

Chapter VIII

Conclusion

8.1. Findings and discussion.

The present study is a modest attempt to analyse the economics of livestock production and its impact on the environment of North Sikkim. North Sikkim i.e. the northern part of the Sikkim State and a formidable mountainous tract is an important segment of the entire Eastern Himalayan ecosystem. Physiographically the region is a distinct unit and covers as much as 60 percent of the total land surface of the state. The most conspicuous features of land use in North Sikkim are that the area under forest and pastures constitutes of more than 50 percent of the total geographical area. In addition, the alpine barren land accounting for another 15.37 percent of the total land surface remains perennially open for sheep and goat grazing. Land under cultivation being quite insignificant largely due to rugged topography and inhospitable terrain, the entire North Sikkim is a potential ground for livestock development in view of its typically extreme climate that stands favorable for certain specific varieties of livestock. In areas like Chho Lhamo and Lhonak etc. in the study area, it has been ascertained that extensive grazing lands are being damaged gradually thereby affecting the growth of the grasses particularly, in view of weathering of rocks of Chho Lhamo and other series and wind induced spreading out of small stones.

The three distinct climatic zones such as humid zone, middle uper zone and upper zone being characteristically different from each other have all necessary conditions for the growth and developement of different kinds of livestock. The

soils of the region being mainly characterized by pH values of varying degree high organic matter, low cation exchange capacity and high lime requirements have a depth normally ranging between 60 cm. to 90 cm.

The three distinct physical landscapes that could be identified incorporate the elevated dry area of Chho-Lhamo and Lhonak, V shaped valley of Lachen and Lachung and the V shaped valleys of Dzongu and Kabi etc. The whole of North Sikkim falls on the upper catchment of the river Tista.

As livestock forms an important component of the economy of North Sikkim, the objective of the study has been primarily to assess the status of livestock farming in the region, in terms of livestock population, economics of production and the cumulative impact of the various activities concerning livestock raising as an economic enterprise on the overall environment of the area under study. The prevailing geographical conditions and the conditions required for the development of livestock have also been discussed critically. As far as geographical condition required for livestock raising in North Sikkim the study reveals that the region being the traditional habitat of a large variety of livestock has immense scope for livestock development in this part of the state on account of its appropriate ecological conditions. The environmental factors influencing livestock raising include largely the bio-climatic regimes incorporating availability of water, land form characteristics climatic conditions and soil fertility etc. The prevailing socio economic phenomena such as the population scenario, agricultural scenario, reserve of fodder resources, infrastructural development like the development of transport and communications, development of a sound marketing network for the livestock products etc. have been adequately highlighted. The effect of various in-

numerable bio-physical factors and their magnitude of inter relationship however, reveal interesting results. In so far as climatic factors are concerned, the study reveals that the productivity of cattles and other livestock in the region will not be affected by nither a minimum temperature that is as low as minus 10° C nor a maximum temperature that is as high as 27° C in the continental upper zone, provided flow of extra feed supplement over and above the maintenance ratios are kept unintrupted commencing from November till March and November till April in areas such as Lachung and Lachen respectively. However, in the continental zone, the extremes of the prevailing temperatures have a definite bearing on the poultry farming. Similarly, in the lower sub-tropical area, the minimum temperature ranging between 3.3°C to 30° C recorded at Manul (1408m.) will not affect the productivity of livestock including poultry nor any extra feed suppliment will be necessary either. In a similar way, the pattern of rainfall and the relative humidity in North Sikkim would not too affect the productivity of livestock.

Water is regarded as the greatest limiting factor in livestock management. In North Sikkim, therefore water has never been a problem particularly during rainy season from May to October. However, the drought period starts from November and continues till April and during this period, the livestock have to depend on rivers, ponds and lakes etc. for their water need.

As regards the topography of the region, nearly 80 percent of the total geographical area appear to be highly undulating and mountainous with unmanageably steeper slopes. Consequently, there is a greater probability of the top soil being washed away if cultivation continues to be carried on and above all encouraged in such geomorphologically vulnerable areas. The

most viable alternative there fore, in such region is to conveniently go in for grass/legume and grass/legume/tree fodder along side livestock farming preferably under stall fed system. This prescription fully corresponds to the guide lines set forth by the G.B. Pant, Himalayan Environmental Institute in which it has been said that up to 40 degree slope, maximum loss of top soil is generally observed in bare & exposed land, followed by land under maize crop. The top soil loss from the forest land was however, minimal. One aspect of goat raising in the well established forest would be beneficial in the sense that goats generally graze to the ground and help reduce the incidence of forest fire originating mainly from bushes and grasses due to man induced habits.

Switching over to the socio-economic scenario of North Sikkim, some very notable observations could be made from the study. The population of North Sikkim has registered an increase of 18.0 percent growth rate over the decade 1981-91 the population figures being 26,455 and 31240 souls respectively. According to 1991 census, the total work force in the region stands at 18.17 percent of the total work force of the state which is proportionately very low. The percentage of literates and educated has also shown a significant increase over the decade.

As regards the agricultural scenario of the region, the following picture emerges on the total available land under cultivation, different agricultural land use system, production of food grains, oil seeds, vegetables and import of food grains for Sikkim in general and North Sikkim in particular. As per the survey conducted by R.R.S.S.C.(1988) North Sikkim has 95.77 sq.km. or 9577 hectares of land under cultivation. Out of 9577 hectares, food grains account for 6391.30 hectares or 66.7

percent. As much as 1000 hectares or 10.44 percent come under potato cultivation. Similarly as much as 400 hectares or 4.18 percent of the total cultivable land has been devoted to vegetables like cabbages, peas and ginger etc. And finally, about 1185 hectares or 12.37 percent of the total cultivable land have been devoted to fodder for livestock, various horticultural crops such as fruits and tuber and rhizomatic crops eg. sweet potato, yams, turmeric and tapioca etc. In Dzongu area, quite a substantial portion of the land is under tapioca cultivation. Area under cardamom cultivation accounts for 51 percent and almost 100 percent of the spices produced in North Sikkim are exported. North Sikkim produces as much as 8777.2 tonnes of food grains and 465.2 tonnes of oil seeds per annum. However, the food grains produced in the region are not sufficient thereby leading to compelling situations for food grain imports from the neighbouring states.

As far as the roads and communication of north Sikkim are concerned the roads up to Lachen and Lachen are metalled and are very reliable. Above these high altitude areas, the road networks are generally prone to landslides and natural hazards. However, the army has opened temporary roads upto Chho-Lhamo area, but the road leading to Lhonak is still a bridge. The only alternative of connecting Lhonak with Thangu could be by digging a tunnel above Chopta. The condition of the road up to Dzongu areas of north Sikkim is very poor and is often blocked during the monsoon season. Hence, the maintenance of the roads in north Sikkim in particular is vital for keeping a continuous and uninterrupted flow of perishable items such as milk, meat and eggs for marketing. The border roads seem to be well maintained along with the National Highway of North Sikkim from Bridge No. 2 to Lachen and Lachung. However, considerable damages seem to have occurred to the flora and

fauna of the region affecting the fragile high mountain ecosystem during the process of construction of roads and communication. It could be inferred from the above that North Sikkim in particular has the right conditions for the development of dairy plants in big way. Processing plants can thus be established provided necessary infrastructures are developed to preserve large quantities of milk ranging from 2500 ltrs/day to 30,000 ltrs/day. At present, a number of processing plants have come up at different locations in the state with necessary infrastructural development to process and preserve quantum of milk ranging between 2500 ltrs/day to 30,000 ltrs/day.

In livestock management, feed and fodder alone constitute of 70 percent of the total cost of production of various livestock products. The fodder requirements of the livestock of North Sikkim have been assessed on the basis of 2 to 2.5 kg. of dry matter per day per 100 kg. of liveweight. The average weight of the livestock of North Sikkim was assessed at 250 kg. and the dry matter requirement assessed was 5 kg. per day or 1825 kg. dry matter per annum. In order to have a uniform picture of fodder requirement, the existing livestock populations are converted into standard cow equivalent units. The total dry fodder requirement in 1977 was 39,547.75m. tonnes, in 1982 the quantity declined to 38,236.49m. tonnes; in 1987, the requirement again shot up to 44491.75m. tonnes. The north district has 908.61 sq. km. or 90861 hectares of pasture land and the production per hectare works out to be 0.50m. tonnes of dry matter. As a result, the present requirement of fodder for livestock will not make any adverse impact on the grassland or pasture land of North Sikkim.

North Sikkim which constitutes three fourth of the total geographical area of Sikkim is an important repository of

genetic variability in plants and animals. The particulars of the animals which are generally found in different ecological zones in the region could be summarized as follows:

Zones	Type of Livestock
1. Dry High Zone (Lhonak & Chho-Lhamu)	Yak, Sheep and Pashmina type of goat.
2. Continental upper zone (Lachen and Lachung)	Cattle, Yak, Goat, Equines and pigs.
3. Sub-Tropical zone (Dzongu Kabi, Phensang etc.)	Cattle, Goat, pigs and poultry.

Livestock is not only reared for milk and meat but it is also a primary source of draught power and manure for agricultural farming. The different varieties of livestock along with their wild related species are found in different climatic zones. A comparative account of poultry and livestock population from 1977 to 1987, their population dynamics and compositional changes also reveal interesting results. The number of total poultry and livestock in north district has increased by 28.47 percent during a period of ten years from 1977 to 1987. As far as the trend of population of different categories of livestock and poultry are concerned, the poultry population shows an increasing trend registering a growth rate of 33.46 percent. Next to poultry comes cattle which occupies the second highest position in the total livestock population of North Sikkim. Cattle accounted for as much as 20.53 percent in 1987 as against 25.86 percent in 1977. However, during 1977 to 1987 the population of cattle has increased by about 2.4 percent only. There

is a decreasing trend in adult male and adult female cattle population from 1977 to 1987. The percentage of male cattle population has decreased from 8.22 percent in 1977 to 4.50 percent in 1987. The adult female population decreased by -9.68 percent over the decade i.e. 1977 to 1987. However, during the same period there has been substantial increase in young stock cattle accounting for 54.95 percent growth rate. The negative rate in case of adult male and female cattles may be largely due to gradual phasing out of the indigenous varieties and introduction of hybrid ones. This is clear from the fact that the proportion of crossbred cattle population to the total cattle population was 12.06 percent in 1982 and the same has gone upto 20.05 percent in 1987. During the period the crossbred cattle population has increased by 58.25 percent. In the same period, the indigenous cattle population which was 13503 in numbers in 1982 has decreased to as much as 11684 in 1987, the percentage of decrease being -13.47 percent. The crossbred cows not only produce more milk but their growth rate and breeding efficiency is much better than the local indigenous cows. As regards the proportion of goat population, to the total livestock population the figure was 16.09 percent in 1977, 17.95 percent in 1982 and 16.71 percent in 1987. The overall percentage of goat population increased by 33.92 percent from 1977 to 1987 in North Sikkim. The proportion of yak population has also increased considerably the percentage being 107.91 percent during the period 1977 to 1987. The proportion of yak population to the total livestock population was 4.25 percent in 1977, 4.10 percent in 1983 and 6.85 percent in 1987. Switching over to pig population it could be observed that though its proportion to the total livestock population was only 2.76 percent in 1977 and 3.57 percent in 1987 never the less the population of pigs registered the highest increase during 1977 to 1987 the percentage growth rate being 160.59 percent. The population of livestock with negative

growth rates during 1977 to 1987 include buffaloes with -95.67 percent and sheep with -8.80 percent. As there is no recorded data available on the distribution of livestock population for the above three identified eco-zones separately, a sample survey was therefore, conducted covering 827 house holds accounting for 25 percent of the total in the three ecozones of North Sikkim, the altitudes of which range between 800m. to 5500m. above the mean sea level. The survey reveals that in the dry high zone there are only three types of livestock species which are reared i.e. sheep, yak and pashmina type of goat. Out of the total livestock population of 4497 surveyed in dry high zone, 3205 or 71.27 percent are from Lhonak region only. As far as the composition of the animals is concerned, the yak and goat populations account for 29.75 and 8.38 percents respectively of the total livestock surveyed. However, the sheep have the highest percentage share i.e. 61.86 percent of the total livestock populations surveyed in the region.

In the continental zone almost all livestock species are found. Out of the total 4959 number of livestock population in this zone 3380 or 68.16 percent are recorded in Lachen vally and the rest i.e. 31.84 percent are found in Lachung. In the subtropical zone, the important livestock species reared are cattle, goat, pigs and poultry. The largest number of live stock population which account for 18.57 percent of the total livestock population (i.e. 4834) surveyed in this zone is found in Kabi followed by Tinda and Chungthang with populations 646 and 621 respectively. In the Dzongu area village Hee-Gyathang has the highest livestock population with 547 heads.

While studying the level of diffusion of modern innovations in the area under study, the educational and occupational background of the farmers have been taken into consideration.

As education is an important instrument of socio-economic change, the prime objective of the study has been to know as to how education influences the decision making process of the farmers to go in for modern technology in livestock farming. It can hypothetically be said that educated farmers are more receptive to new technology. So the data and information procured through field investigation help us arrive at the following conclusions:

1. As regards the educational background of the farmers of North Sikkim, it was found that in the Dry high zone, of the 30 households surveyed, all are found to be having no educational background and are thus supposedly illiterates. In the continental zone, similarly, of the 240 households surveyed more than 60 percent were illiterates and the rest constituting 38.75 percent were literates. In the lower sub-tropical zone, of the 557 households surveyed 50 percent of the respondents were found to be literates and the other 50 percent illiterates. Taking North Sikkim as a whole into consideration, the study indicates that as much as 46.67 percent of the farm households are literates and the rest 53.33 percent are illiterates. Normally, the educated farmers are found to be more interested for adopting new innovations in livestock farming. This has been confirmed by the author while interviewing the farmers directly.

2. As the farm households were selected at random, the following picture emerges from the occupational profile of the farmers. The data indicates that farming community constitutes a staggering 79.20 percent of the total households surveyed. As far as zonewise distribution of family occupation is concerned, it was found that all the farm respondents constituting 100 percent in the dry high zone are animal husband men followed by 75 percent and 79.80 percent respectively in the

continental and sub-tropical zones. Rest of the farmers are engaged in various other occupations such as business, and service etc. Livestock farming is therefore the considered as the most dominant occupation of the people in the region. However, the family size in the region does not show any significant variation. The figures being 5.17, 5.10 and 5.41 for dry high, continental and the lower sub-tropical zones respectively. The average family size comes out to be 5.22 for North Sikkim as evident from the study.

3. As regards the exposure of the farmers to new innovations, the following picture emerges. The analysis of the field data indicates that of the 797 households as much as 30 percent and 12.55 percent of the farmers listen to radio and watch T.V. respectively as their main source of information about modern livestock rearing where as about 57.34 percent of the house hold neither listen radio nor do they watch T.V. From the present study it is quite evident that a large number of farmers are almost unaware of the modern innovations in livestock farming which are widely being given publicity in the electronic media. It has also been observed that not many farmers have attended livestock show. Very little percentage i.e. 16 percent only have gathered knowledge about crossbred cattles and other scientific innovations from livestock show. While most among them found the show quite educative, the rest either could not grasp the technicalities involved in rearing the exotic varieties or were not interested to go in for modern technology and hence did not find the show usefull.

4. As far as livestock farming is concerned visits of the farmers to various scientific training centres help increase awareness amongst them who would prepare themselves for adoption of the new teachnology in the process of its diffusion. In the present

case, Gangtok was selected as the centre for imparting scientific training for livestock rearing as it is the capital of the state being provided with all necessary facilities such as training centre central veterinary hospital, and liquid nitrogen plant for the preservation of frozen semen etc. On being asked to the farmers as to the frequency of their visits to Gangtok, It was found that as much as 97 percent of the farmers of the total respondents do visit Gangtok though their frequency of visits varies from place to place. As far as the level of exposure to new innovations in livestock farming is concerned, it has been ascertained that 38.6 percent of the total households have a low exposure, 31.37 percent of the households have a moderate exposure, as much as 10 percent have high exposure and 16.44 percent seem to be highly exposed to modern livestock farming in the study area.

5. Tradition in livestock rearing in terms of duration supposedly quickens the process of diffusion of modern innovations. It may thus be considered as an important criterion for successful adoption of modern cross breeding technology. From the zonewise distribution of households in terms of rearing of livestock as a commercial venture it is understood that almost all the farmers of Dry High Zone (i.e. Lhonak, Muguthang and Chho-Lhamo grazing grounds) an appreciably higher share of the respondents constituting about 68 percent of the households in the continental Zone i.e. (Lacen and Lachung) and about 57 percent of the households in the sub-tropical humid zone have been rearing livestock for over 10 years in a commercial scale. In an average, commercial farming in the region appears to be a recent phenomenon though livestock rearing as a profession is rooted in the socio economic life of the people. The area is thus progressively moving from a subsistence to surplus & market economy. As far as the population of poultry birds are concerned out of the total poultry population i.e. 4450 in the

sample survey conducted in the area, as many as 3941 (88.56 percent) are found in the sub-tropical zone. Out of 3941 poultry population recorded in this zone, the highest population is found in Kabi which possesses 804 or (20.4 percent) followed by Lingthem (Dzongu) and Chungthang.

From the space distribution of livestock in North Sikkim, it is observed that the yak population is found to be low in Lachung, moderately low in Chho-Lhamo, moderate in Lhonak and high in Lachen.

As far as the productivity of the Indian indigenous cattle breeds are concerned, it was observed that these breeds not only give low milk yield but the cost of milk production is much higher than the crossbred cows. As regards the crossbreeding programme with the exotic cattle breeds, the study reveals that amongst the exotic breeds namely Friesian, Brown Swiss, and Jersey, the Friesian crosses give the best result irrespective of breed and the prevailing agro-climatic conditions. The National Dairy Research Institute (Karnal) has evolved two milch breeds namely "Karan Swiss" and "Karan Fries" which produce 3200 litres and 3500 litres of milk per lactation respectively vis-a-vis the local best milch cattle Sahiwal that gives only 1600 litres of milk per lactation. It can however, be concluded that the crossbreeding programme with exotic animal is quite remunerative and can be augmented with a view to improving the genetic breed of the milch cattle that suit the agro-climatic conditions in the region and thereby improving the prospects of milk production in one hand and the economic conditions of the rural farmers on the other.

Switching over to the economic scenario of livestock rearing in the North Sikkim it has been observed that the economic

of North Sikkim can only be comprehended within the larger domain of the economy of Sikkim as a whole. In the course of the study, it was observed that North Sikkim has vast area under pasture and grazing land. Livestock being the most potential economic sector in this region is supposed to play an important role in boosting the economy of the region rather than playing just a supplemental role. In the past, livestock played a major role both in the life of the Lepchas and the Bhutias. The cattle was considered as a chief sign of wealth and a person with 20 heads of cattle was considered a rich man. Sikkim became a part of Indian Union in May 1975 and the development of Animal Husbandry sector was accelerated after the merger of Sikkim into Indian Union. For example, the budget allocation in the Fourth Five Year plan (1971-76) i.e. pre-merger was Rs. 31.00 lakhs compared to Rs. 263.00 in the Fifth Five Year plan of post merger, period. As a result of planned economic development, the Animal Husbandry Sector is well established in the State today.

According to the survey report on the States' Income conducted by the bureau of Economics and statistics Sikkim, the relative share of the primary sector in real terms comprising agriculture and its allied activities accounts for 45.26 percent during 1991-92 assessed at current price and out of this, animal husbandry sector accounts for 4.73 per cent. As far as the generation of employment is concerned, animal husbandry employs a substantial share of the total employment in agriculture and animal husbandry together, the percentage being 63.07 per cent.

The objectives of the study primarily include the economic assesment of farmers receiving income from livestock farming at three different ecological zones; studying the economic traits of the existing three important dairy animals like yak,

local Seri cattle and crossbred cattle; studying the economics of cost of rearing these animals and cost of production of milk at different zones, comparative studies of livestock farming versus agricultural farming in Lachung valley and finally studying the distributional pattern of expenditure and income of the farmers of dry high zone as a case study. As much as 25 percent of the households have been randomly chosen for the study. The details of the findings are presented below.

(1). A large number of farmers accounting for more than 71 percent depend on livestock for their economic sustenance. The zonewise classification of farmers indicates that in the sub-tropical zone, more than 64.45 percent of the 557 households are found to be dependent on livestock for their sustenance. In the continental zone and Dry high zones livestock is the dominant occupation of the people. A substantial share of all the farmers in this zone have livestock raising practices except a few who take to other occupations.

(2). In order to determine the quantum and the level of income from livestock farming five different categories such as low (below Rs.1000), moderate (Rs.1001 to 5000) high (Rs. 5001 to Rs. 10,000) and very high (above Rs.10,001) were arbitrarily proposed. The zonewise result indicates that 100 percent of the farmers in the dry high zone received very high income i.e. to the tune of Rs.10,001 and above from livestock farming. It is because, livestock rearing is the principal occupation of the inhabitants in this high altitude zone. In the continental zone, as much as 34.59 percent of the households received very high income i.e. above Rs. 10,001, 24.17 percent received high income (Rs.5001 to Rs.10,000) and 20.83 percent received moderate income (1001 to Rs. 5000/-); 5.83 percent received low income (below Rs.1000). In an average, more than 55 percent of the farmers earn high income. It is because of the fact that in

this climatic zone, mixed farming is practised to an appreciable extent. Many farmers, besides livestock, also take to agriculture for raising supplementary income. In the subtropical zone, the percentage share of farmers receiving income (Rs.1001 to Rs. 5000) comes out to be 30.16 percent. As much as 13.82 percent received high income (Rs. 5001 to Rs. 10,000); only 8.98 percent of the total households received very high income (above Rs.10,000/-) from livestock farming. However, a low share of the farm population (5.83%) received low income (below Rs. 1000.00). In subtropical zone, the lower share of farmers receiving high and very high income could be attributed to the fact that in this zone agriculture and allied activities supplement the farm income of a large number of farmers.

A comprehensive survey was conducted to study the economic traits of milch livestock such as yak, local Seri cow and crossbred cows as milk is the direct source of cash return for the farmers and is considered as the most important selection trait. Having analysed their economic traits, one can arrive at that conclusion that cross bred cows are always superior to that of the local cows and the yaks in terms of milk production. As cow milk commands a wider market popularisation of cross bred cows amongst the farmers is essential so as to boost the total quantum of production in the region, which has tremendous potential even for meeting and supplementing the national demand. Surplus milk products can also be exported to foreign countries for foreign exchange earning.

On the other hand, yak is a very localised animal and economically not very viable for commercial milk production. It is because the economic traits such as milk yield, service period, lactation length and dry period etc. are all inferior to that of cows. And second, the demand of yak milk

and milk products is also confined to the area concerned. In the form of suggestion one can say that hybrid yaks may be encouraged for the better production which can substantially supplement the local need as the people are accustomed to yak milk and milk products for self consumption. Besides, yak also serves the farmers in numerous other farm operations.

A comparison between local and crossbred cows in terms of economic traits reveals that the average yield rate in case of crossbred cows is much higher than that of the local cows. The total quantum of production is more than twice in case of crossbred cows. In terms of percentage, therefore, the yield of crossbred cow is 220 percent higher than the local cows. As far as the other traits are concerned the following picture emerges. Higher milk production by the crossbred animals may be attributed to certain important biological traits such as age at puberty, duration of producing first calf, service period, lactation length, dry or unproductive period and calving interval etc. All the above biological traits are found favourable in case of crossbred cows towards achieving higher milk production. The analysis indicates that the age at puberty is almost less by one year in case of crossbred cows than their local counterparts. Similarly the duration for first calving is less by one year in case of crossbred cow than the local cow. However, the lactation length is longer in case of crossbred cows. Consequently, the unproductive or dry period is shorter in case of the animal. Hence, crossbred cows calve earlier, lactate for a long period and remain dry for a short interval and give higher milk production. From the economics of production of the milch livestock, it can however, be inferred that in the continental zone though yak rearing is relatively more profitable and cost effective in terms of net return per yak per animal but as has been said earlier commercial venture in yak farming needs further research

and investigation within the prevailing socio-economic condition of the area.

As far as the local and cross bred cows are concerned the cross bred cows being economically more viable than that of the local in achieving the target of higher production in commercial ventures like dairy farmings has a promising future in North Sikkim. The most important features of dairy farming include the production cost of the farmstead and the unit cost of production of milk and other dairy outputs. The study reveals that the unit cost of production of milk in case of crossbred animals is considerably low which can fetch good price in terms of unit return thereby augmenting the total income of the farms. By adopting modern innovation in the whole of the area with the help of an all around infrastructural development, a milk revolution can be started which can generate gainful employment for the large mass of the ruralites. The following suggestions in this regard will therefore go a long way in promoting this sector as economically the most vibrant that can generate employment and boost the economy of the region for a better future.

1. The infrastructural development be undertaken on war footing to make this enterprise commercially viable.
2. As the products are perishable quicker scientific disposal of the same be given priority.
3. For better income, a strategy should be chalked out for a wider marketing system.
4. Awareness among the farmers has to be created for adopting modern innovations.
5. For improving the investment capacity of the farmers, institutional network should be developed to extend loan facilities through banks and cooperatives to the farmers at lower rate of interest.

6. Adequate training facilities should also be developed to motivate the farmers to go in for modern technology.
7. Over and above educational facilities in the region should be given priority as education is the only instrument to bring about a perceptible change in the outlook of the farmers. Therefore educated farmers are always found to be more receptive to new technology than the uneducated ones.

As one of the most important aspects of the ~~the~~ study is to examine the present status of livestock farming in relation to the prevailing environmental conditions, it will be worthwhile to focus on the problems & prospects of livestock development in the study area keeping a sustainable development perspective in view within the framework of the concept of "environment and development". The present status of livestock farming and the environmental hazards are the current issues despite the fact that livestock still play a beneficial role in conserving earth's fragile ecosystem. In India, today, grazing by livestock is regarded as one of the major causes of deforestation and livestock are thus the range land destroyers. Due to heavy grazing the soil is ultimately exposed for wind and water erosion, a phenomenon which is not only alarmingly evident in the Himalayas but also in the semi-arid regions of Rajasthan. Global emission of methane gas in the world's atmosphere has caused a great environmental concern as the same is produced by livestock through the activity of anaerobic and breaking down of organic matters in the ruminants of the animals. It has been estimated that 18 per cent of the global warming is attributed to methane and the methane accumulation in the atmosphere has tripled over the last three centuries. Another major concern is that for every one litre of milk produced in the developing countries, 240 grams of methane are released as compared to 40 grams in the developed countries. Hence, there is no other alter-

native but to reduce India's livestock population drastically which stands at 460 million at present. It is estimated that in India only 16 million good breedable cows are needed to produce 65 million metric tones of milk and 125 million bullocks for power production by the turn of the century. Long term experiment conducted especially in Central Sheep and Wool Research Institute Avikanagar and Bikaner in Rajasthan have demonstrated that on land unsuitable for crop production, stocking sheep or goats at the rate of 3 sheep or goat per hectare of land produced no deterioration in the physical and chemical properties of soil. It has also been demonstrated that in India by planting livestock fodder namely vativer grass, the rainfall runoff reduced from 40 to 15 per cent and silt losses from 15 tonnes per hectare to 6 tonnes per hectare. Also the beneficial role played by livestock in India today in terms of environmental protection cannot be ignored as 300 millions tonnes of agricultural by products and cellulosic wastes are consumed by livestock. In developed countries these wastes are burnt causing accumulation of carbon-dioxide in the atmosphere. Finally, the growing of fodder i.e. both grasses and legumes would both act as natural sinks for carbon-dioxide and enrich the soil by fixing atmospheric nitrogen.

The livestock and environment interaction in North Sikkim based on four different types of field studies i.e. analysis of soil characteristics of Lhonak and Chho Lhamo region pertaining to the micro nutrient content of the soil, assessment of the present system of management of livestock and the grazing grounds, assessment of productivity of the grassland of Lhonak and Chho Lhamo region based on numerical approach, analysis of micro-nutrient of different kinds of grasses and fodder at different altitude in North Sikkim, and finally studying the different types of vegetation, grasses, fodder trees, tree fodder, poison-

ous plants and performance of exotic grasses and legumes. Field investigation has helped the author arrive at interesting conclusions.

The chemical properties of the soil of dry high region, as per the soil samples collected from Chopta, Lhonak and Chho Lhamu grazing grounds indicate that the pH values, content of organic matter, available phosphorous and potassium ect. have spatial variation and characteristically differ from one place to the other. The important micro-nutrient analysis in the respect of copper, iron and zinc in the soil of Lhonak shows interesting results. The results of the mean values and the ranges of pH values, content of organic matter, the extent of available nitrogen, phosphorous and potassium as widely discussed in chapter-VII could be summarised as follows:

The mean pH value i.e. 5.4 was recorded for Chopta (near Thangu) where as mean values for Lhonak and Chho-Lhamo areas were found to be 6.47 and 6.44. respectively. The pH value in Lhonak region ranges between 5.7 to 8.9 and for Chho-Lhamo region the same has a range between 6 to 6.8. The soil reaction in higher areas is therefore, found to be normally alkaline except Chopta where the reaction is acidic in nature. As the pH. index exceeds the neutral point in some cases the soil reaction is supposed to be alkaline in certain parts in the study area. The mean pH index for Chopta similarly being relatively lower shows that the soil reaction here is comparatively more acidic in nature. In view of favourable pH values in the high altitude parts of North Sikkim, the prospect of the growth of grasses/legumes and the expansion and reclamation of more land for conversion into extensive pastures seems to be brighter. Therefore, the changing land use scenario in the region needs further research and investigation as to how much land is exactly under pasture land

and how much fallow and other forest lands have been put into permanent pastures under the prevailing socio-economic conditions. It is felt imperative, that adequate cadastral surveys be undertaken in these areas of the high Himalayas which are now open to the challenges of environment and development. If there is an increase in livestock population, it is the grass land which is supposed to carry more pressure for grazing. More the pressure on grazing, more is the probability of the land being exposed to the natural force of weathering which will ultimately adversely affect the fragile environment by causing considerable damage to the grassland.

The highest mean value of organic matter that accounts for 7.51 percent was observed in the soil samples of Lhonak region with a range of variation between 4.0 to 9.38 percent. In case of Chho Lhamo area the mean value of organic matter is 3.25 percent with a range that varies between 1.79 to 5.93 percent. As far as Chopta is concerned, the mean value of organic matter was found to be 2.90 percent. It could be inferred from the above that the value being worked out as high in case of Lhonak and low in case of Chho Lhamo and Chopta, helps the author arrive at the conclusion that Lhonak has alkaline soil with high pH index (in some cases of the samples) and high organic content in the soil. So the soil of this area is agriculturally productive and as far as grass and other fodder cultivation is concerned, the area can reasonably support livestock development in the area by producing more. Similarly, the highest mean value of nitrogen in Lhonak was found to be 210 kg. per acre with a range of variation between 91kg. to 301kgs. The mean value of nitrogen in terms of kg. per acre for Chho Lhamo region was found to be 181 kgs. per acre with a range varying between 122 kgs to 289 kgs per acre. As far as Chopta is concerned the mean value is worked out to be 168 kgs per acre. From the above

analysis of the availability of nitrogen content in soils of various grazing lands in North Sikkim, it could be said that the over all position of nitrogen content in the soil of dry higher zone of North Sikkim does not seem to be promising barring a few isolated parts where the content of this important soil nutrient is still considerably low. Such low content of nitrogen in the soil may be attributed to relatively low degradation of the biomass and low humus content in the soil. Unless corrective measures are taken the production of grasses in the open pastures will drastically go down there by discouraging livestock farming in the region. Phosphorous being another vital soil nutrient, was found to be 33.45 ppm for Lhonak. The next mean value of 21.36 ppm was recorded for Chho Lhamo with a range of variation between as low as 11.7 ppm to as high as 65 ppm. As far as Chopta is concerned the mean value of phosphorus content in terms of percentage is 18.2. It could therefore be said that the phosphorus content in the soil of dry high Sikkim appears to be generally high. Available phosphorus being an essential soil nutrient helps in growth and fixation of nitrogen by the leguminous plants. As far as grasses, and other tree fodders are concerned appropriate quantity of phosphorus can accelerate the growth there by generating surplus fodders which can meet the local demand during the off seasons particularly during winter and the pre- monsoon period.

The lowest level of potassium content i.e. 60 ppm in the soil was observed for Chopta region indicating a low content of the nutrient. Potassium which is so vital for the growth of the plants was found to be very rich in the soils of Lhonak the average mean value being 368.33 ppm. However, the content of the same is found to be low in case of Chopta but high for both Lhonak and chho Lhamo. Similarly the mean value of copper content is found to be 6.23 ppm. which is above the critical level.

The mean value of zinc was found to be 2.13 ppm which is above the critical level of 1.00 ppm. Similarly, in case of iron, the mean value was recorded to be 13.83 ppm. As far as the iron content in the soils of Lhonak grazing ground is concerned the same is interestingly found to be above the critical level i.e. 4.55 ppm. The micro nutrient indices above the critical level in the region are favourable for plant growth as far as the quality of the soil is concerned.

As Regards the assessment of the present system of management of livestock and the grazing grounds, farmers/ animal herders were interviewed through personal visits along all the major migration routes and halting points.

Lhonak unlike other parts of North Sikkim is completely an isolated area located in the extreme north western part of the region. However, this area does not depend on the lower and adjacent areas for grazing livestock though its dependence on Tibetan (Chinese) grazing grounds was closed since 1962. As regards the feeding system in this region during winter months, it has been ascertained that the farmers every year set aside a portion of good grassland and the grasses are harvested and preserved as hay in the month of August every year for feeding during the winter. It was also ascertained that the farmers of the region practise rotational grazing system and the movement of the livestock from one area to another is decided by the village headman from the month of September till March every year and the grazing system is further decontrolled from the month of April to August.

Similar rotational grazing system is also adopted in the Chho Lhamo area which is located in the extreme north eastern part of the study area. The slaughtering of the animal in Lhonak,

Chho Lhamo, Lachen & Lachung is done once a year i.e. on the 10th of Sikkimese month which coincides with the english month of November. The effect of environmental conditions on the animal productivity through metabolism and other physiological characteristics can be studied taking into account the environmental and other animal biological parameters. The important environmental parameters considered in the present study thus include natural slope of the land, vulnerability to erosion, climatic conditions, soil fertility, soil reaction (pH), natural soil drainage and water availability. On the basis of the visual scores allotted to each of the above parameters it could be inferred that the area is suitable for perennial grasses and leguminous plants with sustainable soil conditions. However, there are two important limiting factors such as extreme climate owing to high altitude and the vulnerability of the area to wind and snow erosion. Therefore, the soil should not be disturbed especially, during the winter months as the loose soil would be carried away by the wind action. The wild animals such as mountain hare and mouse like creatures also cause considerable harm to the grassland environment.

The analysis of trace elements in grasses and fodder species have not yet been reported for North Sikkim as no research on this aspect has been undertaken. The present study is perhaps the first of its kind in which fodder samples were collected from areas of varying altitudes such as Chho Lhamo (5220 m.), Donkung (5000 m.), Kerang I (5250 m.), Zemu (3050 m.), and Rabum (1830 m.), for analysis of micronutrients such as , zinc, copper and iron. The results indicated that the copper content of the samples ranges between 0.2 to 0.3 ppm. The low copper content in the plants therefore, needs to be corrected. In case of zinc content it was confirmed that zinc as an important trace element ranges between 0.5 to 1.66 ppm. and the nutrient was

found to be relatively more in low altitude plants than that of the high altitude. As far as iron is concerned, the index came out to be 13.5 ppm which was recorded in *Lolium perene* "Dalte" at Rabum AH. The iron content in other plants varies between 0.05 ppm to 3.7 ppm.

The role of vegetation in protecting the top soil from erosion, the direct economic value of different kinds of vegetations in terms of fodder, fuel and other products, retention of plant moisture, prevention of excessive oxidation of organic matter etc. are some of the vital aspects of the study which can lead to very interesting conclusions while studying the existing vegetation of Chho-Lhamo, Chopta and Lachen grazing grounds. From various plant and grass species collected from the extreme north eastern part of North Sikkim i.e. Chho-Lhamo (Gurudongmer lake) Chopta located in the extreme north and Lachen and Lachung (Central and eastern part of the study area), it has been ascertained that there are two important plant species i.e. *Miscanthus nudipus* and *Roscoea purpurea* which are cut and subsequently preserved in the form of hay for winter feeding. In addition, complete compilation of different genera and species of grasses, legumes and fodder trees at different altitudes have been undertaken and a list of 78 species of grasses i.e. 48 species from the dry high zone and continental zone and 30 species from sub-tropical zone have been prepared. Similarly, 89 species of fodder trees, shrubs from 400m to 5000m. above sea level have been compiled and presented in chapter VII. Protecting the domestic animals from poisonous plants is a major concern of the farmers of North Sikkim and in this respect 22 different species of poisonous plants have been presented in chapter VII. The area and elevation of occurrence and the type of poisonous plants and the parts of the plants etc. have been recorded. So the above inventory of grasses and plant

species will be of immense help for the planners, policy makers and plant scientists to undertake further research on the flora of the region.

A trial was carried out to determine the performance of the 11 different exotic grasses and 4 different legumes in the environment of North Sikkim. The details such as the number of days taken to germinate, plant height, plant density and yield per square metre etc. are presented in chapter VII. In summery *Lolium perene multiflorum* var. Dalte gave the best result followed by *Lolium multiflorum* var. Billiberi and *Phalaris aquatica* var. Sirosa amongst the grasses and *Trifolium repens* was the best amongst the legumes. It can be thus concluded that the above grasses and legumes have enormous scope for cultivation as these are prized grasses and legumes particularly in European countries.

From the sample survey conducted to study the relationship between cattle holding size and the land holdings in two zones it was found that in the continental zone, the maximum households owning livestock are the farmers having only a hectare of land followed by the farmers having by 1 to 2 hectares. In case of sub-tropical zone, the farmers with 2.4 hectares of land have the maximum cattle holding followed by farmers with 1.2 hectares. It is quite evident that the land holding in tropical climatic zone is relatively more than the other zones in view of congenial climatic conditions for agriculture. The other zones in the high Himalayas are however not favourable for cultivation. The land is community owned and thus left for grazing the year round.

During the course of field survey as many as 797 households were questioned as to whether the elimination of trees

would harm the mountain environment. After having analysed the data it could be confirmed that a substantial share of the respondents (65.25%) were aware of the fact that cutting down of trees would harm the environment. Likewise the farmers were asked to indicate whether the milk and meat are carrier of diseases or not. Only 8 percent of the farmers were aware of the fact that milk is the carrier of diseases. Similarly as much as 22 percent of the farmers were aware that meat is the carrier of various diseases. From the questions put about the environmental awareness, it could be gathered that though the inhabitants are by and large aware about the adverse effect of cutting trees on the environment but as far as the more intricate aspects of health and hygiene are concerned like the germ carrying capacities of milk and meat etc., the people are yet to be conscious for which they have to be reasonably educated.

8.2. Recommendations.

Keeping the above findings in view, the following suggestions/recommendations will go a long way in formulating policy for achieving the goal of a quicker and sustainable development of livestock and animal husbandry sector in North Sikkim.

1. Infrastructure being one of the most vital components of economic development, has considerable significance in organizing and quickening the process of livestock development in this formidable mountain territory. Therefore, infrastructural development in terms of improved accessibility with the help of better transport and communications, financial institutions such as banks and cooperatives, technological break through such as imparting scientific training to the progressive farmers, introducing modern innovations in livestock farming etc. be given top most priority for achieving higher productivity.

2. Efforts must be directed to evolve a strategy for a rational and scientific management of grassland and the community pastures by enforcing laws through government legislations.
3. Corrective measures should be taken to improve the fertility status of the soil in ecologically vulnerable areas.
4. The nutrient deficit areas should be brought under scientific studies with a set objective of replenishing such soils with the required nutrients.
5. A cadastral survey be under taken to determine the exact area under pastures in the study area for further planning and policy formulation for livestock development.
6. Efforts, be made to rehabilitate and improve the economic conditions of the livestock holders who practice trans humance in the high Himalayas since time immemorial.
7. Efficient extension services should be rendered to bring the farmers home about the profitability of modern and scientific farming with a view to increasing the family income.
8. For furthering the cattle breeding programmes the following steps will help realise the set targets.
 - (i) Cattle breeding programmes can be further strengthened by distributing superior bulls in the inaccessible areas of North Sikkim.
 - (ii). Castration of the undesirable and inferior bulls must therefore be under taken on extensive scale.

(iii). The animals which are accessible by better road and communication and particularly located near the jeepable roads must be covered under artificial insemination programme.

(iv). Finally milk recording system should be introduced to identify the superior cows.

9. Fodder production both in the farmers and pasture land must be stepped up and distribution of mineral feed suppliments must be introduced extensively in three identified ecological zones.

10. Atleast two germplasm centres i.e. one for sub-tropical zone and another for continental zone and dry high zone should be established to study the local grasses, fodder trees and schrubs for further conservation of the species.

11. As has been said earlier extensive construction of road and communication network has caused concern for the planners and policy makers in view of the fact that considerable damage has been inflicted to the fragile ecosystem of North Sikkim;there fore proper scheme should be chalked out with a set objective of protecting and regenerating the resources affected by such activities.

12. In the course of the study it has been ascertained that recurrent mine blasts especially in the dry high regions are potential threats to the livestock population in the region. Many livestock are reported to have perished due to such man induced hazards. It is high time therefore that a task force consisting of army, civilian technocrats and mine sweeper experts and senior government officials should be raised to study and identify the area and the grazing grounds and make them free of mines.

13. Keeping the perspective of sustainable development in view, commercial livestock farming in the region should be so carried on in consonance with the natural surrounding as to have no adverse impact on the environment.

14. As livestock normally graze to roots in the open pastures on the hill slopes farmers should be motivated to stall feed their animals rather than allowing the same for stray grazing. It is because indiscriminate grazing in the hill slopes will ultimately lead to exposure of the top soil there by causing heavy soil erosion and leaching.

15. For commercial meat production, livestock slaughter units should be scientifically managed so that the same do not create any environmental problem such as pollution.

16. Emission of methane gas through the metabolic process of the animals is an environmental concern. Therefore, the problem should be tackled in two ways i.e. to raise only productive livestock and secondly the feeding of livestock based on crop residue should be minimised as far as possible.

17. Care must be taken while raising infrastructure in the area particularly the construction of roads and communication for improved accessibility so that such activities do not cause wide spread damage to the environment. In this respect, it has been ascertained that road construction in the higher Himalayas in Sikkim has led to extinction of some very endangered flora such as rare orchids and plants species etc.

18. As indiscriminate cutting of hill slopes for construction of road and buildings is going on in full owing, land slides have become a common and frequent phenomenon in certain parts of

the state. Therefore adequate scientific measures should be taken to check such man induced calamities which lead to grave consequences in regard to environment and the economy of the region.

19. In the dry high zone of North Sikkim as the grazing lands are owned by the community, there is a perceptible danger of mismanagement of the grazing grounds i.e. if large scale livestock farming is encouraged at grass root level through economic incentives provided through various schemes. Therefore, proper legislation should be enacted by the government to check such tendencies in the interest of sustainable environmental policy.

20. Above all, co-ordination between technologists, administrators, planners and policy makers to bring about a balanced development of the economy is inevitable. Any slackness in this regard therefore may adversely affect the process of organisation and development of the livestock in the region.