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.

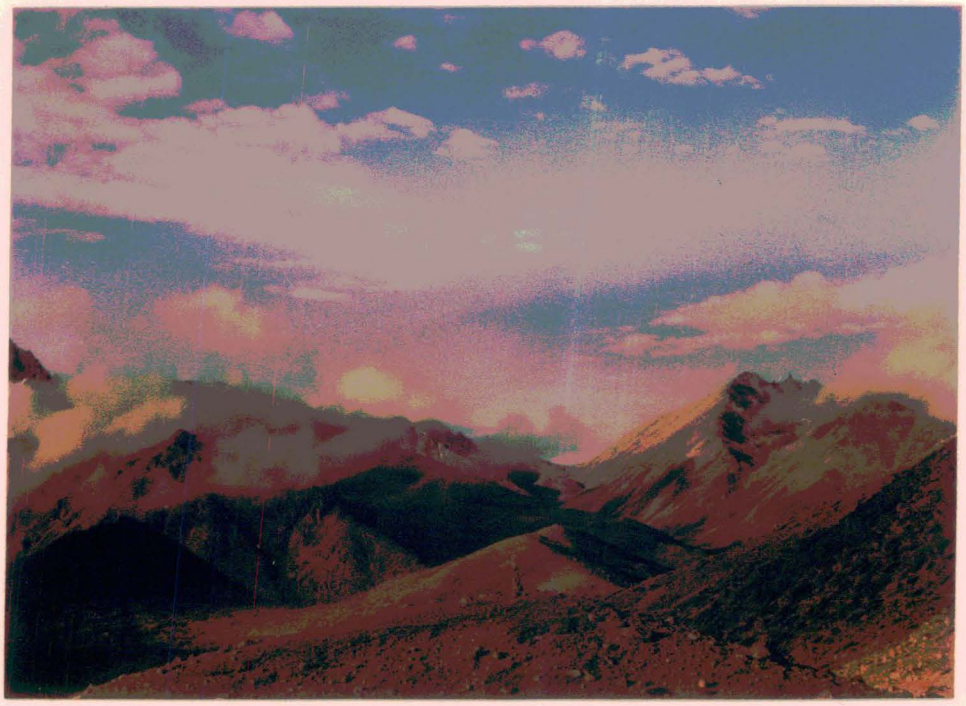

Plate 8. Landscape of Dry high Lhonak region.

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.