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.