. But cattles cannot graze on the grasses shorter than half an inch.

7.2.2.3.3. Chho-Lhamo Grazing ground.

Chho-Lhamo lies in the shadow of Dongkhia mountains. The entire valley is almost flat bearing certain portions which seem slightly undulating. The flat area around Mount Kanchengyo with grasslands for yak and sheep grazing on the fringes of the mountain is one of the most remarkable landscapes in the world. The feeding and management system for livestock adopted in this area is very similar to that of the Lhonak region. The details of the migration routes area of grazing and different livestock management activities adopted in this region are enumerated in table 7.5

Table 7.5

Livestock Migration and Management practices adopted in Chho-Lhamo (North Sikkim)

Sikkimese month	Coresponding English month	Area	Livestock	Activities
1.	February	Chora Below Gurudongmar	sheep	Lambing
2.	March	Phago	sheep	Lambing
3.	April	Donkung	-	-
4.	May	Lasher area	Reno (yak)	Calving
5.	June	Lasher area	claving of Reno (yak)	
6.	July	Lasher area	1. shearing of sheep 2. servicing of Reno	
7.	August	Donkung	servicing of Reno (yak)	
8.	September	Donkung	servicing of sheep	
9.	October	Donkung		
10.	November	Donkung	slaughter of livestock	
11	December	Chho-Lhamo		
12.	January	Chho-Lhamo		

The yaks and sheep are wintered in the Chho-Lhamo lake areas near Kerang. In the month of February the animals are moved to Chora below Gurudongmar where sheep lambing starts. In March they are moved to Phago and in April to Donkung. From May to July the animals are kept at Donkung which fall in the Chho-Lhamo area. The slaughtering of the animal in Lhonak area, Lachen and at Lachung is done once a year i. e. on the 10th of Sikkimese month which coincides with the english month of November. This looks again another positives aspect as far as the mobility of the animals are concerned when they are culled before the winter so that unecessary feeding during the scarcity winter days is saved. The meat is also saved as storing meat in winter months is not a problem. It would neither be spoilt nor would it be resorted to distress selling. the deried meat yak of sheep is considered as prized meat of meat of luxury by the Indian Sikkimese living down the vallley and it is believed that the meat also has medicinal values. The old people are generally fed on such meat which would particularly cure their body ache and their tooth ache problems. The meat in general contains more fat than that of the same animals reared in the low lands.

7.2.3. Assessment of the productivity of Lhonak and Chho-Lhamo grassland regions.

Before going into the details of the productivity of grassland in the study area it is imperative to understand and establish relationship between animals, plants and microbes present in the soil. The livestocks have been evolved as for future planning and development of this important and resourceful sector.The three important productivity parameters which exert their influence directly or indirectly have been identified as mentioned in chapter one. The importance and the justification of

the inclusion of the above parameters in the analysis are discussed below.

(a). Soil Capability:

Fertility of soil is considered to be very essential for the growth of plants ad grasses. Similarly soil reaction in terms of ph values is very curical for the growth of legumes and fixation of atomsheric nitrogen in the soil. Hence ph and fertility of the soil are the important aspects of soil analysis and therefore the values representing these parameters have to be determined prior to going in for the gradation of the grasslands.

(b). Study of external land feature eg. natural slope, vulnerability to erosion, vegetation and grass cover which are inevitable components of the vast eco-system of the universe which is make up of various biotic components. In short the plants convert solar energy into various energy rich nutrients through a process known as photosyntheiss. These nutrients are utilized by the livestocks for their growth and production. The animal excreta (dung and urene), animal carcasses etc. are ultimately returned to the earth where the microbes break down these organic forms into inoranic substances to be later utilized for the bio-recycling process. The nature has established this unique "bio- recycling" "Food Chain" process where the plants are the Bio-synthesizers,animals bio-utilizers and microbes as bio-degraders. Keeping the above discourse in view the present exercies is a modest atempt to assess the grazing grounds of north Sikkim in terms of their bio- physical characteristics. Grazing lands beings the important components of livestock farming, the biotic components present in the soil need to be studied intensively are considered to be importent factors that are to be taken in consideration while grading a grazing ground. In steep moun-

tain slopes the livestock usually suffer from broken limbs and death are reported in many cases. Hence if the area is too steep it is normally not recommended for livestock farming. Secondly, vulnerability to erosion has to be taken into consideration while assessing the grassland because the above phenomenon might further disturb the grassland thereby leading to an environmental degradations. Finally the study of vegetation resources is also essential as it supports the life of the animals. The capacity of a grazing ground to support livestock depends not on the quantity of forage it produces but also on the to a large extent quality or the nutritional value of the vegetation.

(c). Environmental conditions affects an animals productivity through its influence on the over all physiology of the animal. If the environmental conditions are favourable than the productivity of grasses and livestock would step up. Water has been regarded as the greatest limiting factor in livestock farming. Hence, therefore the availability of water and its types of sources and the distance of its availability are important factors to be incorporated while assssing the conditions of grazing land. The natural soil and drainage of the grazing ground would also affect the growth of plants and the animals grazing in the area. The boggy areas are not suitable for plant growth. Many livestock disease carrier parasites harbour in such areas.

All the above parameters thus contribute significantly towards the productivity of the grazing ground and finally help to determine the clasess of a grazing land. Thus four classes of grazing grounds or grass lands have been proposed in chapter one (Table 1.4.). After studying the grazing grounds, soil and climatic factors numerical scores have been alloted to the grazing grounds of Lhonak and Chho-Lhamo. The details are persented in Table 7.6

Table 7.6

ASSESSMENT OF GRASSLAND RESOURCES IN NORTH SIKKIM

Parameters	In Lhonak		Chho-Lhamo Area	
	Muguthang	Chho-Lhamo	Kerang	Gurudongmar
Natural slope of land	5	8	8	6
Vulnerability to erosion	4	3	3	2
Climatic Conditions	4	3	3	2
Soil fertility	7	6	7	6
Soil reaction	8	7	7	6
Natural soil drainage	5	5	3	6
Water availability	8	7	9	7
Total	41	39	40	35

Total points being below 44, the above two region are grouped under class 111 grade of grasslands (Table 1.4). On the basis of the scores alloted it could be infered that the area is suitable for perenial grasses and leguminous plants with sustainable soil conditions. The area has two limiting fators i. e. extreme climate owing to high altitude and the vulnerability of the area to wind and snow erosion. Therefore the soil should not be disturbed especially during the winter months as the loose soil would be carried out by the wind. There are also wild animals such as mountain hair and mouse like creatures that

cause considerable harm to the grassland environment.

7.2.3.1. Analysis of Micro-Nutrients in Grass and Fodder Sample.

Considerable work has been done on chemical analysis of macronutrients and yields of many fodder trees, grasses and other fodder species of Sikkim including north Sikkim by Paljor (1978). Balaram (1981), Sinha *et al* (1981) and Balaram & Golay 1991. However, analysis of trace elements in grasses and fodder species have not been reported from north Sikkim so far and is probably yet to be attempted. Therefore a modest attempt has been made in this regard to analyse the trace elements present in the grasses and fodder species found in north Sikkim through a sample survey. Thus as many as twelve sample of grasses and fodder species were collected from different areas and later analysed for trace elements namely copper, zinc and iron.

7.2.3.1.1. MATERIALS AND METHODS

As has been said earlier the grass and fodder samples were collected from areas of varying altitudes such as Chho-Lhamo (5200 m), Donkbung (5000 m), Kerang i (5250 m), Zemu (3050 m), zine, copper and iron were analysised from the triacid extract following the standerd procedure of Lindsay and Nor well (1967) with the help of atomic absorption specto- photometer at Agricultural soil testing Lab. Tadong (East Sikkim).

7.2.3.1.2. RESULTS AND DISCUSSION

In utilization of iron for the formation of haemoglobin in livestock, copper plays an important role. Similarly zinc starvation manifests itself in several noticeable symptoms such

as retardation of growth, delayed sexual maturity, high mortality rates, reduced production of milk etc. in animals[53]. These elements are reiquired by livestock in traces. The content of zinc, iron and copper in the aforesaid samples of grasses and fodder species samples ranges from 0.2 to 0.3 ppm and there is no spatial variation within samples. It is reported that animals on diets of forage or pasture containing 5 or more ppm of copper do not suffer from copper dificiency. Serious disease is likely to occur when the forage or pasture contains 1 to 3 ppm. of copper[54]. Hence copper content in the grass and fodder samples are low and it needs to be corrected.

In case of zine cotent it is observed that the same ranges from o.5 ppm to 1.66 ppm for *Cyperaceus* and *Lolium pereenne multiflorum* respectively. The zinc content is more in plants of the lower areas than that of high altitude plants. In *Trifolium subterraneum* clover zinc content of 15 ppm, showed deficiency symptoms and the same was corrected when the level was raised to 39 ppm.[55] The highest iron contest of 13.5 ppm is recorded in cultivated exotic introduced grass i.e. *Lalium perenne multifloxum* var. Dalte at Rubum A.H. farm (1829m). However, the iron content of the same plant grown at an elevation of 3049 m. at Zemu was only 1.4 ppm. The iron content in other plants ranges from 0.5 ppm to 3.7 ppm. Iron content of intermediate range between 3.00 to 9.00 ppm was recorded in leaves of Alfalfa (*Medicago sativa*)alongwith the high range of 13 to 52 ppm in the same plant[56].

53. Morrison, F.B. Minerals in livestock feeding in (Feeds & Feeding, New Delhi CBS publishers and Distributors, 1984. p.102-136)
54. Reuther, W.and Lafanausks, K.C. Copper. In (Chapman, H.D. ed Diagnostic Criteria for plants and Soils. New Delhi, Eurasia Publishing House, 1975. p. 157-179)
55. Riceman, D.S. and G.B. Jones - Distribution of dry weight and of zinc and copper among the indidual leaves of seedlings of subterranean clover (Trifolium subterraneum) grown in a complete culture soiution and in a culture solution deficient in zinc. Australian Journal of Agricultural Research. Vol.9, 1958. p. 446-463.
56. Brewer, R.F. cited by Chapman H.D. Tissue Analysis values useful in indigating NUtrient Status. In (Chapman, H.D. ed. Diagnostic Giteria for plants and Soils. New Delhi, Eurasia Publishing Mouse, 1975. p. 570-728).

Table - 7.7

PLANT MICRO NUTRIENT LEVEL ANALYSIS REPORT OF NORTH SIKKIM

SI No.	Name of the plant	Area & altitude of collection	Micronutrient level ppm copper	Zine	Iron
1.	*Triseotum spicatum*	Chho-Lhamo 5200m.	0.3	0.9	3.1
2.	*Cyperacens*	Chho-Lhamo 5200m.	0.2	0.5	3.7
3.	*Poa* spp.	Chho-Lhamo Lake area 5200m.	0.2	0.8	0.5
4.	*Poa* spp.	Chho-Lhamo area 5200m	0.2	0.8	0.5
5.	*Elymus nutans*	Kerang I Chho-Lhamo 5000m	0.3	0.7	0.8
6.	*Urtica dioca*	Donkung Chho-Lhamo 5000m	0.2	0.8	2.1
7.	*Miscanthus nudipus*	Zemu 3050 m	0.3	0.8	2.1
8.	*Roscoea purpurea Var. auriculata*	-do-	0.2	1.0	0.9
9.	*Lolium perenne multi-florum var. auriculata*	-do-	0.3	1.6	1.6
10.	*Trifolium* spp. (White clover)	-do-	0.3	1.0	0.9
11.	*Trifolium* spp red or white clover mix	Rabum 1830 m	0.3	0.8	0.1
12.	*Lolium perenne multifilorum* var delta	-do-	0.2	1.4	13.5

7.2.4. Study of Vegetation, Grasses, Fodder Trees and Poisonous Plants.

An modest attempt has been made to Study the role of vegetation, grasses, fodder trees, tree fodder, poisonous plants and performance of exotic grasses legumes in the environment of North Sikkim. The important of soil and plant sustaining the livestock farming system has been highlighted in chapter III. However, with the general soil destructive agricultural farming practices adopted in Sikkim, tons and tons of fertile soil is beeing eroded to the plains.

It is estimated that 19 million tones of soil is lost annually as a result fo shifting cultivation in an area of 3865 thousand hectares in north states. This loss of top soil results in heavy loss of plant nutrients amounting to 10.3 million of organic matter[57]. The problem of soil erosion has now reached an alarming situation especially in the North Eastern Himalayas as the steep areas are being converted into crop land on account of increasing population pressure. Here again livestock farming has got a significant role to play.

It has been demonstrated that by planting livestock fodder namely vetiver grass, the rainfall runoff would be reduced from 40 per cent to 15 percent and silt losses could be reduced from 15 tonnes per hectare to 6 tonnes per hectare [47]. The conversion of forest land to pasture land for the production of fodder serves as natural sinks for carbon-dioxide. The leguminous fodder crops grown alongwith the grasses in the pasture lands are capable of fixing atomoshere nitrogen in the soil, thus reducing the requirement of nitrogenous fertilizer and further reducing the emmission of nitrous oxide in the atmosphere. Besides their direct economic value in terms of fodder, fuelwood and other prod-

57. Indian Council of Agricultural Research. Soils Erosion Calander. Shillong, 1990.

ucts, a sufficient number of fooder trees in the farmland would have the following ecological effects [58].

(a). Conservation of top soil from erosion by binding the soil and acting as windbreaks.
(b). Retention of moisture in the terraces due to increased permeability of water into the soil.
(c). Provide shade against excessive soil temperature during the warm, relatively moist pre-and post monsoon periods, thus preventing excessive oxidation of organic matter.

To emphasize the above points the following field studies were carried out in North Sikkim.

(i). To study vegetation of Chho-Lhamo, Chopta and Lachen grazing ground.
(ii). To study the existing grasses, fodder trees and tree fodder recorded at different altitude in North Sikkim.
(iii). To study the poisonous plants in the environment of North Sikkim,
(iv). Evaluation of exotic grasses and legumes in the environment of North Sikkim.

7.2.4.1. Vegetation of Chho-Lhamo, Chopta and Lachen grazing ground.

The Grazing ground of Chho-Lhamo, Chopta and Lachen areas were extensively surveyed and besides the study of soil, and plants, grasses were also collected and their botanical names were identified at the Botanical Survey office at Gangtok. The names of the plants identified area-wise are presented below.

58. Panday K.K. Fodder Trees and Tree Fodder in Nepal, Switzerland. Swiss Devlopment Co operation and Swiss Federal Institute of Forestry Research. 1982. p. 48-52.

7.2.4.1.1. Region-Chho Lhamo-specific location - Gurudongmar lake.

In the Gurdongmar lake area the common and dominant plant species include *Elymus nutans* and *Poa poophagorum* among the grasses and *Deliphirum nepalense*, *Anaphalis triplinervis* and *Astragalus sp.* among the other plants. The name of the plants identified in Gurudongmar lake area are as follows:

1. *Anaphalis triplinervis*
2. *Astragalus sp.*
3. *Asteraceae sp.*
4. *Allium sikkimensis*
5. *Artimesia sp.*
6. *Dracacephalum haterophyllum*
7. *Delphinum nepalense*
8. *Elymus nutans*
9. *Festuca avine*
10. *Kabresia schoenoides*
11. *Meconopsis horridula*
12. *Poa poophagorum*
13. *Poa sp.*
14. *Potentilla Sp.*

7.2.4.1.2. Chho-Lhamo lake area.

In the Chho-Lhamo lake area the dominant species among the grasses are *Trisetum spectum* and *Carex astrofusca.*

1. *Anaphalis sp.*
2. *Asteraceae sp.*
3. *Allium sikkimensis*
4. *Bistorta amplexicanle*
5. *Carex astrofusca*
6. *Cortea hookeri*
7. *Delphenium nepalense*
8. *Kobresia sp.*
9. *Poa sp.*
10. *Saussuria yakla*
11. *Trisetum specatum.*

7.2.4.1.3. Chopta (Upper Thanggu) Moist area.

In the Chopta grazing ground area the plants identified are as follows:

1. *Anaphalis contorta*
2. *Anaphalis*
3. *Agrostis canena*
4. *Bistorta macrophylla*
5. *Cynoglossum glochidiatum*
6. *Cyperus sp.*
7. *Erigeron sp.*
8. *Gentiana sp.*
9. *Kobresa pygmaea*
10. *Leonotopodium jacotianum*
11. *Pleurospermum sp.*
12. *Potentilla mooniana*
13. *Pedicularis sp.*
14. *Ranunculus hirtatus*
15. *Rumex nepaleusis*
16. *Rubus splendidissimus*
17. *Senecio chrysanthemoides*
18. *Selinium tenuifolium*
19. *Senecis sp.*
20. *Trisetum flavescens*

7.2.4.1.4. Lachen Area

The dominant plants found in the Lachen grazing grounds were collected and identified in the Botanical Survey of India office at Gangtok as indicated earlier. The plants identified are as follows:

1. *Aconogonum malle*
2. *Anaphales contorta*
3. *Artimisia nilagirica*
4. *Carex filicina*
5. *Carex pulchrra*
6. *Calamagrostis emodensis*
7. *Fimbristyles schaenoides*
8. *Isachne albens*
9. *Miscanthus nudipes*
10. *Pycrens sanguinolentus*
11. *Roscoea purpurea var auriculata.*

It was found that the above two important plant species that is *Miscanthus nudipus* and *Roscoea purpurea* are cut and dried in form of hay for winter feeding of yak and other livestock.

7.2.4.2. Grasses and Fodder Trees

North Sikkim is rich in variety of numerous, legumes and fodder trees, In this field numerous works have recorded and identified the different genera and species of grasses, legumes and fodder trees at different altitudes in north Sikkim. The details have been extensively reviewed in Chapter 2. In this section all the findings have beem complied and two lists are prepared i.e. for fodder and grasses. A list of tree fodder and fodder shrubs are presented in Appendix XIV. Similarly a list of grasses of North Sikkim are presented in Appendix XV and Appendix XVI. They are mostly prized grasses that are commercially cultivated in European countries and in New Zealand. In Sikkim these grasses are considered valuable as nutrions fodder for domestic animals and are used as green fodder and in the form of hay. In view of quality of these grasses as nutritions fodder adequate protection of these grass species for further research for commercial exploitation in terms of higher productivity is needed. As for instance a variety of grass known as *Hierochloe redolance* found in New Zealand have higher photosynthetic efficiencies than other grasses. In Sikkim similar grasses known as *Hierochloc Hookeri* which are considered very useful fodder for livestock. similarly there is a grass known as *Cythopus Sikkimensis* in Sikkim. This grass was discovered by Sir J. D. Hooker way back in 1847 in Lachung valley. However, according to Botanical Survey carried out by the Gangtok branch of the botanical survey of India, this species was not found in Lachung but could be traced at Changu situated in East Sikkim.

PRECAUTION

Amongst the aforesaid grasses, there are some varieties if fed to the livestocks might cause problems which may be even

fatal in some cases. For example a local gross known as "gongring" found in te sub-tropical zone below 1200 m. altitude the botanical nomenclature being *Saccharum spontaneum* when fed to the livestock causes instant death. This is largely due to Hydrocyic content in the plant (HCN). It has however been observed that this same species of grass has not carried any risk of poisoning effect when kept over night after cutting.

In the higher regions of North Sikkim the seeds of *Stip* a species frequently observed to have bored into the skin and intestines of the animals especially sheep causing fatal inflammatum and peritonites. Similarly horses fed on the straw of *Avena sativa* had developed phytobezoars (hair balls) in their stomach. This harmful development in the stomach of horses is induced by the hay of *Avena sativa.* In Sikkim particularly in the dry high zone, death due to grass poisoning is very rare and there is no evidence of such occurrence what so ever. However the animals have developed problems while grazing in the lower elevations particularly during the summer months.

7.2.4.3. Poisonous plants of North Sikkim.

Protecting the domestic animals from poisonous plants is a major conern of the farmers of north Sikkim. Sir J.D. Hooker way back in 1847 reported death of livestock by consuming poisonous plants in north Sikkim. I.C.A.R. (1965) has published a complete outline of the botanical, chemical, pharmocological and economic aspects of over 110 genera of poisonous plants belonging to 34 families[59]. A list of important poisonous plants of North Sikkim are presented in this chapter along with the details of the parts of the plants that are poisonous to livestock. It may be seen that a poisonous plant known as *Taxus baccata* causes instant death to the goats on consumption of the leaves. How-

59. Chopra, R.N. and others. Poisonous Plants of India. In (Kurup C.G.R et. al. eds. Poisonous Plants of India, New Delhi. Indian Council of Agricultural Research, Vol 2, 1965. p. 972.).

ever the same plant is being used for treating overian Cancer[60]. In north sikkim author came across a plant known *Coriaria* genus and according to the farmers of north Sikkim the plant is poisonous to sheep and cattle and the goats are able to eat it without any ill effect. The same plant is found in New Zealand upto an elevation of 1067 m and takes a toll of 5 to 10 per cent of livestock every year form tutu poisioning[61]. A toxic substance known as tutin was isolated from five New Zealand species of Corearia and from *Coriaria terminolis* of Tibet [62]. In New Zealand no antidotes were available and the farmers usually save the animals by cutting ears, facial veins or nose to make them bleed. However, the farmers control the spread of this plant by herbicides spray with a helicopter and the cost is subsidized by the New Zealand government.

60 Rai;L.and Sharma, E. Medicinal Plants of the Sikkim Himalays. Dehra Dun Govind Ballabh Pant Institute of Himalayan Environment and Development, No.5. 1994. p.152.

62. Huges, J.G. et. al. Beef Cattle on Tussock Country. In (Runga J.ed. Lincoln Popers in Resource Management No. 1. Canterbury (Newzealand). Lincoln College Press, 1971. p. 63-66.

62. Lowe, M.D. and White, E.P. Tutin in Coriaria Species, identification and estimation. New Zealand Journal of Sciance Vol. 15 (3) 1972 p. 303-307.

LIST OF POISONOUS PLANTS OF NORTH SIKKIM

The poisonous plants of north Sikkim other than that of grasses are given below:

Sl.No.	Name of the plant	Area & elevation	Remarks
1.	*Aconitum laciniatum*	Zemu 11000ft.	Intake of roots is fatal (stimulating and paralysing the sensory nerves and depressing activity of perepheral termination of the nervous system.
2.	*Aconitum specatum*	High altitude of north Sikim	Intake of root is fatal. The name of the alkaloid is bikhoconitne. The action is same *A. laciniatum*.
3.	*Andromeda elliptica*	Low alt. of North Sikkim	Intake of plant leaves causes instant death in case of goats.
4.	*Artemisia vulgaries*	Tista valley to Lachen & Lachung valley	Intake of leaves and flowers are poisonous except to the goats.
5.	*Arisaema tortuosum*	Tong 4000 to 50000 n ft.	Both corns & plants are acrid.
6.	*Buddleae*		ICAR (1981) have recorded it as poisonous plants.However in north Sikkim only three species are found: 1.*B.asuatica* 2. *B. Colvillei* 3. *B. macrostrechya*

7. *Clemates* spp.	North Sikkim	Three species are reorded under the genera in north Sikkim. The leaves are siad to be poisonous.
8. *Coriaria nepalensis*	Lachen & Lachen 9000ft.	The young short and leaves are poisonous which causes instant death. The genera is similar to that of New Zealand *Coriaria* where it is considered as poisonous.
9. *Cuscuta reflexa*	Lachen 8000 ft.	The plant is poisinius and causes abortion females animals.
10. *Euphorbia* spp:	Lachen & Lachung Zemu 10000 ft.	The latex is injurious to eyes of the animals including man.
11. *Laportea* spp.	Lachen Lachung 8000 ft.	Contact with the plant causes dermatites and acute burning sensation.
12.*Pieres fromosa*	Charten 8000 ft. Lachung 10000 ft Tundhay 12000 ft.	Intake of leaves causes swelling in the neck and animal dies within 24 hours.
13. *Pieres avalifolia*	Tsungthang	Poisonous especially for the Goats and Sheep.

14. *Pieres villosa*	Lachung 10000 ft.	Do-
15. *Ribesgta ciale*	N. Sikkim mid altitude	Intake of planat causes instant death.
16. *Pteridium aquilina*	Lower area	Intake of the plant causes sore on the tongue of the animal.
17.*Ranunculus* spp.	North Sikkim mid altitude	Contact with the plant causes blisters on the skin.
18. *Rhododendrum griffithianum*	North Sikkim	Poisonous
19. *Senecio* spp.	North Sikkim high altitude	There are 17 species recorded. The alkaloid is not affected by drying or storage. The animal after taking the leaves loses weight, the liver is destroyed and recovoery is impossible.
20. *Trichosanthes* Spp.	Teesta valley 4500 ft.	Root has violent purgative properties.
21. *Taxus baccata*	2500 to 3500	Leaves are poisonous especially to the goats.
22. *Zanthokylum* spp.		The stem, roots and bark are poisonous.

7.2.5. Trials of various strains of Grasses and legumesat Rabum A.H. farm North Sikkim.

An important feature of plants suitable for introduction in the mountains in Sikkim is the ability to grow at low temperatures. Such plants must also be
able to withstand mechanical effects of continual freezing and thawing during the establishment period.

7.2.5.1. MATERIALS AND METHODS

The aim of the trial was to evaluate the performance of the prized temperate grasses and legumes in the climate of North Sikkim. These grasses and legumes are very popular and widely grown in the pasture lands of U. K. , Australia and New Zealand. The following varieties of grasses and 5 varieties of Legumes were sown at Rabum. A.H. farm in North Sikkim. The area falls under continental Sikkim.

GRASSES

1. *Lolium multiflorum*, 4N variety Billiken
2. *Dactylis glomerata*, varety Frontier
3. *Phleuma pratense*, variety Barvanti.
4. *Festuca arundinacea*, variety Sodar Streambank.
5. *Agropyron riparium*, variety Sodar Streambank.
6. *Lolium perenne multiflorum*, variety Dalita.
7. *Festuca avena*, variety MX-86.
8. *Phalaris aquatica*, variety Sirosa
9. *Bromus inermis*, variety Manchar.
10. *Paspalum dilatatum*, variety Jiri
11. *Festuca rubra commutata*, variety Barnica

LEGUMES

1. *Trifolium subterraneum*, variety Dalbeith
2. *Trifolium resupinatum*, variety Kyambro
3. *Medicage satica*, variety Resis
4. *Trifolium repens*, variety Alban.

The above grasses and legumes were sown in 4 lines of 1 sq. m. (Plot size of 1 metre by 1 metre) each on random selection. The plants were supplied and sown under the technical guidance of Himalayan Pasture and Fodder Research Network, Krishi Bhawan, New Delhi. The dates of germination were recorded and the germinated plants were left to pass the winter and various monthly records of the plant density, height and effect of frost were recorded. The legumes were innoculated with their respective matching strains of Rhizobium. to facilitate their nitrogen fixing ability.

7.2.5.2. RESULTS

The results of the trials are divided into three groups i.e. germination, plant growth and vigour and green fodder production.

Germination.

Out of the 11 grasses and 4 legumes sown, only three varieties of grasses and two varieties of liyumes were found to be germinated. The germination of the other varieities were very poor and discarded.

Varieties	No. of days teken for Germination
Grasses	
1. *Lolium multiforum* var Billibeni	5 days
2. *Lolium perenne multiflorum* var. Dalita	5 days
3. *Phalaria aquatica* var. Sirosa.	10 days
Legumes	
1. *Trifolium repense* var Alban	5 days
2. *Trifolium resupinatum* var. Kymboo	7 Months & 2 days.

Quick germination of the grasses and legumes under harsh climatic conditions of the north Sikkim is a big and added advantage. Hence based on the ability to germinate fast the following grades have been given.

A. Grasses

1. *Lolium multiflorum* var. Billibani	"A"
2. *Lolium derene multiflorum* var Dalta	"A"
3. *Phalaris aquatica* var. sieoca	"B"
1. *Trifolium repense* var. Alban	"A"
2. *Trifolium resupinatum.*	"D" rejected

The above plants did not show any change in colour nor burning of leaves during winter. The other plants were unable to survive the winter cold temperature and frost.

PLANT HELGHT, DENSITY AND YIELD.

The result details of the plant hight in cm., plant density per square metre and yield per square metre in kgs. along with the overall ratings of the grasses and legumes are presented in Table 7.8.

Table 7.8

The average plant height, density per sq. m. and green yield per sq. m. is kg.

Plant Species overal	Plant height in cm.	Plant density sq. m.	yield in by Kg per sq. m.	Overall rating
Grasses				
1. *Lolium mulliflorum* Var Billibeni	42.25	3600	4.25	B
2. *Lolium perenne* multiflorum Var. Dalita	43.75	2400	14.20	A
3. *Phalaris aquatica* Var Sirosa Legumes	35.50	1800	5.10	B
1.*Trifolium repens*	10.75	7000	4.25	B

The maximum yield per sq. metre was obtained from *Lolium perenne multiflorum* Var Dalta and the yeild from orther grasses and legume were more or less equal. The *Lolium peranne multiflorum var,* Dalita is now being extensively multiplied (Plate 24 and 25) in North Sikkim.

7.2.6. Land Holding and Cattle Population.

With the growing human population, rotational and optimum utilization of resources is the need of the hour in the present day world. As land is deemed as the most precious resource, its utilization particularly in hills unlike plains areas has to be rational and judicious as nonavailability of flat fertile land in the hills is comparatively less. As human number keeps grow

Plate 24. Hybrid Rey grass grown extensively for seed production at Rabum Animal Husbandry Farm (North Sikkim).

Plate 25. An excellent Rye grass and white clover stand at Rabum Animal Husbandry Farm (North Sikkim).

ing there is a subsequent demand for more fertile agricultural land to meet the growing food requirement. Besides livestock forms an important component in the whole process of production of food and utilization of other agricultural raw materials. As such animals have to be properly fed, the pressure on land thereby proportionately increases with increase in family size. Secondly the pressure that is exerted on the land is for feeding more livestock. The demand of animal protein increases with corresponding increase in family size a phenomenon which is responsible for an increase in livestock population the subsequent pressure on land for increased fodder. As per the sample survey conducted on the size of holding it may be seen from the Appendix XVII. that in the Dry High Zone, 100 percent of the people are found to be landless as the land belong to forest department. In the continental upper zone out of 240 households surveyed 5.83% farmers are landless, 63.75% farmers have land below one hectare, 19.58% of the farmers have 1-2 hectare land below only and 8.33% of the household have 2-4 hectares and 2.50% of the farmers have land between 4-10 hectares.

In the sub-tropical zone 12.93% of the farmers are landless, 17.41% of the farmers have land below one hectare, 25.13% have lnad between 1- 2 hectare 24.06% have land between 2-4 hectare, 16.34% have land between 4-10 hectare and 4.13% have and above 10 hectare. The distribution of land holdings in respect to the households of sub-tropical regions seems to be much better than that of the continental zone. As regards the distributions of yak holdings, in the dry high zones only 3.33% of the houselands have yaks between 9-12 and the rest i.e. 96.67% have yaks above 13 para. In the continental zone 30% of the farmers have cattle in the rang of 5-8 followed by 23.75% having 2-4 cattle heads, next 16.25% having cattle heads above 13, and 10.83% of the households do not have any cattle and so

on (Appendix XVIII). In the sub-tropical humid zone as much as 49.37 percent of houselands have cattle ranging between 2-4 followed by 22.62% having 5-8 cattles. As low as 11.49% have only and cattle each. Similarly 10.77 percent houseland have no cattle at all. However, there are 1.62% of the houselands who have cattle heads over 13 nos.

The relationship between cattle holding size and the land holdings have been compiled for two zones i.e. continental zone, and sub-tropical humid zone. In the continental zone the maximum households owning livestock are the farmers having one hectare. and above landed property i.e. the marginal farmers. It may be seen from the Table 7.9 that 48 households having a hectre of land each posses 5.8 cattle holdings and 18 households have cattle population generally above in numbers. Similarly, there are 13 households who rear cattles varying between 1 to 13 are landless. From the above analysis it could be infered that the farmers of continental zone depend increasingly forest pastures than their own land holdings.

Table 7.9

Distribution of household in relation with land and cattle holdings in Continental Upper zone.

	CATTLE HOLDING UNIT						
	0	One	2-4	5-8	9-12	Above 13	Total
0 Hect	1	3	7	2	0	1	14
1 Hect	20	5	41	48	21	18	153
1 to 2 Hect.	3	5	6	11	7	15	47
2 to 4 Hect.	2	-	2	8	3	5	20
4 to 10 Hect.	0	0	1	3	2	0	6
10 Hect. & above	-	-	-	-	-	-	-
Total	26	13	57	72	33	39	240

In case of sub-tropical zone it may be seen from the Table 7.10 that 80 households with it 2 hect. of land own 2-4 cattle heads each and 70 households with 2-4 hect. of land own 2-4 hect. of land. This is withen the animal carrying capacity of the land as one hectre of land can carry 2-5 cattle heads without destroying the grazing grounds. However there are 50 house holds having 2-12 cattle heads each . But such households are supposedly land less and depend exclusively on the forest grazing ground. In terms of perctage they constitute only 8.98 percent of the total.

Table 7.10

Distribution of household in relation with land and cattle holding in sub-tropical zone of North Sikkim.

CATTLE HOLDING UNIT

	0	One	2-4	5-8	9-12	Above 13	Total
0 Hect.	29	10	27	5	1	-	72
1 Hect. & above	9	14	57	14	2	1	97
1 to 2 Hect.	13	22	80	19	3	3	140
2 to 4 Hect.	5	11	70	41	7	-	134
4 to 10 Hect.	4	6	32	38	7	4	91
10 Hect. & above	-	1	9	9	3	1	23
Total	60	64	275	126	23	9	557

7.2.7. ENVIRONMENTAL AWARENESS

As many as 797 houselands were qustioned as to whether the elimination of trees would harm our environment. The answer and the source of the information for each respondent household were recorded. The result indicated that 520 farmers consisting 65.25 of the total respondents are aware that the cutting down of the trees would harm our environment. The percentage of the farmers with various sources of informations is given below.

(a). Radio	32.12%	(c). Parents	14.23
(b). T.V.	15.58%	(d).Other Source	38.08

Likewise the farmers were asked to indicate whether the milk and meat are carrier of diseases or not. It is interesting to note that as much as 8% of the farmers were aware of the fact that milk is a carrier of various diseases and a stagering 92% of the farmers were ignorant of this fact. When asked whether meat is a carrier of various diseases as high as 68 percent of the farmers were found to be ignorant of the fact where as only 22 percent of the households were aware.

Chapter VIII

Conclusion

8.1. Findings and discussion.

The present study is a modest attempt to analyse the economics of livestock production and its impact on the environment of North Sikkim. North Sikkim i.e. the northern part of the Sikkim State and a formidable mountainous tract is an important segment of the entire Eastern Himalayan ecosystem. Physiographicaly the region is a distinct unit and covers as much as 60 percent of the total land surface of the state. The most conspicuous features of landuse in North Sikkim are that the area under forest and pastures constitutes of more than 50 percent of the total geographical area. In addition, the alpine barren land accounting for another 15.37 percent of the total land surface remains perennially open for sheep and goat grazing. Land under cultivation being quite insignificant largely due to rugged topography and inhospitable terrain, the entire North Sikkim is a potential ground for livestock development in view of its typically extreme climate that stands favorable for certain specific varieties of livestocks. In areas like Chho Lhamo and Lhonak etc. in the study area, it has been ascertained that extensive grazing lands are being damaged gradually thereby affecting the growth of the grasses particularly, in view of weathering of rocks of Chho Lhamo and other series and wind induced spreading out of small stones.

The three distinct climatic zones such as humid zone, middle uper zone and upper zone being characteristically diffrent from each other have all necessary coditions for the growth and developement of different kinds of livestocks. The

soils of the region being mainly characterized by pH values of varying degree high organic matter, low cation exchange capacity and high lime requriments have a depth normally ranging between 60 cm. to 90 cm.

The three distinct physical landscapes that could be identified incorporte the elevated dry area of Chho-Lhamo and Lhonak, V shaped valley of Lachen and Lachung and the V shaped valleys of Dzongu and Kabi etc. The whole of North Sikkim falls on the upper catchment of the river Tista.

As livestock forms an important component of the economy of North Sikkim, the objective of the study has been primarily to asses the status of livestock farming in the region,in terms of livestock population, economics of production and the cummulative impact of the various activities concerning livestock raising as an economic enterprise on the over all environment of the area under study. The prevailing geographical conditions and the conditions required for the development of livestocks have also been discussed critically. As far as geographical condition required for livestock raising in North Sikkim the study reveals that the region being the traditional habitat of a large variety of livestocks has immense scope for livestock development in this part of the state on account of its appropriate ecological conditions. The environmental factors influencing livestock raising include largely the bio-climatic regimes incorporating availability of water, land form characteristics climatic conditions and soil fertility etc. The prevailing socio economic phenomena such as the population scenario, agricultural scenario, reserve of fodder resources, infrastructural development like the development of transport and communications, development of a sound marketing network for the livestock products etc. have been adequately highlighted. The effect of various in-

numerable bio-physical factors and their magnitude of inter relationship however, reveal interesting results. In so far as climatic factors are concerned, the study reveals that the productivity of cattles and other livestocks in the region will not be affected by nither a minimum temperature that is as low as minus 10° C nor a maximum temperature that is as high as 27° C in the continental upper zone, provided flow of extra feed supplement over and above the maintenance ratios are kept unintrupted commencing from November till March and November till April in areas such as Lachung and Lachen respectively. However, in the continental zone, the extremes of the prevailing temperatures have a definite bearing on the poultry farming. Similarly, in the lower sub-tropical area, the minimum temperature ranging between 3.3°C to 30° C recorded at Manul (1408m.) will not affect the productivity of livestock including poultry nor any extra feed suppliment will be necessary either. In a similar way, the pattern of rainfall and the relative humidity in North Sikkim would not too affect the productivity of livestocks.

Water is regarded as the greatest limiting factor in livestock management. In North Sikkim, therefore water has never been a problem particularly during rainy season from May to October.However,the drought period starts from November and continues till April and during this period, the livestocks have to depend on rivers, ponds and lakes etc. for their water need.

As regards the topography of the region, nearly80 percent of the total geographical area appear to be highly undulating and mountainous with unmanageably steeper slopes. Consequently, there is a greater probability of the top soil being washed away if cultivation continues to be carried on and above all encouraged in such geomorphologically vulnerable areas. The

most viable alternative there fore, in such region is to convniently go in for grass/legume and grass/legume/tree fodder along side livestock farming preferably under stall fed system. This prescription fully corresponds to the guide lines set forth by the G.B. Pant, Himalayan Environmental Institute in which it has been said that up to 40 degree slope, maximum loss of top soil is generally observed in bare & exposed land, followed by land under maize crop. The top soil loss from the forest land was however, minimal. One aspect of goat raising in the well established forest would be beneficial in the sense that goats generally graze to the ground and help rednce the incidence of forest fire orignating mainly from bushes and grasses due to man induced habits.

Switching over to the socio-economic scenario of North Sikkim,some very notable observations could be made from the study. The population of North Sikkim has registered an increase of 18.0 percent growth rate over the decade 1981-91 the population figures being 26,455 and 31240 souls respectively. According to 1991 census, the total work force in the region stands at 18.17 percent of the total work force of the state which is proportionately very low. The percentage of literates and educated has also shown a significent increase over the decade.

As regards the agricultural scenario of the region, the following picture emerges on the total available land under cultivation, different agricultural land use system, production of food grains, oil seeds, vegetables and import of food grains for Sikkim in general and North Sikkim in particular. As per the survey conducted by R.R.S.S.C.(1988) North Sikkim has 95.77 sq.km. or 9577 hectares of land under cultivation. Out of 9577 hectares,food grains account for 6391.30 hectares or 66.7

percent. Asmuch as 1000 hectares or 10.44 percent come under potato cultivation. Similarly as much as 400 hectares or 4.18 percent of the total cultivable land has been devoted to vegetables like cabbages,peas and ginger etc. And finally, about 1185 hectares or 12.37 percent of the total cultivable land have been devoted to fodder for livestocks, various horticultural crops such as fruits and tuber and rhizomatic crops eg. sweet potato, yams,turmeric and tapioca etc. In Dzongu area, quite a substantial portion of the land is under tapioca cultivation. Area under cardamom cultivation accounts for 51 percent and almost 100 percent of the spices produced in North Sikkim are exported. North Sikkim produces as much as 8777.2 tonnes of food grains and 465.2 tonnes of oil seeds per annum. However, the food grains produced in the region are not sufficient thereby leading to compelling situations for food grain imports from the neighbouring states.

As far as the roads and commnuication of north Sikkim are concerned the roads up to Lachen and Lachen are mettalled and are very reliable. Above these high altitude areas, the road networks are generally prone to landslides and natural hazards. However, the army has opened temporary roads upto Chho-Lhamo area, but the road leading to Lhonak is still bridle. The only alternative of connecting Lhonak with Thangu could be by digging tunnel above Chopta. The condition of the road up to Dzongu areas of north Sikkim is very poor and is often blocked during the monsoon season. Hence, the maintenance of the roads in north Sikkim in particular is vital for keeping a continuous and uninterrupted flow of perishable items such as milk, meat and eggs for marketing. The border roads seem to be well maintained along with the National Highway of North Sikkim from Bridge No. 2 to Lachen and Lachung. However, considerable damages seem to have occured to the flora and

fauna of the region affecting the fargile high mountain ecosystem during the process of construction of roads and communication. It could be infered from the above that North Sikkim in particular has the right conditions for the development of dairy plants in big way. Processing plants can thus be established provided necessary infrastructures are developed to preserve large quantities of milk ranging from 2500 ltrs/day to 30,000 ltrs/ day. At present, a number of processing plants have come up at different locations in the state with necessary infrastructural development to process and preserve quantum of milk ranging between 2500 ltrs/day to 30,000 ltrs/day.

In livestock management, feed and fodder alone constitute of 70 percent of the total cost of production of various livestock products. The fodder requirements of the livestock of North Sikkim have been assessed on the basis of 2 to 2.5 kg. of dry matter per day per 100 kg. of liveweight. The average weight of the livestock of North Sikkim was assessed at 250 kg. and the dry matter requirement assessed was 5 kg. per day or 1825 kg. dry matter per annum. In order to have a uniform picture of fodder requirement, the existing livestock populations are converted into standard cow equivalent units. The total dry fodder requirement in 1977 was 39,547.75m. tonnes, in 1982 the quantity declined to 38,236.49m. tones; in1987, the requirement again shot up to 44491.75m. tonnes. The north district has 908.61 sq. km. or 90861 hectares of pasture land and the production per hectare works out to be 0.50m. tonnes of dry matter. As a result, the present requirement of fodder for livestock will not make any adverse impact on the grassland or pasture land of North Sikkim.

North Sikkim which constitutes three fourth of the total geographical area of Sikkim is an important repository of

genetic variability in plants and animals. The particulars of the animals which are generally found in different ecological zones in the region could be summarized as follows:

Zones	Type of Livestock
1. Dry High Zone (Lhonak & Chho-Lhamu)	Yak, Sheep and Pashmina type of goat.
2. Continental upper zone (Lachen and Lachung)	Cattle, Yak, Goat, Equines and pigs.
3. Sub-Tropical zone (Dzongu Kabi, Phensang etc.)	Cattle, Goat, pigs and poultry.

Livestock is not only reared for milk and meat but it is also a primary source of drought power and manure for agricultural farming. The different varieties of livestock along with their wild related species are found in different climatic zones. A comparative account of poultry and livestock population from 1977 to 1987, their population dyanamics and compositional changes also reveal interesting results. The number of total poultry and livestock in north district has increased by 28.47 percent during a period of ten years from 1977 to 1987. As far as the trend of population of different categories of livestock and poultry are concerned, the poultry population shows an increasing trend registering a growth rate of 33.46 percent. Next to poultry comes cattle which occupies the second highest position in the total livestock population of North Sikkim. Cattle accounted for as much as 20.53 percent in 1987 as against 25.86 percent in 1977. However, during 1977 to 1987 the population of cattle has increased by about 2.4 percent only. There

is a decreasing trend in adult male and adult female cattle population from 1977 to 1987. The percentage of male cattle population has decreased from 8.22 percent in 1977 to 4.50 percent in 1987. The adult female population decresed by -9.68 percent over the decade i.e. 1977 to 1987. However, during the same period there has been substantial increase in young stock cattle accounting for 54.95 prcent growth rate. The negative rate in case of adult male and female cattles may be largely due to gradual phasing out of the indigenous varieties and introduction of hybrid ones. This is clear from the fact that the proportion of crossbred cattle population to the total cattle population was 12.06 percent in 1982 and the same has gone upto 20.05 percent in 1987. During the period the crossbred cattle population has increased by 58.25 percent. In the same period, the indigenous cattle population which was 13503 in numbers in 1982 has decreased to as much as 11684 in 1987, the percentage of decrease being -13.47 percent. The crossbred cows not only produce more milk but their growth rate and breeding efficiency is much better than the local indigenous cows. As regards the proportion of goat population, to the total livestock population the figure was 16.09 percent in 1977. 17.95 percent in 1982 and 16.71 percent in 1987. The overall percentage of goat population increased by 33.92 percent from 1977 to 1987 in North Sikkim. The proportion of yak population has also increased considerably the percentage being 107.91 percent during the period 1977 to 1987.The proportion of yak population to the total livestock population was 4.25 percent in 1977, 4.10 percent in 1983 and 6.85 percent in 1987. Switching over to pig population it could be observed that though its proportion to the total livestock population was only 2.76 percent in 1977 and 3.57 percent in 1987 never the less the population of pigs registered the highest increase during 1977 to 1987 the percentage growth rate being 160.59 percent. The population of livestock with negative

growth rates during 1977 to 1987 include buffaloes with -95.67 percent.and sheep with -8.80 percent. As there is no recorded data available on the distribution of livestock population for the above three identified eco-zones separately, a sample survey was therefore, conducted covering 827 house holds accounting for 25 percent of the total in the three ecozones of North Sikkim, the altitudes of which range between 800m. to 5500m. above the mean sea level. The survey reveals that in the dry high zone there are only three types of livestock species which are reared i.e. sheep, yak and pashmina type of goat. Out of the total livestock population of 4497 surveyed in dry high zone, 3205 or 71.27 percent are from Lhonak region only. As far as the composition of the animals is concerned, the yak and goat populations account for 29.75 and 8.38 percents respectively of the total livestocks surveyed. However, the sheep have the highest percentage share i.e. 61.86 percent of the total livestock populations surveyed in the region.

In the continental zone almost all livestock species are found. Out of the total 4959 number of livestock population in this zone 3380 or 68.16 percent are recorded in Lachen vally and the rest i.e. 31.84 percent are found in Lachung. In the subtropical zone, the important livestock species reared are cattle, goat, pigs and poultry. The largest number of live stock population which account for 18.57 percent of the total livestock population (i.e. 4834) surveyed in this zone is found in Kabi followed by Tinda and Chungthang with populations 646 and 621 respectively. In the Dzongu area village Hee-Gyathang has the highest livestock population with 547 heads.

While studying the level of diffusion of modern innovations in the area under study, the educational and occupational background of the farmers have been taken into consideration.

As education is an important instrument of socio-economic change, the prime objective of the study has been to know as to how education influences the decision making process of the farmers to go in for modern technology in livestock farming. It can hypothetically be said that educated farmers are more receptive to new technology. So the data and information procured through field investigation help us arrive at the following conclusions:

1. As regards the educational background of the farmers of North Sikkim, it was found that in the Dry high zone, of the 30 households surveyed, all are found to be having no educational background and are thus supposedly illiterates. In the continental zone, similarly, of the 240 house holds surveyed more than 60 percent were illiterates and the rest constituting 38.75 percent were literates. In the lower sub-tropical zone, of the 557 house holds surveyed 50 percent of the respondents were found to be literates and the other 50 percent illeterates. Taking North Sikkim as a whole into consideration, the study indicates that as much as 46.67 percent of the farm households are literates and the rest 53.33 percent are illeterates. Normally, the educated farmers are found to be more interested for adopting new innovations in livestock farming. This has been confirmed by the author while interviewing the farmers directly.

2. As the farm households were selected at random, the following picture emerges from the occupational profile of the farmers. The data indicates that farming community constitutes a staggering 79.20 percent of the total households surveyed. As far as zonewise distribution of family occupation is concerned, it was found that all the farm respondents constituting 100 percent in the dry high zone are animal husband men followed by 75 percent and 79.80 percent respectively in the

continental and sub-tropical zones. Rest of the farmers are engaged in various other occupations such as business, and service etc. Livestock farming is therefore the considered as the most dominant occupation of the people in the region. However, the family size in the region does not show any significant variation. The figures being 5.17, 5.10 and 5.41 for dry high, continental and the lower sub-tropical zones respectively. The average family size comes out to be 5.22 for North Sikkim as evident from the study.

3. As regards the exposure of the farmers to new innovations, the following picture emerges. The analysis of the field data indicates that of the 797 households as much as 30 percent and 12.55 percent of the farmers listen to radio and watch T.V. respectively as their main source of information about modern livestock rearing where as about 57.34 percent of the house hold neither listen radio nor do they watch T.V. From the present study it is quite evident that a large number of farmers are almost unaware of the modern innovations in livestock farming which are widely being given publicity in the electronic media. It has also been observed that not many farmers have attended livestock show. Very little percentage i.e. 16 percent only have gathered knowledge about crossbred cattles and other scientific innovations from livestock show. While most among them found the show quite educative, the rest either could not grasp the technicalities involved in rearing the exotic varieties or were not interested to go in for modern technology and hence did not find the show usefull.

4. As far as livestock farming is concerned visits of the farmers to various scientific training centres help increase awareness amongst them who would prepare themselvs for adoption of the new teachnology in the process of its diffusion. In the present

case, Gangtok was selected as the centre for imparting scientific training for livestock rearing as it is the capital of the state being provided with all necessary facilities such as training centre central veterinery hospital, and liquid nitrogen plant for the preservation of frozen semen etc. On being asked to the farmers as to the frequency of their visits to Gangtok, It was found that as much as 97 percent of the farmers of the total respondents do visit Gangtok though their frequency of visits varies from place to place. As far as the level of exposure to new innovationsin livestock farming is concerned, it has been ascertained that 38.6 percent of the total households have a low exposure, 31.37 percent of the households have a moderate exposure, as much as 10 percent have high exposure and 16.44 percent seem to be highly exposed to modern livestock farming in the study area.

5. Tradition in livestock rearing in terms of duration supposedly quickens the process of diffusion of modern innovations. It may thus be considered as an important criterion for successful adoption of modern cross breeding technology. From the zonewise distribution of housholds in terms of rearing of livestocks as a commercial venture it is understood that almost all the farmers of Dry High Zone (i.e. Lhonak, Muguthang and Chho-Lhamo grazing grounds) an appreciably higher share of the respondents constituting about 68 percent of the housholds in the continental Zone i.e. (Lacen and Lachung) and about 57 percent of the housholds in the sub-tropical humid zone have been rearing livestocks for over 10 years in a commercial scale. In an average, commercial farming in the region appears to be a recent phenomenon though livestock rearing as a profession is rooted in the socio economic life of the people. The area is thus progressively moving from a subsistence to surplus & market economy. As far as the population of poultry birds are concerned out of the total poultry population i.e. 4450 in the

sample survey conducted in the area, as many as 3941 (88.56 percent) are found in the sub-tropical zone. Out of 3941 poultry population recorded in this zone, the highest population is found in Kabi which posseses 804 or (20.4 percent) followed by Lingthem (Dzongu) and Chungthang.

From the space distribution of livestocks in North Sikkim, it is observed that the yak population is found to be low in Lachung, moderately low in Chho-Lhamo, moderate in Lhonak and high in Lachen.

As far as the productivity of the Indian indigenous cattle breeds are concerned, it was observed that these breeds not only give low milk yield but the cost of milk production is much higher than the crossbred cows. As regards the crossbreeding programme with the exotic cattle breeds, the stady reveals that amongst the exotic breeds namely friesian, brown Swiss, and Jersey, the Friesian crosses give the best result irrespective of breed and the prevailing agro-climatic conditions. The National Dairy Research Insititute (Karnal) has evolved two milch breeds namely "Karan Swiss" and "Karan Fries" which produce 3200 litres and 3500 litres of milk per lactation respectively vis-a-vis the local best milch cattle Sahiwal that gives only 1600 litres of milk per lactation. It can however, be concluded that the crossbreding programme with exotic animal is quite remunerative and can be augmented with a view to improving the genetic breed of the milch cattles that suit the agro-climatic conditions in the region and thereby improving the prospects of milk production in one hand and the economic conditions of the rural farmers on the other.

Switching over to the economic scenario of livestock rearing in the North Sikkim it has been observed that the economic

of North Sikkim can only be comprehended within the larger domain of the economy of Sikkim as a whole. In the course of the study, it was observed that North Sikkim has vast area under pasture and grazing land. Livestock being the most potential economic sector in this region is supposed to play an important role in boosting the economy of the region rather than playing just a supplemental role. In the past, livestock played a major role both in the life of the Lepchas and the Bhutias. The cattle was considered as a chief sign of wealth and a person with 20 heads of cattle was considered a rich man. Sikkim became a part of Indian Union in May 1975 and the development of Animal Husbandry sector was accelerated after the merger of Sikkim into Indian Union. For example, the budget allocation in the Fourth Five Year plan (1971-76) i.e. pre-merger was Rs. 31.00 lakhs compared to Rs. 263.00 in the Fifth Five Year plan of post merger, period. As a result of planned economic development, the Animal Husbandry Sector is well established in the State today.

According to the survey report on the States' Income conducted by the bureau of Economics and statistics Sikkim, the relative share of the primary sector in real terms comprising agriculture and its allied ctivities accounts for 45.26 percent during 1991-92 assessed at current price and out of this, animal husbandry sector accounts for 4.73 per cent. As far as the generation of employment is concerned, animal husbandry employs a substantial share of the total employment in agriculture and animal husbandry together, the percentage being 63.07 per cent.

The objectives of the study primarily include the economic assesment of farmers receiving income from livestock farming at three different ecological zones; studying the economic traits of the existing three important dairy animals like yak,

local Seri cattle and crossbred cattle; studying the economics of cost of rearing these animals and cost of production of milk at different zones, comparative studies of livestock farming versus agricultural farming in Lachung valley and finally studying the distributional pattern of expenditure and income of the farmers of dry high zone as a case study. As much as 25 percent of the households have been randomly chosen for the study. The details of the findings are presented below.

(1). A large number of farmers accounting for more than 71 percent depend on livestock for their economic sustenance. The zonewise classification of farmers indicates that in the sub-tropical zone, more than 64.45 percent of the 557 households are found to be dependent on livestock for their sustenance. In the cotinental zone and Dry high zones livestock is the dominant occupation of the people. A sustantial share of all the farmers in this zone have livestock raising practices except a few who take to other occupations.

(2). In order to determine the quantum and the level of income from livestock farming five different categories such as low (below Rs.1000), moderate (Rs.1001 to 5000) high (Rs. 5001 to Rs. 10,000) and very high (above Rs.10,001) were arbitrarily proposed.The zonewise result indicates that 100 percent of the farmers in the dry high zone received very high income i.e. to the tune of Rs.10,001and above from livestock farming. It is because, livestock rearing is the principal occupation of the inhabitants in this high altitude zone. In the continental zone, as much as 34.59 percent of the households received very high income i.e. above Rs. 10,001, 24.17 percent received high income (Rs.5001 to Rs.10,000) and 20.83 percent recived moderate income (1001 to Rs. 5000/-); 5.83 percent received low income (below Rs.1000). In an average, more than 55 percent of the farmers earn high income. It is because of the fact that in

this climatic zone, mixed farming is practised to an appreciable extent. Many farmers, besides livestock, also take to agriculture for raising supplimentory income. In the subtropical zone, the percentage share of farmers receiving income (Rs.1001to Rs. 5000)comes out to be 30.16 percent.As much as 13.82 percent received high income (Rs. 5001 to Rs. 10,000); only 8.98 percent of the total households received very high income (above Rs.10.000/-) from livestock farming. However, a low share of the farm population (5.83%) received low income (below Rs. 1000.00).In subtropical zone, the lower share of farmers receiving high and very high income could be attributed to the fact that in this zone agriculture and allied acitivities supplement the farm income of a large number of farmers.

A comprehensive survey was conducted to study the economic traits of milch livestock such as yak, local Seri cow and crossbred cows as milk is the direct source of cash return for the farmers and is considered as the most important selection trait. Having analysed their economic traits, one can arrive at that conclusion that cross bred cows are always superior to that of the local cows and the yaks in terms of milk production. As cow milk commands a wider market popularisation of cross bred cows amongst the farmers is essential so as to boost the total quantum of production in the region, which has tremendous potential even for meeting and supplementing the national demand. Surplus milk products can also be exported to foreign countries for foreign exchange earning.

On the other hand, yak is a very localised animal and economically not very viable for commercial milk production. It is because the economic traits such as milk yield,service period, lactation length and dry period etc. are all inferior to that of cows. And second, the demand of yak milk

and milk products is also confined to the area concerned. In the form of suggestion one can say that hybrid yaks may be encouraged for the better production which can substantially supplement the local need as the people are accustomed to yak milk and milk products for self consumption. Besides, yak also serves the farmers in numerous other farm operations.

A comparision between local and crossbred cows in terms of economic traits reveals that the average yield rate in case of crossbred cows is much higher than that of the local cows. The total quantum of production is more than twice incase of crossbred cows. In terms of percentage, therefore, the yield of crossbred cow is 220 percent higher than the local cows. As far as the other traits are concerned the following picture emerges. Higher milk production by the crossbred animals may be attributed to certain important biological traits such as age at puberty, duration of producing first calf,service period, lactation length, dry or unproductive period and calving interval etc. All the above biological traits are found favourable in case of crossbred cows towards achieving higher milk production. The analysis indicates that the age at puberty is almost less by one year in case of crossberd cows than their local counter parts. Similarly the duration for first calving is less by one year in case of crossbred cow than the local cow. However, the lactation length is longer in case of crossbred cows. Consequently, the unproductive of dry period is shorter in case of the animal. Hence, crossbred cows calve earlier, lactate for a long period and remain dry for a short interval and give higher milk production. From the economics of production of the milch livestocks, it can however, be infered that in the continental zone though yak rearing is relatively more profitable and cost effective in terms of net return per yak per animals but as has been said earlier commercial venture in yak farming needs further research

and investigation within the prevaling socio-ecomic condition of the area.

As far as the local and cross bred cows are concerned the cross bred cows being economically more viable than that of the local in achieving the target of higher production in commercial ventures like dairy farmings has a promising future in North Sikkim. The most important features of dairy farming include the production cost of the farmstead and the unit cost of production of milk and other dairy outputs. The study reveals that the unit cost of production of milk in case of crossbred animals is considerably low which can fatch good price in terms of unit return thereby augmenting the total income of the farms. By adopting modern innovation in the whole of the area with the help of an all around infrastructural development, a milk revolution can be started which can generate gainful employment for the large mass of the ruralites. The following suggestions in this regard will there fore go a long way in promoting this sector as economically the most vibrant that can generate employment and boost the economy of the region for a better future.

1. The infrastructural development be undertaken on war footing to make this enterprise commercially viable.
2. As the products are perishable quicker scientific disposal of the same be given priority.
3. For better income, a strategy should be chalked out for a wider marketing system.
4. Awareness among the farmers has to be created for adopting modern innovations.
5. For improving the investment capacity of the farmers, institutional network should be developed to extend loan facilities through banks and cooperatives to the farmers at lower rate of interest.

6. Adequate training facilities should also be developed to motivate the farmers to go in for modern technology.
7. Over and above educational facilities in the region should be given priority as education is the only instrument to bring about a perceptible change in the out look of the farmers. Therefore educated farmers are always found to be more receptive to new technology than the uneducated ones.

As one of the most important aspects of the ~~the~~ study is to examine the present status of livestock farming in relation to the prevailing environmental conditions, it will be worthwhile to focus on the problems & prospects of livestock development in the study area keeping a sustainable development perspective in veiw within the frame work of the concept of "environment and developement". The present status of livestock farming and the environmental hazards are the current issues despite the fact that livestocks still play a beneficial role in conserving earths fragile ecosystem. In India, today, grazing by livestocks is regarded as one of the major causes of deforestation and livestocks are thus the range land destroyers. Due to heavy grazing the soil is ultimately exposed for wind and water erosion,a phenomenan which is not only alarmingly evident in the Himalayas but also in the semi-arid regions of Rajasthan.Global emmision of methane gas in the world's atmosphere has caused a great environmental concern as the same is produced by livestocks through the activity of anaerobic and breaking down of organic matters in the ruminants of the animals.It has been estimated that 18 per cent of the global warming is attributed to methane and the methane accumulation in the atmosphere has trippled over the last three centuries. Another major concern is that for every one litre of milk produced in the developing countries, 240 grams of methane are released as compared to 40 grams in the developed coutries. Hence, there is no other alter-

native but to reduce India's livestock population drastically which stands at 460 milion at present. It is estimated that in India only 16 million good breedable cows are needed to produce 65 million metric tones of milk and 125 million bullocks for power production by the turn of the century. Long term experiment conducted espectially in Central Sheep and Wool Research Institute Avikanagar and Bikaner in Rajasthan have demonstrated that on land unsuitable for crop production, stocking sheep or goats at the rate of 3 sheep or goat per hactare of land produced no deterioration in the physical and chemical properties of soil. It has also been demonstrated that in India by planting livestock fodder namely vativer grass, the rainfall run off reduced from 40 to 15 per cent and silt losses from 15 tonnes per hactare to 6 tonnes per hectare. Also the benefcial role played by livestock in India today in terms of environmental protection connot be ignored as 300 millions tonnes of agricultural by products and cellulosic wastes are consumed by livestocks. In developed countries these wastes are burnt causing accumalation of carbon-dioxide in the atmosphere. Finally,the growing of fodder i.e. both grasses and legumes would both act as natural sinks for carbon-dioxide and enrich the soil by fixing atmospheric nitrogen.

The livestock and environment interaction in North Sikkim based on four different types of field studies i.e. analysis of soil characteristics of Lhonak and Chho Lhamo region pertaining to the micro nutrient content of the soil, assessment of the present system of managment of livestock and the grazing grounds, assessment of productivity of the grassland of Lhonak and Chho Lhamo region based on numerical approach, analysis of micro- nutrient of different kinds of grasses and fodder at different altitude in North Sikkim, and finally studying the different types of vegetation, grasses, fodder trees, tree fodder, poison-

ous plants and performance of exotic grasses and legumes. Field investigation has helped the author arrive at intresting conclusions.

The chemical properties of the soil of dry high region, as per the soil samples collected from Chopta, Lhonak and Chho Lhamu grazing grounds indicate that the pH values, content of organic matter, available phosphorous and potassium ect. have spatial variation and characteristically differ form one place to the other. The important micro-nutrient analysis in the respect of copper, iron and zinc in the soil of Lhonak shows interesting results. The results of the mean values and the ranges of pH values, content of organic matter, the extent of available nitrogen, phosphorous and potassium as widely discussed in chapter-VII could be summarised as follows:

The mean pH value i.e. 5.4 was recorded for Chopta (near Thangu) where as mean values for Lhonak and Chho-Lhamo areas were found to be 6.47 and 6.44. respectively. The pH value in Lhonak region ranges between 5.7 to 8.9 and for Chho-Lhamo region the same has a range between 6 to 6.8. The soil reaction in higher areas is therefore, found to be normally alkaline except Chopta where the reaction is acidic in nature. As the pH. index exceeds the neutral point in some cases the soil reaction is supposed to be alkaline in certain parts in the study area. The mean pH index for Chopta similarly being relatively lower shows that the soil reaction here is comparatively more acidic in nature. In view of favourable pH values in the high altitude parts of North Sikkim, the prospect of the growth of grasses/legumes and the expansion and reclamation of more land for conversion into extensive pastures seems to be brighter. Therefore, the changing land use scenario in the region needs further research and investigation as to how much land is exactly under pasture land

and how much fallow and other forest lands have been put into permanant pastures under the prevailing socio-economic conditions. It is felt imperative, that adequate cadastral surveys be under taken in these areas of the high Himalayas which are now open to the challenges of environment and development. If there is an increase in livestack population, it is the grass land which is supposed to carry more pressure for grazing. More the pressure on grazing, more is the probability of the land being exposed to the natural forcess of weathering which will ultimately adversely affect the fragile environment by causing considerable damage to the grassland.

The highest mean value of organic matter that accounts for 7.51 percent was observed in the soil samples of Lhonak region with a range of variation between 4.0 to 9.38 percent. In case of Chho Lhamo area the mean value of organic matter is 3.25 percent with a range that varies between 1.79 to 5.93 percent. As far as Chopta is concerned, the mean value of organic matter was found to be 2.90 percent. It could be infered from the above that the value being worked out as high in case of Lhonak and low in case of Chho Lhamo and Chopta, helps the author arrive at the conclusion that Lhonak has alkaline soil with high pH index (in some cases of the samples) and high organic content in the soil. So the soil of this area is agriculturally productive and as far as grass and other fodder cultivation is concerned, the area can reasonably support livestock development in the area by producing more. Similarly, the highest mean value of nitrogen in Lhonak was found to be 210 kg. per acre with a range of variation between 91kg. to 301kgs. The mean value of nitrogen in terms of kg. per acre for Chho Lhamo region was found to be 181 kgs. per acre with a range varying between 122 kgs to 289 kgs per acre. As far as Chopta is concerned the mean value is worked out to be 168 kgs per acre. From the above

analysis of the availability of nitrogen content in soils of various grazing lands in North Sikkim, it could be said that the over all position of nitrogen content in the soil of dry higher zone of Noth Sikkim does not seem to be promising baring a few isolated parts where the content of this important soil nutrient is still considerably low. Such low content of nitrogen in the soil may be attributed to relatively low degradation of the biomass and low humus content in the soil. Unless corrective measures are taken the production of grasses in the open pastures will drastically go down there by discouraging livestock farming in the region. Phosphorous being another vital soil nutrient, was found to be 33.45 ppm for Lhonak. The next mean value of 21.36 ppm was recorded for Chho Lhamo with a renge of variation between as low as 11.7 ppm to as high as 65 ppm. As far as Chopta is concerned the mean value of phoshporus content in terms of percentage is 18.2. It could therefore be said that the phosphorus content in the soil of dry high Sikkim appears to be generally high. Available phosphorus being an essential soil nutrient helps in growth and fixation of nitrogen by the leguminous plants. As far as grasses, and other tree fodders are concerned appropriate quantity of phosphorus can accelerate the growth there by generating surplus fodders which can meet the local demand during the off seasons particularly during winter and the pre- monsoon period.

The lowest level of potassium content i.e. 60 ppm in the soil was observed for Chopta region indicating a low content of the nutrient. Potassium which is so vital for the growth of the plants was found to be very rich in the soils of Lhonak the average mean value being 368.33 ppm. However, the content of the same is found to be low in case of Chopta but high for both Lhonak and chho Lhamo. Similarly the mean value of copper content is found to be 6.23 ppm. which is above the critical level.

The mean value of zinc was found to be 2.13 ppm which is above the critical level of 1.00 ppm. Similarly, in case of iron, the mean value was recorded to be 13.83 ppm. As far as the iron content in the soils of Lhonak grazing ground is concerned the same is interestingly found to be above the critical level i.e. 4.55ppm. The micro nutrient indices above the critical level in the region are favourable for plant growth as far as the quality of the soil is concerned.

As Regards the assessment of the present system of management of livestock and the grazing grounds, farmers/ animal herders were interviewed through personal visits along all the major migration routes and halting points.

Lhonak unlike other parts of North Sikkim is completely an isolated area located in the extreme north western part of the region. However, this area does not depend on the lower and adjacent areas for grazing livestock though its dependence on Tibetan (Chinese) grazing grounds was closed since 1962. As regards the feeding system in this region during winter months, it has been ascertained that the farmers every year set aside a portion of good grassland and the grasses are harvested and preserved as hay in the month of August every year for feeding during the winter. It was also ascertained that the farmers of the region practise rotational grazing system and the movement of the livestock from one area to another is decided by the villlage headman from the month of September till March every year and the grazing system is further decontrolled from the month of April to August.

Similar rotational grazing system is also adopted in the Chho Lhamo area which is located in the extreme north eastern part of the study area. The slaughtering of the animal in Lhonak,

Chho Lhamo, Lachen & Lachung is done once a year i.e. on the 10th of Sikkimese month which coincides with the english month of November. The effect of environmental conditions on the animal productivity through metabolism and other physiological characteristics can be studied taking into account the environmental and other animal biological parameters. The important environmental parameters considered in the present study thus include natural slope of the land, vulnerability to erosion. climatic conditions, soil fertility, soil reaction (pH), natural soil drainage and water availability. On the basis of the visual scores alloted to each of the above parameters it could be infered that the area is suitable for perenial grasses and leguminous plants with sustainable soil conditions. However, there are two important limiting factors such as extreme climate owing to high altitude and the vulnerability of the area to wind and snow erosion. Therefore, the soil should not be disturbed especially, during the winter months as the loose soil would be carried away by the wind action. The wild animals such as mountain hare and mouse like creatures also cause considerable harm to the grassland environment.

The analysis of trace elements in grasses and fodder species have not yet been reported for North Sikkim as no research on this aspect has been undertaken. The present study is perhaps the first of its kind in which fodder samples were collected from areas of varying altitudes such as Chho Lhamo(5220 m.), Donkung (5000 m.), Kerang I (5250 m.), Zemu (3050 m.), and Rabum (1830 m.), for analysis of micronutrients such as , zinc, copper and iron. The results indicated that the coppper content of the samples ranges between 0.2 to 0.3 ppm. The low copper content in the plants therefore, needs to be corrected. In case of zinc content it was confirmed that zinc as an important trace element ranges between 0.5 to 1.66 ppm. and the nutrient was

found to be relatively more in low altitude plants than that of the high altitude. As far as iron is concerred, the index came out to be 13.5 ppm which was recorded in *Lolium perene* "Dalte" at Rabum AH. The iron content in other plants varies between 0.05 ppm to 3.7 ppm.

The role of vegetation in protecting the top soil from erosion, the direct economic value of different kinds of vegetations in terms of fodder, fuel and other products, retention of plant moisture, prevention of excessive oxidation of organic matter etc. are some of the vital aspects of the study which can lead to very interesting conclusions while studying the existing vegetation of Chho-Lhamo, Chopta and Lachen grazing grounds. From various plant and grass species collected from the extreme north eastern part of North Sikkim i.e. Chho-Lhamo (Gurudongmer lake) Chopta located in the extreme north and Lachen and Lachung (Central and eastern part of the study area), it has been ascertained that there are two important plant species i.e. *Miscanthus nudipus* and *Roscoea purpurea* which are cut and subsequently preserved in the form of hay for winter feeding. In addition, complete compilation of different genera and species of grasses, legumes and fodder trees at different altitudes have been undertaken and a list of 78 species of grasses i.e. 48 species from the dry high zone and continental zone and 30 species from sub-tropical zone have been prepared. Similarly, 89 species of fodder trees, shrubs from 400m to 5000m. above sea level have been compiled and presented in chapter VII. Protecting the domestic animals from poisonous plants is a major concern of the farmers of North Sikkim and in this respect 22 differnt species of poisonous plants have been presented in chapter VII. The area and elevation of occurence and the type of poisionous plants and the parts of the plants etc. have been recorded. So the above inventory of grasses and plant

species will be of immense help for the planners, policy makers and plant scientists to undertake further research on the flora of the region.

A trial was carried out to determine the performance of the 11 different exotic grasses and 4 different legumes in the environment of North Sikkim. The details such as the number of days taken to germinate, plant height, plant density and yield per square metre etc. are presented in chapter VII. In summery *Lolium perene multiflorum* var. Dalte gave the best result followed by *Lolium multiflorum* var. Billiberi and *Phalaries aquastica* var. Sirosa amongst the grasses and *Trifolium repens* was the best amongst the legumes. It can be thus concluded that the above grasses and legumes have enormous scope for cultivation as these are prized grasses and legumes particularly in European countries.

From the sample survey conducted to study the relationship between cattle holding size and the land holdings in two zones it was found that in the continental zone, the maximum households owning livestocks are the farmers having only a hectare of land followed by the farmers having by 1 to 2 hectares. In case of sub-tropical zone, the farmers with 2.4 hectares of land have the maximum cattle holding followed by farmers with 1.2 hectares. It is quite evident that the land holding in tropical climatic zone is relatively more than the other zones in view of congenial climatic conditions for agriculture. The other zones in the high Himalayas are however not favourable for cultivation. The land is community owned and thus left for grazing the year round.

During the course of field survey as many as 797 households were questioned as to whether the elimination of trees

would harm the mountain environment. After having analysed the data it could be confirmed that a substantial share of the respondents (65.25%) were aware of the fact that cutting down of trees would harm the environment. Likewise the farmers were asked to indicate whether the milk and meat are carrier of diseases or not. Only 8 percent of the farmers were aware of the fact that milk is the carrier of diseases. Similarly as much as 22 percent of the farmers were aware that meat is the carrier of various diseases. From the questions put about the environmental, awarness, it could be gathered that though the inhabitants are by and large aware about the adverse effect of cutting trees on the environment but as far as the more intricate aspects of health and hygiene are concerned like the germ carrying capacities of milk and meat etc., the people are yet to be concious for which they have to be reasonably educated.

8.2. Recommendations.

Keeping the above findings in view, the folowing suggestions/recommendations will go a long way in formulating policy for achieving the goal of a quicker and sustainable development of livestock and animal husbandry sector in North Sikkim.

1. Infrastructure being one of the most vital components of economic development, has considerable significance in organizing and quickening the process of livestock development in this formidable mountain territory. Therefore, infrastructural development in terms of improved accessibility with the help of better transport and communications, financial institutions such as banks and cooperatives, technological break through such as imparting scientific training to the progressive farmers, introducing modern innovations in livestock farming etc. be given top most priority for achieving higher productivity.

2. Efforts must be directed to evolve a strategy for a rational and scientific management of grassland and the community pastures by enforcing laws through government legislations.

3. Corrective measures should be taken to improve the fertility status of the soil in ecologically vulnerable areas.

4. The nutrient deficit areas should be brought under scientific studies with a set objective of replenishing such soils with the required nutrients.

5. A cadastral survey be under taken to determine the exact area under pastures in the study area for further planning and policy formulation for livestock development.

6. Efforts, be made to rehabilitate and improve the economic conditions of the livestock holders who practice trans humance in the high Himalayas since time immemorial.

7. Efficient extension services should be rendered to bring the farmers home about the profitability of modern and scientific farming with a view to increasing the family income.

8. For furthering the cattle breeding programmes the following steps will help realise the set targets.

(i) Cattle breeding programmes can be further strengthened by distributing superior bulls in the inaccessible areas of North Sikkim.

(ii). Castration of the undesirable and inferior bulls must therefore be under taken on extensive scale.

(iii). The animals which are accessible by better road and communication and particularly located near the jeepable roads must be covered under artificial insemination programme.

(iv). Finally milk recording system should be introduced to identify the superior cows.

9. Fodder production both in the farmers and pasture land must be stepped up and distribution of mineral feed suppliments must be introduced extensively in three identified ecological zones.

10. Atleast two germplasm centres i.e. one for sub-tropical zone and another for continental zone and dry high zone should be established to study the local grasses, fodder trees and schrubs for further conservation of the species.

11. As has been said earlier extensive construction of road and communication network has caused concern for the planners and policy makers in view of the fact that considerable damage has been inflicted to the fragile ecosystem of North Sikkim;there fore proper scheme should be chalked out with a set objective of protecting and regenerating the resources affected by such activities.

12. In the course of the study it has been ascertained that recurrent mine blasts especially in the dry high regions are potential threats to the livestock population in the region. Many livestocks are reported to have perished due to such man induced hazards. It is high time therefore that a task force consisting of army, civilian technocrats and mine sweeper experts and senior government officials should be raised to study and identify the area and the grazing grounds and make them free of mines.

13. Keeping the perspective of sustainable development in view, commercial lvestock farming in the region should be so carried on in consonance with the natural surrounding as to have no adverse impact on the environment.

14. As livestock normally graze to roots in the open pastures on the hill slopes farmers should be motivated to stall feed their animals rather than allowing the same for stray grazing. It is because indiscriminate grazing in the hill slopes will ultimately lead to exposure of the top soil there by causing heavy soil erosion and leaching.

15. For commercial meat production, livestock slaughter units should be scientifically managed so that the same do not create any environmental problem such as pollution.

16. Emission of methane gas through the metabolic process of the animals is an environmental concern. Therefore, the problem should be tackled in two ways i.e. to raise only productive livestock and secondly the feeding of livestock based on crop residue should be minimised as far as posible.

17 . Care must be taken while raising infrastructure in the area particularly the construction of roads and communication for improved accessibility so that such activities do not cause wide spread damage to the environment. In this respect, it has been ascertained that road construction in the higher Himalayas in Sikkim has led to extinction of some very endangered flora such as rare orchids and plants species etc.

18. As indiscriminate cutting of hill slopes for construction of road and buildings is going on in full owing, land slides have become a common and frequent phenomenon in certain parts of

the state. Therefore adequate scientific measures should be taken to check such man induced calamities which lead to grave consequences in regard to environment and the economy of the region.

19. In the dry high zone of North Sikkim as the grazing lands are owned by the community, there is a perceptable danger of mismanagement of the grazing grounds i.e. if large scale livestock farming is encouraged at grass root level through economic incentives provided through various schemes. Therefore, proper legislation should be enacted by the government to check such tendencies in the interest of sustainable environmental policy.

20. Above all, co-ordination between technologists, administrators, planners and policy makers to bring about a balanced development of the economy is inevitable. Any slackness in this regard therefore may adversely affect the process of organisation and development of the livestock in the region.

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Appendix I

Questionnaire for Animal Husbandry Production of House holds residing in the forest blocks.

1. Name of the livestock holder :
2. Name of the forest block : _____
3. Do you own the livestock - Yes/No.
4. If No name of the owner : _____
   Name of village : _____

5. How long have you been looking after the livestock ?
   a. Below one year ;
   b. 1-2 years;
   c. 2-5 Years;
   d. 5-10 Years;
   e. Above 10 Years;

6. What is your production :
   I. Sale of livestock per year;

   a. _____
   b. _____
   c. _____
   d. _____

   II. Sale of milk & milk products per year;

   a. _____
   b. _____
   c. _____

7. Do you consider livestock a profitable venture ?

7.5 What is your livestock population ?

a. Cattle
b. Yak
c. Sheep
d. Goat
e. Other livestock.

8. What is your views to improve or enhance livestock production in the area?

a.
b.
c.
d.

9. Do You pay forest fees Yes / No.
10. What is the rate per animal ?

a.
b.
c.

11. What is the role of the forest officer (Tick .....).

a. Visit regularly and advice on reduction of the stock ;
b. Frequent visit count the number of livestock and no advice ;
c. None of the forest officers visit the area except the forest guard ;

12. What is your total income from the livestock per year

13. What are your major expenditure per annum ;

a. Purchase of stock Rs.

b. Purchase of feed Rs.

c. On Personal food and clothing Rs.

d. Any other expenditure Rs

14. What is your famaly size ?

Age group	Male /Female.	Total
a. Adult		
b. Children		

Appendix II

QUESTIONAIRE FOR ANIMAL HUSBANDRY PRODUCTION SURVEY OF HOUSE HOLDS RESIDING IN THE VILLAGES.

I. Name of the block :

II. Village :

1. Name of the Head of the Family :
2. Age : 3. Sex: a. Male b. Female
4. Marital status: Married/Unmarried/widow/widower/Separated/ divorced :
5. Educational status of the respondent :

6. Type of educational institution:
   attended by the respondent :
   a. Primary
   b. Secondary Education
   c. College
7. Occupation of the respondent :
8. Other Members Staying with the responsent in the house :

Relationship with the respodent.	Sex	Age	Marital Status	Educational Status	Occupational Status	Nature of Occupation
1	2	3	4	5	6	7

If permanent Agri-Non Agri.	Working with the respondent	If not does he/she contribute financially in the economic of the respondent.	Does he/she eat in the same kitchen.
8.	9.	10.	11.

9. Different types of livestock maintained by the family :

	Dry	In milk	Bullocks	Total	Breed
i. Cattle.					
ii. Buffaloes.					
iii. Yak.					
iv. Goat.					
v. Sheep.					
vi. Pigs.					
vii. Poultry.					
viii. Other animals.					

10 . What is the size of your farm land ?
Total area

i. Area under cardamom.
ii. Area under paddy.
iii Dry area.
iv. Area for fodder.
v. Total.

11. How long have you been rearing livestock (tick ...) ?

a. Below one Year.
b. 1 -2 Years.
c. 2 - 5 Years.
d. Above 10 Years.

12. Why are you rearing livestock ? (Tick ...)

i. For farm yard manure.
ii. Provide employment to the family.
iii. To suppliment income.

iv. Family tradition.
v. Availing subsidy.
vi. Meet quality milk/meat.

13. Did you get financial Assistance from any source for investment in your farm? (Tick...)

a. Bank.
b. Coperative society.
c. Local money lender.
d. Own fund.

14. How much did you borrow for your livestock farming ?

Sl.No.	Particulars of loan	Unit	Total amount borrowed
i.			
ii.			
iii.			
iv.			

15. Do you vaccinate your animals ? When was the date of last vaccination?

Sl.No.	Date of vaccination	No. of animals Vaccinated	Type of vaccines
i.			
ii.			
iii.			

16. Do you have bullocks ? Yes / No.
If Yea Nos .

17. How are the bullocks engaged?
    (a). Full time a year
    (b). 50% of the year
    (c). Occassionally a year

18. Did you receive any subsidy from the government ? Yes/No.
    If Yes --- Amount received Rs :

19. How did you invest your loan ?

Sl.No	Particulars	Unit	Amount in Rs .
i.	Purchase of livestock		
ii.	Construction of shed		
iii.	Electricity & drinking water		
iv.	Fodder cultivation		
v.	Purchase of feed		

20. Do you visit Gangtok frequently ?

    If Yes -- how many times a year

21. How did you come to know about the modern technique related to livestock rearing ?

22. Do you use modern equipments ? If yes which type ?

23 Do you listen to radio / Tv programme concerning livestock rearing ?

24. Have you ever watched Krishi Darshan in Doordarshan Yes / No .

25. Has any calf ralley /Livestock show / AH extension programmes been held in your village ? Yes / No.

26. If Yes , did you find it educative ? Yes /No.

27. How many animals did you sell ? Yes / No .If Yes :

Sl.No	Type of animal	Last years Nos.	Price fetched Rs ;	This year	Price fetched
i.	Cattle				
ii.	Buffaloes				
iii.	Yak				
iv.	Sheep				
v.	Goat				
vi.	Pigs				
vii.	Poultry				

28. Do you sell your animals through middle man or diret from the Bazar.

29. How far is your nearest market in Km.

30. Do you kill livestock ? Yes /No

How many a year ? Year and how do you utilize -

i. For Own consumptin

ii. For puja & self consumption

iii. 1/3 for self consumption & rest for sale

iv. 50%/50 consumption & sale

v. 100% for sale

31. How do you utilize the Hide /Skin. ?

	Nos	Price Fetched in Rs.
Own Purpose		
Sale		

32. What is your daily livestock production and sale ?

	Total No.	Retained for own consumption	Sale	Cost Obtained
i. Milk (in ltr.)				
ii. Egg (in nos.)				
iii. Other products				

33. Are you happy with sale price ?

34. Do you have any milk cooperative centre in your village ? yes\no

35. Do you supply your milk to the centre ? Indicate litres per day.

36. What is your yearly house hold expenditure per annum ?

(Amount in Rs)

i. Food
ii Dress
iii. Festivals / Pujas
iv. Education
v. Any other

37. What is your yearly income ?

(Amount in Rs)

i livestock
ii. Agriculture
iii. Other sources

38. Do you grow your own fodder ? Yes/ No .
If yes area

39. How do your grow your fodder ?
    i. As pure crop
    ii. Mixed crop
    iii. Inter crop
    iv. Along the boundaries
    v. Fooder trees

40. If you are not cultivationg your fodder where is your source (Tick)
    i. Reserved forest land
    ii. Gaucharan land
    iii. Private forest

41. What is the time taken to get one load of grass ? (tick ,)
    i Whole day
    ii. one morning
    iii. 1/2 day .

42. What is your dependence on crop waster ? (Tick).

    i. 100% dependence ;
    ii. 50% dependence ;
    iii. 25% dependence ;
    iv. No dependence

43. What is the availability of fodder in your farm ?

Sl. No	Position	Green fodder	Dry fodder
i.	In extreme scarcity		
ii.	Scarcity		
iii.	No problem		
iv.	In abundance supply.		

44. Do you know that the cutting down trees would harm our environment. Yes /No.

45. If Yes , source of your knowledge: T.V./Radio /Friend / Political Speech /Parents.

46. Do you know about balance feed ? Yes /No.

47. If yes, did you feed it to your livestocok ? Yes / No.
If yes, result -Good/fair /So,So/No change in production of livestock.

48. Do you give concentrates to your animals ? (Tick).

Quantity per day/per animal

(a) Balance feed
(b) Bhusa & Pina with mineral mixture
(c) Only Bhusa
(d) Only Pina
(e) Salt only

49. Do you know that milk is a carrier of T.B.and other diseases. Yes/No.
50. Do you know that meat is a carrier of many diseases. Yes/ No.
51. Which breed of livestock do you prefer, local /cross bred.

52. What are your reasons for rearing cross bred cows (Tick).
Do you believe that cross bred cows -
(a). give 100% higher or more than local cows
(b). 50% above than local cows.
(c). 25% Local cows.
(d). Same as local cows

53. Which breed do you prefer ? (Tick)
(a). Cattle - Jersey /Frisin / Darjeeling/breed / Local breed.
(b). Pigs - Local /black Exotic pigs/white exotic pigs/black and white mixed colour pigs.
(c). Poultry -- Desi (Local) /White leg horn/Red cornish breed.

54. Do you believe in cross breeding ? (YES/NO)
55. Do you believe in quality of bull. (YES/NO)
56. Which service do you prefer : (Tick)
    Artificial Insemination / Frozen semen / Natural service.
57. Do you have Artificial Insemination station/Government breeding bull / Private breeding bull in your village ?
58. Did you come across any problem with cross breed animals ?

Appendix III

GRADATION OF PARAMETERS USED IN ASSESSING THE EXISTING GRASSLAND RESOURCE OF NORTH SIKKIM

(Scores in parenthesis)

Different stages of parame-ters. 1	Natural slope of land in degrees. 2	Vulnera-bility to ero-sion. 3	Climatic conditions. 4	Soil fer-tility. 5	Soil re-action 6	Natural soil drainage. 7	Water avail-ability. 8	Vegeta-tion & grass-land cover.
(1)	0-2 (10)	nil (10)	excellent (10)	high (10)	6.5-7.5 (10)	water flowing (10)	perennial source(10)	With 3-tier plant cover(10)
(2)	2-8 (9)	Negligible (9)	Very good (9)	Medium (7)	5.0-6.5 (6)	Less water logging (9)	Very good source (9)	Plant cover with grasses & shrubs (8)
(3)	8-15 (8)	Moderate (6)	good (8)	Low (4)	4.5-5.0 (4)	Frequent water logging(5)	Only rain water (5)	Scanty vegeta-tion cover (5)
(4)	15-30 (5)	Severe (2)	Poor (2)	-	Below-4 (2)	Severe water logging(2)	Dry area (3)	Bareland (2)
(5)	30 or more (2)	-	-	-	-	-	-	Highly eroded (0)

Source: Modified by self from the proposed land used capability classification a numerical approach in the *Journal of Hill Research*.2(2) 1989.p. 166-167.

Appendix IV

GRADATION OF PARAMETERS USED IN ASSESSING THE PRESENT MANAGEMENT OF GRAZING LAND IN NORTH SIKKIM. (SCORE IN PARENTHESIS)

A*	B*	C*	D*	E*	F*
(1)	No evidence of human disturbance. (10)	No evidence of livestock grazing (10)	No evidence of poisonous plants (10)	With 3-Tier plant cover (10)	100% dependence. (2)
(2)	No human disturbance (9)	Livestock grazing with return of dung & no evidence of plant destruction. (9)	No evidence of piosonous plants. (7)	Plant cover with grasses shurbs. (9)	50% dependence (6)
(3)	Moderate human disturbance (6)	Moderate grazing with dung return (6)	Moderate evidence of poisonous plant (5)	Scanty Vegetarion cover (5)	25% dependence. (9)
(4)	Severe human disturbance (2)	Severe grazing & collection of dung (2)	Severe evidence of poisonous plants. (2)	Bare land (2)	0% dependence (10)

*A. Different stages of Parameters.
*B. Human disturbance.
*C. Livestock disturbance.
*D. Occurance of Poisonous plants.
*E. Vegetation and canopy cover
*F. Dependence on Agriculture.

Appendix V

Mean, Mean Maximum, Mean Minimum Monthly Temperature ^{0}C recorded at Lachen and Lachung (North Sikkim)

	LACHUNG 2633 m.				LANCHEN (2697 m. a. s.l)			
Months	Mean t.'C	Temp t.'C	M.Max. t.'C	M.Min. t.'C	M.temp. t.'C	M.max. t.'C	M.min. max.	Ht. Lt. t.'C
Jan	3.9	13.5	-5.75	1.5	6.9	-3.9	18.9	-9.7
Feb	5.13	13.5	-3.25	1.8	7.8	-4.2	18.9	-8.3
Mar	10.13	19.75	1.25	4.4	10.3	-1.5	18.9	-6.7
Apr	14.0	23.25	4.75	6.2	14.3	-2.0	20.0	-5.6
May	16.5	25.00	8.00	10.5	16.1	4.8	21.5	0.6
Jun	17.88	25.75	10.00	12.4	17.0	7.8	28.9	5.0
July	19.50	26.25	12.75	13.1	17.8	8.4	21.7	6.1
Aug	18.75	26.00	11.50	13.0	17.2	8.7	21.4	6.1
Sep	17.13	26.75	7.50	11.9	17.0	6.8	20.2	-0.6
Oct	14.75	24.25	5.25	9.0	14.4	3.6	20.0	0.3
Nov	9.13	17.50	-0.75	4.6	10.5	-1.4	18.0	-2.5
Dec	5.13	13.25	-3.00	2.2	7.9	-3.6	15.0	-4.3

Source : 1. Lachen - Mudhopadhyay,S.C. Tista Basin (1982) 2. Lachung complied and analyzed by self from records of 46 Border Roads.

Appendix VI

Mean, Maximum, Mean Minimum Monthly Temperature in °C recorded at Gnon Sandong and Manual North Sikkim Gnon Sandong (Dzongu) 1100 m. a.s.l. MANUAL 1408 M. a.s.l.

	Gnon Sandong			Manual		
Months	M.Tem t. 'C	M. Max t.'C	M. Min. t' C	M. Temp. t' C	M. Max. t' C	M. Min. t' C
January	12.27	16.37	8.16	11.25	19.20	3.3
Feb.	13.20	17.75	8.64	12.67	21.67	3.67
March	16.15	21.39	10.91	17.00	26.80	7.2
April	19.27	24.74	13.80	19.75	28.17	11.33
May	21.83	27.85	15.81	21.96	29.00	14.92
June	24.66	30.0	19.32	23.09	29.67	16.50
July	24.67	29.87	19.47	24.50	31.00	18.00
August	25.05	30.07	20.03	24.50	30.00	19.00
Sept.	23.77	29.30	19.23	21.75	29.17	14.33
Oct.	20.77	26.27	15.26	19.17	26.17	12.17
November	17.07	34.36	10.87	17.09	25.00	9.17
December	13.04	18.25	7.82	13.33	21.33	5.33

Soruce: 1. Gnon Sandong and Manual compiled and analyzed by self from records of Regional Agricultural Centre at Gnon Sandong (Dzongu) and 46 Border Roads respectively.

Appendix VII.

REVISED ESTIMATES OF AREA, PRODUCTION AND YIELD OF PRINCIPAL CROPS OF SIKKIM DURING 1992-93

Sl.No.	Items	Area in '000 Ha	Production in '000 Tonnes	Ave.Yield in Kg. Ha.
1.	Rice	16.07	20.71	1,289.26
2.	Wheat	7.99	14.10	1,765.32
3.	Maize	40.33	53.95	1,337.86
4.	Finger-millet	5.01	4.71	939.68
5.	Barley	0.90	1.18	1,317.69
6.	Buckwheat	1.73	1.46	844.44
Total Cereals		72.02	96.12	1,334.63
7.	Urd	4.01	3.01	749.93
8.	Other Pulses	2.12	2.40	1,130.76
	Total Pulses	6.14	5.41	881.67
Total Foodgrains		78.16	101.53	1,299.06
9.	Rape & Mustard	3.25	2.74	840.92
10.	Soybean	3.61	3.03	839.77
11.	Other Oilseeds	0.09	0.06	712.34
	Total Oilseeds	6.95	5.83	838.69
12.	Orange	6.36	16.66	2,618.87
13.	Other Fruits	1.97	2.98	1,512.68
Total Fruits		8.33	19.64	2,357.00

14. Vegetables	2.85	17.20	6,036.15
15. Potato	5.20	32.25	6,201.92
16. Large Cardamom	23.56	3.80	161.32
17. Ginger	3.54	19.14	5,405.93
18. Other Tuber & Rhizomatic Crops	0.55	1.82	3,330.28

Source: Gyatso K.Department of Agriculture Government of Sikkim. 1994.

Appendix VIIa

SIKKIM CROP AREA ESTIMATIES OF NORTH DISTRICT FOR 1990-92.

(In Thousand Hectares)

Sl. No	Crops/Particulars	Kharif	Rabi	Annual
1.	Rice	1.1349	----------	1.1349.
2.	Wheat	0.0598	0.0598	0.6416.
3.	Maize	2.9992	----------	2.9992.
4.	Finger-millet	0.5136	----------	0.5236.
5.	Barley	----------	0.1013	0.1013.
6.	Buckwheat	0.0289	0.0848	0.1137
	TotalCereals (1+..+6)	4.7364	0.7678	5.5042
7.	Pulses	0.0412	0.0264.	0.0676
	Total foodgrains (1+..+7)	4.7776	0.7942	5.5718
8 .	Rape &Mustard	---------	0.0825	0.0825.

9.	Soybean	0.2305	----------	0.2305
10.	other oilseeds	---------	----------	----------
Total Oilseeds (8+..+10)		0.2305	0.0825	0.3130
11.	Beans	0.0168	0.0004	0.0172
12.	Chayote	0.0043	----------	0.0043
13.	Leaf -mustard	0.0001	0.0205	0.0206
14.	Radish	0.0049	0.0117	0.0167
15.	Garden Pea	------	0.0097	0.0097
16.	Cabbage	0.0937	----------	0.0937
17.	Other Vagetables	0.0935	0.0622	0.1557
Total Vagetables (11+..+17)		0.2134	0.1046	0.3179
18.	Orange	0.0487	0.1483	0.1483
19.	Banana	0.4341	0.0090	0.4341
20.	Other Fruits	0.0640	0.0640	0.0640
Total Fruits(18+..+20)		0.5469	0.2213	0.6464
21.	LargeCardamoom	6.7419	7.1700	7.1700
22.	Potato	0.2142	0.2031	0.4173
23.	Ginger	0.0108	0.0093	0.0108□
24.	Other Tuber & Rhizomatic	0.0383	0.0383	0.0383
25.	Other Misc. Crops	0.0429	0.0957	0.1386
Total Misc.Crops (21+..+25)		7.0481	7.5165	7.7751
GROSS CROPPED AREA (1+..+25)		12.8164	8.7191	14.6242

Source - Gyatso K. Agriculture department Government of Sikkim.1992 p.35-43.

Appendix VIII

Estimation of Area, Production and average yield of field crops in North Sikkim.(1992-93).

Sl.No.	Name of crop	Area in '000 hectres	Production in '000 tonnes	Yield Per Kg. Ha.
1.	Rice	1.3756	1.7430	1267.08
2.	Wheat	1.0005	1.7400	1739.13
3.	Maize	2.9733	4.2420	1426.70
4.	Finger Millet	0.7099	0.6738	949.1478
5.	Barley	0.1000	0.1300	1,300.000
6.	Buckwheat	0.1600	0.1800	1125.000
7.	Pulses	0.0720	0.0684	950.0000
	Total Food grains.	6.3913	9.7772	1,373.3043
8.	Oil Seeds			
i.	Rapeseed & Mustard.	0.220	0.1550	704.5455
ii.	Soybeen	0.3807	0.3102	814.8148
	Total oil seeds.	0.6007	0.4652	774.4298

Source Agriculture Department, Govt. of Sikkim.1994.

Appendix IX

PERCENTAGE DISTIBUTION OF LIVESTOCKS IN NORTH SIKKIM.

ZONE & REVENUE BLOCKS	YAK		CATTLE		GOAT		SHEEP		PIGS		EQUINE		POULTRY	
	No.	% to total No. of yaks	No	.% to total No. of cattles	No.	% to total No. of goats	No.	% to total No. of sheeps	No.	% to total No. of pigs	No.	% to total No. of equine	No.	% to total No. of poultry
A. DRY HIGH ZONE.														
1. Lhonak	750	26.74	0	0	260	8.80	2195	57.16	0	0	0	0	0	0
2.Chho-Lhamo	588	20.96	0	0	117	3.96	587	15.29	0	0	0	0	0	0
	1338	47.70	0	0	377	12.76	2782	72.45	0	0	0	0	0	0
B. CONTINENTAL UPPER ZONE.														
1. Lachen	963	34.33	793	20.58	384	13.00	948	24.68	59	9.77	233	100	296	6.65
2. Lachung	504	17.97	931	24.16	13	0.44	110	2.87	21	3.48	0	0	213	4.79
	1467	52.30	1724	44.73	397	13.44	1058	27.55	80	13.25	233	100	509	1.44
C. SUB-TROPICAL HUMID ZONE.														
1. Chungthang	0	0	294	7.63	241	8.16	00	00	86	14.24	00	00	447	10.04
2. Ship-gear	0	0	112	2.91	129	4.37	00	00	15	2.48	00	00	283	6.36
3. Naga Namgor	0	0	84	2.18	92	3.11	00	00	18	2.98	00	00	200	4.49
4. Pakshep	0	0	51	1.32	43	1.46	00	00	8	1.33	00	00	92	2.07
5. Kazor	0	0	52	1.35	70	2.37	00	00	19	3.15	00	00	109	2.45
6. Singhik	0	0	220	5.71	161	5.45	00	00	38	6.29	00	00	341	7.66

7. Hee Gyathang	0	0	217	5.63	234	7.92	00	00	96	15.89	00	00	380	8.54
8. Lingthem	0	0	166	4.31	165	5.59	00	00	67	11.09	00	00	487	10.94
9. Gnon Sangdong	0	0	96	2.48	43	1.46	00	00	28	4.64	00	00	264	5.93
10.Ramthang	0	0	35	0.91	27	0.90	00	00	9	1.49	00	00	55	1.24
11. Kabi	0	0	463	12.01	357	12.09	00	00	77	12.75	00	00	804	18.07
12.Tingda	0	0	185	4.80	444	15.03	00	00	17	2.81	00	00	333	7.48
13. Mangan	0	0	155	4.02	174	5.89	00	00	46	7.62	00	00	146	3.23
	0	0	2130	55.27	2180	73.80	00	00	524	86.75	00	00	3941	88.56
Grand Total:	2805	100	3854	100.00	2954	100.00	3840	100	604	100.00	233	100	4450	100

Appendix X

INCOME FROM LIVESTOCK

Sl.No. Zone and Revenue Blocks	No. of House hold Surveyed	No Income		Below Rs. 1000		Rs. 1000-5000		Rs. 5000-10000		Above Rs. 10000	
		No.	%	No.	%	No.	%	No.	%	No.	%
A. DRY HIGH ZONE.											
1. Lhonak & Muguthang	15	0	0.00	0	0.00	0	0.00	0	0.00	15	100.00
2. Chho-Lhamo	15	0	0.00	0	0.00	0	0.00	0	0.00	15	100.00
Total	30	0	0.00	0	0.00	0	0.00	0	0.00	30	100.00
B. CONTINENTAL UPPER ZONE.											
1. Lachen	122	0	0.00	0	0.00	17	13.93	33	27.05	72	59.02
2. Lachung	118	35	29.66	14	11.86	33	27.97	25	21.19	11	9.32
Total (B)	240	35	14.58	14	5.83	50	20.83	58	24.17	83	34.58

C. SUB-TROPICAL HUMID ZONE.

1. Chungthang	108	41	37.96	30	27.78	28	25.93	5	4.63	4	3.70
2. Ship-gear	29	0	0.00	3	10.34	16	55.17	9	31.03	1	3.45
3. Naga Namgor	20	6	30.00	1	5.00	11	55.00	1	5.00	1	5.00
4. Pakshep	14	5	35.71	0	0.00	1	7.14	8	57.14	0	0.00
5. Kazor	23	17	73.91	2	8.70	3	13.04	1	4.35	0	0.00
6. Singhik	59	33	55.93	0	0.00	12	20.34	6	10.17	8	13.56
7. Hee Gyathang	61	26	42.62	2	3.28	25	40.98	7	11.48	1	1.64
8. Lingthem	49	20	40.82	4	8.16	21	42.86	4	8.16	0	0.00
9. Gnon Sangdong	16	9	56.25	1	6.25	6	37.50	0	0.00	0	0.00
10.Ramthang	19	14	73.68	0	0.00	3	15.79	2	10.53	0	0.00
11. Kabi	83	24	28.92	20	24.10	14	16.87	22	26.51	3	3.61
12.Tingda	32	3	9.38	1	3.13	22	68.75	4	12.50	2	6.25
13. Mangan	44	0	0.00	0	0.00	6	13.64	8	18.18	30	68.18
Total (C)	557	198	35.55	64	11.49	168	30.16	77	13.80	50	8.99
Grand Total:	827	233	28.17	78	9.43	218	26.36	135	16.32	163	19.71

Appendix XI

Soil Analysis (Macro) Report of Lhonak region.

Code no. of Various sites	Nitrogen Kg/Acres	Phosphorus (P_20_5 Ppm)	Potassium (K_20 Ppm)	Organic (%)	pH Values
S - 1	301	37.70	460	7.87	6.7
S - 2	91	35.10	360	4.00	6.0
S - 3	112	18.20	260	7.31	6.9
S - 4	252	13.00	4.00	9.38	5.9
S - 5	238	13.00	375	8.14	6.0
NG - 6	238	27.30	310	7.18	6.3
G 7	189	28.60	420	7.87	5.7
NG - 8	154	18.20	335	6.07	8.9
NG - 9	210	36.40	450	7.73	6.8
NG - 10	301	48.10	480	8.56	5.8
NG - 11	133	75.10	225	8.14	6.2
S - 12	301	50.70	345	7.87	6.4
Mean Value	210	33.45	368.33	7.51	6.47

Appendix XII

Soil test report of Lhonak region

Code No of Various sites	Parts Per Milion (Micro) Copper	Zinc	Iron
S - 1	0.2	2.8	15
S - 2	0.2	3.7	15
S - 3	0.1	0.5	11
S -4	0.1	0.5	13
S - 5	0.2	1.0	18
NG - 6	0.2	0.5	14
G - 7	0.1	0.4	15
NG - 8	0.4	0.6	8
NG - 9	0.3	1.6	16
NG - 10	0.3	5.5	14
G - 11	0.5	8.0	18
S - 12	0.1	0.4	9
Mean Value	0.23	2.13	13.83

Appendix XIII

Soil Analysis report of Chho-Lhamo region (MACRO NUTRIENTS)

Sl.No	Plot no.	P.H (1:2)	organic matter (Per cent)	N(Kg/acre)	AVAILABLE P (P_2O_5 ppm)	P (k_2O p.pm)
1.	CHOPT.A.	5.4	2.90	168	18.2	60
2.	C.L.(2)	6.6	1.79	112	20.8	75
3.	CHORA	6.4	4.14	119	65.0	470
4.	C.L.K.(2)	6.0	4.42	280	6.5	275
5.	C.L.(3)	6.6	5.93	189	14.3	225

6.C.L.K.(1)	6.3	1.93	266	14.3	475
7. C.L.(1)	6.4	2.62	175	16.9	450
8. C.L.(1)	6.8	1.93	1.26	11.7	100
Mean Value	6.44	3.25	181	21.36	295.71

Appendix XIV

Name of fodder trees and shurbs of North Sikkim

Sl.No.	Latin Name	Altitude and Area of Distribution
1.	*Albizzia odoratissima*	400 m to1220 m.
2.	*Artemisia parviflora*	2134 m.to3354 m.
3.	*Artemisia sacrorum*	2134m. to 3354 m.
4.	*Artocarpus lokoocha*	400m.
5.	*Aralia cachemirica*	2439m. to 2744m.
6.	*Bauhinia purpurea*	610m. to 1220m.
7.	*Bauhinia variegate*	400m.
8.	*Betula alnoides*	1524m. to 2439m.
9.	*Betula utills*	2439m. to 2744m.
10.	*Bomax malabaricum*	915m.
11.	*Boehmeria rugulosa*	400m.
12.	*Boehmeria malabarica*	1524m.
13.	*Brassaiopsio hispida*	2134m.
14.	*Brassaiopsis hainla*	400m. to 1220m.
15.	*Brassaiopsis alpina*	2439m. to 3049m.
16.	*Butea frondosa*	400m.
17.	*Buddleja asiatica*	915m. to 1829m.
18.	*Castanopsis indica*	305m. to 1220m.
19.	*Castanopsis tribuloides*	1829m. to 2439m.

20. *Cotoneaster acuminata*	2134m. to 3963m.
21. *Dalbergia sissoo*	1829m.
22. *Dalbergia pinnata*	400m.
23. *Dracocephalum heterophyllum*	4878m.
24. *Eurya japonica*	915m. to 1524m.
25. *Eurya acuminata*	2439m.
26. *Eurya japomica*	2744m.
27. *Eriobotrya dubia*	1524m. to 2134m.
28. *Ficus benjammina*	400 m.
29. *Ficus hispida*	1220m.
30. *Ficus nemoralis*	1524 m. to 2439 m.
31. *Ficus roxburghii*	305 m. to 1829 m.
32. *Ficus cunia*	400 m.
33. *Ficus calavata*	400 m.
34. *Ficus religiosa*	915 m.
35. *Ficus Hookeri*	305 m. to 1829 m.
36. *Ficus infectoria*	400 m.
37. *Ficus sikkimensis*	305 m. to 1220 m.
38. *Ficus faveolata*	610 m. to 2134 m.
39. *Ficus bengalensis*	1220 m.
40. *Garuga pinnata*	915 m.
41. *Grewia oppositifolia*	1220 m.
42. *Ilex intricata*	2744 m. to 3049 m.
43. *Ilex fragilis*	2439 m.
44. *Ilex sikkimensis*	
45. *Iris sp.*	3049 m.
46. *Lonicera hypolenca*	
47. *Litses polyantha*	915 m.
48. *Litsee citrata*	2134 m. to 2744 m.
49. *Litsea spp.*	2744 m. to 3049 m.
50. *Machilus edulis*	1220 m. to 2439 m.
51. *Machilus gamplei*	1220 m.

52. *Mallotus philippinensis*	1220 m.
53. *Mallotus nepalensis*	2134 m. to 2439 m.
54. *Maosachisia Buch*	400 m.
55. *Maesa rugosa clarke*	1520 m. to 1829 m.
56. *Michelia champaca*	305 m. to 915 m.
57. *Michelia lanuginosa*	1829 m.
58. *Morus indica*	1220 m.
59. *Morus laevigata*	610 m. to 1524 m.
60. *Oxytropis microphylla*	4268 m. to 4878 m.
61. *Polygonum molle Don*	2134 m.
62. *Premna bengalensis*	
63. *Premna interrupta*	1524 m. to 2134 m.
64. *Picea morindoides*	2439 m. to 2744 m.
65. *Premna latifolia Roxb varmucronata*	
66. *Potentilla fruticosa*	Lhonak-4878 m. to 4268 m.
67. *Prunus cerasoides*	1829 m.
68. *Potamogeton javanicus*	4268 m.
69. *Pittosporum nepalense*	1524 m. to 2439 m.
70. *Quercus fenestrata*	1829 m. to 2439 m.
71. *Quercus glauca*	610 m. to 1829 m.
72. *Quercus incana*	1524 m. to 2439 m.
73. *Quercus dilatata*	1524 m. to 2439 m.
74. *Quercus lanata*	1524 m. to 2439 m.
75. *Quercus lamellosa*	2134 m. to 2439 m.
76. *Quercus semecarpifolia*	Dikchu valley
77. *Receoea purpurea varauriculata*	Lachung-2744 m. to 3049 m.
78. *Rhus succedancea*	2134 m. to 2439 m.
79. *Saurauia nepalensis*	305 m. to 2439 m.
80. *Salix Sikkimensis*	3354 m. to 3963 m.
81. *Salix babylonica*	2744 m. to 4573 m.
82. *Salix spp.*	Zema to Lhonak - 2744m. to 4573m.
83. *Schima wallicha*	1524 m.
84. *Symplocos ramosissima*	2134 m. to 2744 m.

85. *Terminala belerica*	915 m.
86. *Terminalia chebula*	400 m.
87. *Terminalia tomentosa*	
88. *Urtica dioica*	Lhonak(4421m.),Chho Lhamo(5030m.)
89. *Zanthoxtlum acanthopodium*	1220 m. to 2134 m.

Appendix XV

List of Grasses recorded in different altitudes of North Sikkim

Sl.No. Scientific Name	Area of Distribution	Altitude Range
1. *Agrositis myriantha*	Lachen	1439m
2. *Agropyron longearistatum*	Lhonak	4878m
3. *Avena aspera*	Zenu,Tallam Samdong	2744m to 3354m.
4. *Avena subnspicata*	Zemu, Lhonok	3049m to 5183m.
5. *Avena flavescens*	Zemu valley	3049m to 39069m.
6. *Bulbostylis copillaris*	Lachen & Zemu	2439m to 3049m.
7. *Calamagrostes emodensis*	Zemu	3335 m.
8. *Calamagrostes nepalensis*	Zemu	3049m.
9. *Calmagrostes pilosula*	Chakunchu	4268m.
10. *Carex inasues*	Lachen	2683 m.
11. *Carex nubegina*	Lachen	2683m.
12. *Carex pracilara*	Jonsang La valley	5031 m.
13. *Carex obscura*	Zemu valley	3902 m.
14. *Carex pulchra*	-Do-	2439 m.
15. *Carex filitima*	-Do-	3049 m.
16. *Carex crenta*	-Do-	4421m.
17.*Carex linearis*	Thongchung La	4878m.

18. *Catatrosa sikkimensis*	Lhonak	4421 m.
19.*Cyathopus sikkimensis*	Lachung Valley	2134 m to 3049m.
20. *Danthonia cachemyriana*	Thangu	3659 m.to 4268m.
21. *Danthonia cachemyriana var. minor*	Thangu	4268 m.
22. *Deyeuxia scabrescens*	Zemu	3049 m. to 3350 m.
23. *Deyeuxia pulchella*	Lhonak	4573 m.
24. *Dischampsia caespitosa*	Zemu Lhonak	3354 m.
25. *Eragrostis nigra*	Lachen & Tista Valley	400m.to 2744 m.
26. *Erianthus sikkimensis*	Lachen Valley	1829 m.
27. *Festyca valesiaca*	Lhonak	5183 m.
28. *Festuca calesica*	Lhonak	4421 m.
29. *Festuca polycolea*	Zemu & Lhonak	3354 m. to 3968m.
30. *Festuca avena*	Lhonak	4878m.
31. *Hicrochloa Hookeri*	Zemu	2439m to 3049m.
32. *Isachne clarbei*	Lachung Valley	2439m to 3354m.
33. *Kobresea Pygmala*	Lhonak	4421m.
34. *Miscanthus nudipis*	Zemu	2744m to 3049 m.
35. *Oryzopsis spp*	Giagong	4537m.
36. *Phleum alpinum*	Zemu Thangu	3354 m to 3963 m.
37. *Poa attenuata*	Kongrala	4878 m.
38. *Poa pseudo-pratensis*	Zemu,Lhonak, Nabucchu valley	3659 m to 4878 m.
39. *Poa fleuxuosa*	Zemu,Lhonak Giagong Yakla	3354 m to 4573 m.
40. *Poa lirighumis*	Lachung Valley	3354m to 5488 m.
41. *Poa annua vbar sibimensis*	North Sikkim	3354m to 4537m .
42. *Poa tibetica*	North Sikkim	4878m to 5183m.
43. *Scerpus articulata*	Chungthang Valley	2134 m.
44. *Scerpus setacens*	Zemu Valley	3659 m.
45. *Scerpus carecis*	Lhonak	4421m.
46. *Stipa Purpurea*	Naku La Lhonah	4878m.

47. *Stipa mongolica*	Lhonak	4482m.
48. *Tripogon filiformis*	Lachen	2683 m to 3049 m.

Appendix XVI

Distribution of Grasses in low warm areas i.e. Sub-Tropical Humid Zone of North Sikkim.

Sl.No: Scientific Name	Altitude of distribution(Range)
1. *Andropogon oacicularis*	Upto 1524 m.
2. *Andropogan assimilis*	Upto 1524 m.
3 *-do- brevifiloius*	Below 1220 m.
4. *-do- Nardus*	Above 1220 m.
5. *Arthraxon ciliaris*	Upto 1524 m.
6. *Arthraxon microphayullus*	1524m to 3354 m.
7. *Arundinaria Ploystachya*	---- ---
8. " *racemosa*	1829m to 2134 m.
9. " *intermedia*	1220m to 2134 m.
10. " *Hookereana*	1220 to 2134 m.
11. " *aristata*	2896m to 3354 m.
12. *Bambusa nutana*	Upto 1524 m.
13. *Bambusa pallida*	Upto 1524 m.
14. *Coix Lachryma-Jobi Var Ma-yuem (Garay mala)*	Upto 1524 m.
15. *Gynodon dactylon*	Upto 1220 m.
16. *Dendrocalamus Lamiltonii*	1220m to 1829 m.
17. *-do- patellaris*	Upto 1220 m.
18. *Elusing coradana (activated)*	Upto 1220 m.
19. *Elusine indica*	Upto 6010 m.
20. *Tsachne albnens*	400m to 1220 m.
21. *Oriza sativa (cultivated*	Upto 1220 m.

22. *Paspalum conjugatum*
23. *-do- compactum* Uupto 1524 m.
24. *Paspalum sanguinal* Upto 1829 m.
25. *Pennisetum clandestinum* Upto 1829 m.
26. *Panicum plicatum* Upto 1524 m.
27. *Panicum colonum* Upto 1829 m.
28. *panicum indicum* Upto 1829 m.
29. *Saccharum spontaneum (Gongring)* Upto 1220 m.
30. *Thysonolaena agrostis* 400 m.to1524 m.

Appendix XVII

Land Holdings in North Sikkim

Sl. No.	Zone and Revenue Blocks	No. of House-hold 'Surveyed		Nil Land Holding		1 Ha. and below Land Holding		1-2 Ha. Land Holding		2-4 Ha. Land Holding		4-10 Ha. Land Holding		Above 10 Ha. Land Holding	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
A. DRY HIGH ZONE.															
1.	**Lhonak & Muguthang**	15	15	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	
2.	**Chho-Lhamo**	15	15	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	
	Total (A)	30	30	200.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	
B. CONTINENTAL UPPER ZONE.															
1.	**Lachen**	122	13	10.66	67	54.92	9	15.57	18	14.75	5	4.10	0	0.00	
2.	**Lachung**	118	1	0.85	86	72.88	28	23.73	2	1.69	1	0.85	0	0.00	

Total (B)	240	14	5.83	153	63.75	47	39.30	20	8.33	6	2.50	0	0.00
C. SUB-TROPICAL HUMID ZONE.													
1. **Chungthang**	108	39	36.11	8	7.41	17	15.74	31	28.70	11	10.19	2	1.85
2. **Ship-ger**	29	11	37.93	1	3.45	12	41.38	4	13.79	1	3.45	0	0.00
3. **Naga Namgor**	20	2	10.00	4	20.00	3	15.00	8	40.00	3	15.00	0	0.00
4. **Pakshep**	14	0	0.00	10	71.43	3	21.43	0	0.00	1	7.14	0	0.00
5. **Kazor**	23	0	0.00	7	30.43	8	34.78	7	30.43	1	4.35	0	0.00
6. **Singhik**	59	1	1.69	22	37.29	19	32.20	16	27.12	1	1.69	0	0.00
7. **Hee Gyathang**	61	0	0.00	0	0.00	14	22.95	19	31.15	21	34.43	7	11.48
8. **Lingthem**	49	4	8.16	8	16.33	22	44.90	10	20.41	4	8.16	1	2.04
9. **Gnon Sangdong**	16	0	0.00	1	6.25	3	18.75	5	31.25	2	12.50	5	31.25
10. **Ramthang**	19	8	42.11	3	15.79	6	31.58	2	10.53	0	0.00	0	0.00
11. **Kabi**	83	0	0.00	2	2.41	12	14.46	21	25.30	40	48.19	8	9.64
12. **Tingda**	32	5	15.63	13	40.63	10	31.25	1	3.13	3	9.38	0	0.00
13. **Mangan**	44	2	4.55	18	40.91	11	25.00	10	22.73	3	6.82	0	0.00
Total (C)	**557**	**72**	**12.93**	**97**	**17.41**	**140**	**25.13**	**134**	**24.06**	**91**	**16.34**	**23**	**4.13**
Grand Total	**827**	**116**	**14.06**	**250**	**30.23**	**187**	**22.61**	**154**	**18.62**	**97**	**11.73**	**23**	**2.78**

Appendix XVIII

Cattle Holdings in North Sikkim

Sl. No.	Zone and Revenue Blocks	No. of House-hold Surveyed	Nil Cattle Holding		1 Ha. and below Land Holding		1-2 Ha. Cattle Holding		2-4 Ha. Cattle Holding		4-10 Ha. Cattle Holding		Above 10 Ha. Cattle Holding	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
A. DRY HIGH ZONE.														
1.	**Lhonak & Muguthang**	15	0	00.00	0	0.00	0	0.00	0	0.00	1	6.67	14	93.33
2.	**Chho-Lhamo**	15	0	00.00	0	0.00	0	0.00	0	0.00	0	0.00	15	0.00
	Total (A)	30	0	00.00	0	0.00	0	0.00	0	0.00	1	3.33	29	96.67
B. CONTINENTAL UPPER ZONE.														
1.	**Lachen**	122	3	2.46	4	3.28	33	27.05	52	42.62	17	13.93	13	10.66
2.	**Lachung**	118	23	19.49	9	7.63	24	20.34	20	16.95	16	13.56	26	22.03
	Total (B)	240	26	10.83	13	5.42	57	23.75	72	30.00	33	13.75	39	16.25
C. SUB-TROPICAL HUMID ZONE.														
1.	**Chungthang**	108	37	34.26	9	8.33	44	40.74	14	12.96	4	3.70	0	0.00
2.	**Ship-ger**	29	5	17.24	8	27.59	10	34.48	2	6.90	2	6.90	2	6.90
3.	**Naga Namgor**	20	0	0.00	1	5.00	12	60.00	6	30.00	1	5.00	0	0.00
4.	Pakshep	14	0	0.00	10	71.43	3	21.43	0	0.00	1	7.14	0	0.00
5.	Kazor	23	2	8.70	2	8.70	18	78.26	1	4.35	0	0.00	0	0.00
6.	Singhik	59	3	5.08	7	11.86	28	47.46	19	32.20	1	1.69	1	1.69
7.	Hee Gyathang	61	3	4.92	10	16.39	31	50.82	15	24.59	1	1.64	1	1.64
8.	Lingthem	49	4	8.16	4	8.16	30	61.22	9	18.37	2	4.08	0	0.00

Gnon														
Sangdong	16	0	0.00	0	0.00	6	37.50	7	43.75	2	28.50	1	6.25
0. Ramthang	19	2	10.53	3	15.79	11	57.89	3	15.79	0	0.00	0	0.00
1. Kabi	83	1	1.20	1	1.20	34	40.96	37	44.58	7	8.43	3	3.61
2.Tingda	32	0	0.00	8	25.00	22	68.75	1	3.13	1	3.13	0	0.00
3. Mangan	44	3	6.82	8	18.18	22	50.00	9	20.45	1	2.27	1	2.27
otal (C)	557	60	10.77	64	11.49	275	49.37	126	22.62	23	4.13	9	1.62
rand Total	827	86	10.40	77	9.31	332	40.15	198	23.94	57	6.89	77	9.31