

Chapter 3

Changes in Livelihood Patterns

3.1 Different forms of Livelihood:

According to dictionary, Livelihood is “means to living”. According to Chambers and Conway (1992:7) - “Livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required to for a mean of living.” This definition directs the link between assets and options people possess in practice to pursue alternative activities that can generate income level required for survival. The followers of Chambers and Conway have identified five main categories of capital contributing to assets in livelihood, which are as follows: i) Natural Capital, ii) Physical Capital, iii) Human Capital, iv) Financial Capital and v) Social Capital.

- i) *Natural Capital*: It refers to the natural resource base (land, water, trees) that yields products for the use of human survival.
- ii) *Physical Capital*: It refers to assets, which are essential for economic production process, e.g. tools, machines, terraces in mountains for cultivation and irrigation canals etc.
- iii) *Human Capital*: It refers to education level and health status of population.
- iv) *Financial Capital*: It refers to stock of cash to purchase production and consumption of goods.
- v) *Social Capital*: It refers to the social networks and associations in which people participate for deriving support for livelihoods.

The definition of livelihood has been formulated in a most comprehensive way as follows:

“A livelihood comprises the assets (the natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social

relations) that together determine the living gained by the individual or household".
[Frank Ellis]

But the elements cannot assume to be fixed. Rather available activities fluctuate seasonally and across the year. At present, in developing countries, the characteristic of rural livelihood is to adapt in order to survive. The shifting norms and events in the social and institutional context surrounding their livelihoods compel the individual household to change the access to resources and opportunities.

The terms livelihood and income are not synonymous, rather income of an individual, at a given point of time, is the most direct and measurable outcome of the livelihood process. Livelihood is the way to generate income for living. Income consists of both cash and in kind contributions to the material welfare of the household deriving from the set of livelihood activities in which wages, rents and remittances are the components of cash income; and consumption of own-farm produce, payments in kind, and transfers or exchanges of consumption items are the components of in-kind income.

It is also important to know the difference between farm income, off-farm income and non-farm income.

Farm Income: The income generated from own account farming whether on owner occupied land or in tenant land. Broadly, it includes livestock income, crop income, consumption income of own-farm output as well as cash income obtained from output sold.

Off-farm Income: It typically refers to wage or exchange labour on other farm within agriculture. It includes labour payment in kind (either may be as harvest share system or other non-wage labour contracts). It may include the income obtained from local environmental resources such as firewood, charcoal, house-building materials, wild plants etc.)

Non-farm Income: It refers to non-agricultural income sources. It may include the followings - a) Salary income, b) Business income, c) Rental income, d) Urban to rural remittances, e) Pension payment and f) International remittances.

According to Frank Ellis, “Rural livelihood diversification is defined as the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standard of living.”

The evolution of rural livelihoods can be described by three main groups of theories, namely, agricultural development, political economy and population and technology theories.

The evolving role of agricultural sector to the development process has been described by the Agrarian Development Theories. The dual economy approach (Lewis, 1954; Fei and Ranis, 1964) envisaged no prospects for rising productivity in so called traditional agriculture, which could only therefore passively supply resources to the modern sector of the economy until the latter eventually expanded to take its place. Later models retained the core idea that agriculture would decline in its share of GDP as development process, as in the history of the industrialized countries.¹

In 1970, the central focus of agricultural development was the achievement of rising productivity in small-farm agriculture and it remained the orthodoxy well into the 1990.

[Tomich et al., 1995]

The main livelihood activities in mountain areas are terraced agriculture, paddy farming and cash cropping, grazing, fishing, tourism, shifting cultivation, agroforestry etc. Thus the main source of livelihood revolves around agriculture. According to one study, livelihood of majority of the mountain people in the Hindukush Himalayan (HKH) region countries (Nepal, Bangladesh, Bhutan, Pakistan, India, China, Myanmar and Afghanistan) revolves around agriculture. In the HKH countries, a population of about 150 million inhabitants lives in an area of 3.4 million sq. km, with about 35 persons/sq.km. The actual pressure on sloping hills and mountains on the agricultural land is much greater in terms of food security and livelihood of the mountain people (Pratap, 2001).

Mountain area has various constraints in the way of maintaining livelihoods. Almost all the mountain area has limited livelihood options than in the plains. Common

livelihood options prevailing in the mountain area are: terrace cultivation, forestry, service, petty trade, livestock rearing, plantations, cottage industries and tourism etc. In Sikkim, the main livelihood options are – crop cultivation, large cardamom plantation, livestock, agricultural labour, non-agricultural labour, service and business/shop and of late, tourism. Terrace cultivation is practiced in all the four districts. Though crop productivity is not so good in Sikkim Himalaya, most of the people in this state depend on agriculture for their livelihoods. Plantation is another important means of livelihood. In Sikkim, various plantation activities are possible, e.g., of tea cultivation and processing, large cardamom cultivation and processing, mandarin orange, plum, pear and peach growing and packaging, etc. Large cardamom is the most important plantation crop in Sikkim. Livestock rearing is also an important livelihood option in Sikkim. It has both domestic and business aspects. Mainly pig, sheep, buffalo, cow, yak, poultry etc are reared in this area. The service sector has second largest contribution for the livelihoods of the Sikkimese. People working at state or central govt. offices, teachers, doctors etc. fall in this sector. Many people maintain their livelihoods through trading and female participation is quite good in this field.

Agriculture: As can be expected, agriculture is the main livelihood in Sikkim. More than fifty percent people of Sikkim depend primarily on agriculture to earn a living. Though mountain areas have many constraints, the population pressure has compelled the people to plough intensively by way of terrace farming. As flat piece of land is hardly available, people practice terrace farming on mountain slopes having moderate slope. In the pre-merger period, the state was much backward economically and more than 90% people depended on agriculture to maintain their livelihood. But, in post-merger period, the dependency declined to 52%. The people were primarily practicing cereal crop-based farming before 1975. Subsequently they have adapted certain cash crops.

Agricultural Labour: This livelihood option is not as widespread as in the plains, because, there are many constraints of agriculture and labour is a high priced commodity in the mountains. Most of the farm owners work in their own land for to raise crop.

Large Cardamom Plantation: Growing cardamom in small plantations and in forested areas is an age-old livelihood activity of the indigenous tribes of Sikkim. Most of the rural people grow cardamom to supplement their livelihoods. Larger plantations were created much later by wealthy indigenous farmers owing to high profitability and cash rewards brought home by exporting the crop. It is widespread throughout the state, particularly in humid forest areas. Large cardamom is also the main commercial crop in Sikkim. The state is the largest producer of this spice.

Livestock Rearing: The congenial temperate climate and sub-alpine vegetation in the Himalayas are highly favorable for exotic high producing livestock. The highlanders like Lachungpas, Lachenpas, Gurungs and Sherpas of Sikkim have a traditional pastoral economy which has been handed over from generation to generation with their typical kinds of livestock such as Yaks, sheep, mountain goats, pigs and poultry. With the increase in population and the limited availability of land (as 70% of the holding in Sikkim is smaller than 2 hectares) there is already great pressure on the cultivable land and forest and on the environment as well. Many farmers are complaining about the change in environment and decline in soil fertility. Under such situation livestock farming which requires minimal use of land, labour and capital would be ideal sustainable model for development in such difficult mountainous terrain. At present almost 70% of the farmers rear their livestock under stall fed condition and has drastically reduced pressure on land due to overgrazing.

The development of livestock would not only provide supplementary source of income but would provide high protein rich food items such as milk, eggs and meat and organic manure for crop production.²

Forestry

The land cover under forestry was always high in Sikkim. This forest is the hotspot of tremendous biodiversity with 4500 flowering plants, 515 orchids, 36 rhododendrons etc. The latest data of forest land as found from the Forest Survey of India (FSI), State Forestry Report 2003, has shown that the dense forest covered area has declined 29 sq.km., whereas the open forest area has increased 98 sq.km. and scrub area cover has increased also up to 19 sq.km. It can be concluded from the following table that the decrease in non-forest area came under the forest area, which was consequence of the

measures taken to conserve the forest area for environmental aspects. Since most of the forests in Sikkim are protected, people cannot maintain their livelihood depending only on forestry. However they supplement their resources by collecting various forest products, such as, firewood, fruits, roots, resin, etc.

Table 3.1: Sikkim Forest Cover Change from 2001-2003(Sq.Km.)

Category	2001	2003
Dense Forest	2391	2362
Open Forest	802	900
Scrub	341	360
Non-forest	3562	3474
Total	7096	7096

Source: Forestry Survey of India, 2003, Dept. of Forests, Gol

Tourism: The most upcoming economic activity in Sikkim is tourism. Nowadays, it is very important livelihood opportunity open to the people of the mountains like Sikkim Himalaya. The very rich natural and cultural heritage of Sikkim and scenic beauty of the hills make this small Himalayan state in Northeastern India an attractive destination for international and domestic tourists. With over 90,000 domestic and 6,000 international tourists in 1995, tourism is rapidly becoming an important livelihood activity for the Sikkimese people.

3.2 Workers

According to Census of India, “work” is defined as participation in any economically productive activity with or without compensation, wages or profit. Such participation may be physical and/or mental in nature. Work involves not only actual work but also includes effective supervision and direction of work. It even includes part time help or unpaid work on farm, family enterprise or in any other economic activity. All persons engaged in 'work' as defined above are workers. Persons who are engaged in cultivation or milk production even solely for domestic consumption are also treated as workers. Reference period for determining a person as worker and non-worker is one year preceding the date of enumeration. The workers are further sub-divided into

Main Workers, Marginal Workers, Cultivators, Agricultural Labourers, Household Industry Workers and Other Workers.

Main Workers:

Those workers who had worked for the major part of the reference period (i.e. 6 months or more) are termed as Main Workers.

Marginal Workers:

Those workers who had not worked for the major point of the reference period (i.e. less than 6 months) are termed as Marginal Workers.

Cultivators:

The land owned or held from govt. or from private persons/institutions for payment in money, kind or share and cultivated by a cultivator. The effective supervision or direction in cultivation is included in the cultivation activity.

But, if a piece of land is given out to another person or persons or institution for cultivation in exchange of money, kind or share and not directly supervised by or directed by the owner of the land, then the persons are not treated as cultivators, rather they will be treated as agricultural labourer.

The plantation of tea, coffee, rubber, coconut, betel-nuts etc are not included in cultivation. It involves ploughing, sowing, harvesting and production of cereals, millet crops such as wheat, paddy, jowar, bajra, ragi etc and other crops such as sugarcane, tobacco, ground-nuts, tapioca and pulses, raw jute and kindred fiber-crop, cotton, cinchona and other medicinal plants, fruit growing, vegetables growing or keeping orchards or groves etc.

Agricultural Labourers:

The agricultural labourer has no risk in the cultivation, but simply works on another person's land for wages. They have no right of lease or contract on land on which they work.

Household Industry Workers:

The industry conducted by one or more members of the household at home or within village in rural areas and only within the boundaries of the house where the household lives in urban areas, is called household industry. Most of the workers in this industry consist of members of the household. These are not registered under the Indian Factories Act. The participation of one or more members of a household is the main criterion of a household industry even if the industry is not located in home or in the village. The household industry is not prominent in the area of organized industry in any urban area. The industry should be located within the boundaries of the house in the urban area, otherwise it will not be considered as household industry. It relates to production, processing, servicing, repairing or making and sometimes selling of goods. But, it does not include professions such as a Pleader, Doctor, Musician, Dancer, Waterman, Astrologer, Dhobi, Barber, etc., or merely trade or business, even if such professions, trade or services are run at home by members of the household.

Other Workers:

The workers that are not included in the category of Agricultural Labourer or Household Industry Workers but engaged in the economic activity during last one year are known as Other Workers. It includes all government servants, municipal employees, teachers, factory workers, plantation workers, those engaged in trade, commerce, business, transport, banking, mining, construction, political or social work, priests, entertainment artists, etc.³

Keeping in mind the earlier classification of workforce and the various livelihood opportunities available in Sikkim, the data of various workforce participation since 1971 to 2001 have been shown in the following table to graph the change of the participation.

Table 3.2:**Work Force Participation in Sikkim since 1981 to 2001**

Items	1971	1981	% Change	1981	1991	% Change	1991	2001	% Change
Population	209843	316385	50.8	316385	406457	28.5	406457	540851	33.1
Total Workers	111609	152814	36.9	152814	168721	10.4	168721	263043	55.9
Main Workers	111609	147436	32.1	147436	164392	11.5	164392	212904	29.5
a) Cultivators	NA	88610	NA	88610	97834	10.4	97834	101200	3.4
b) Agricultural Labourers	NA	4887	NA	4887	13793	182.2	13793	9081	-34.2
c) Worker in HHIndustry	NA	1586	NA	1586	1309	-17.5	1309	3168	142
d) Other Workers	NA	52353	NA	52353	55785	6.6	55785	99455	78.3
Marginal Workers	NA	5378	NA	5378	4329	-19.5	4329	50139	1058.2
Non Workers	98236	163571	66.5	163571	237736	45.3	237736	277808	16.9

Source: Adapted from Census of Sikkim and India, 1971, 1981, 1991 and 2001, GoI, New Delhi

The above table shows the broad categories of work-force participation in different censuses of Sikkim. Sikkim became the member of Indian Union in 1975. So, the workforce details were not available in the 1971 census. The detailed data were available in 1981, 1991 and the latest census of 2001. In the decade after the merger of Sikkim with India, the population of Sikkim increased by 50.8 percent. The number of total workers increased by 36.9 percent, but the increase in non-workers was alarming (66.5 percent). The main workers also increased by 32.1 percent. The high growth of population and high growth of non-workers was due to the merger of Sikkim with India. Many people from various parts of the country and even from Nepal came to Sikkim in search of livelihoods.

The second decennial change in population was smaller (28.5 percent) compared to the previous one. The rate of growth of non-workers too slowed down. By that time Sikkim already had substantial increase in total workforce. In that decade, there was 11.5 percent increase in main workers and a very high rate of growth was registered in the category of agricultural labourers, which was 182.2 percent. The most unusual change was seen in case of household industry and marginal farmers. In both the cases, the change was negative. But, during this period the rate of growth of non-workers (45.3 percent) was much higher than the rate of growth of main workers (11.5 percent). This gap proves that the unemployment rate was pretty high during that period.

During the last decade, the rate of growth of population was higher than in the previous decade. But the absorption of the workforce was mainly in 'other workers' category. The rate of growth in cultivators was much lower than the previous decade, which reflects the fact that the agricultural sector was saturated. People supplemented their livelihood by working in marginal work category. The non-agricultural activity e.g., household industrial work too increased substantially.

Table 3.3: District-wise Comparative Workforce Participation (1991-2001)

District	Area (km ²)	Main Workers		Marginal workers		Non-workers		Cultivators		Agricultural Labourers	
		1991	2001	1991	2001	1991	2001	1991	2001	1991	2001
North	4226	42.9	42.83	1.23	14.78	55.87	42.39	46.25	38.82	14.95	8.87
South	750	41.8	43.55	0.98	9.49	57.22	46.96	70.79	69.57	5.12	3.83
East	954	37.14	37.77	1.37	9.94	61.49	52.29	39.27	32.5	8.4	6.92
West	1116	44.32	36.67	0.54	6.46	55.14	56.87	77.41	67.3	7.29	7.69

Source: Sikkim: A Statistical Profile 2002, DESME, Govt. of Sikkim, Gangtok

The North district of Sikkim, with an area of 4226 sq. km, covers more than fifty percent area of the state. But, most of the area is uninhabited because of high altitude and very low temperature. In 1991, more than half (55.8 percent) of the population was non-workers and 42.9 percent was main workers. Very few (1.23 percent) were marginal workers. In 2001, the number of marginal workers has increased substantially, accounting for 14.7 percent while the number of non-workers decreased to 42.3 percent. It might happen that many people have got the opportunity to work for less than 180 days in a year during the decade.

It is also to be noted that the number of agricultural labourers and cultivators have reduced remarkably, which indicates that, peoples were absorbed marginally in other works.

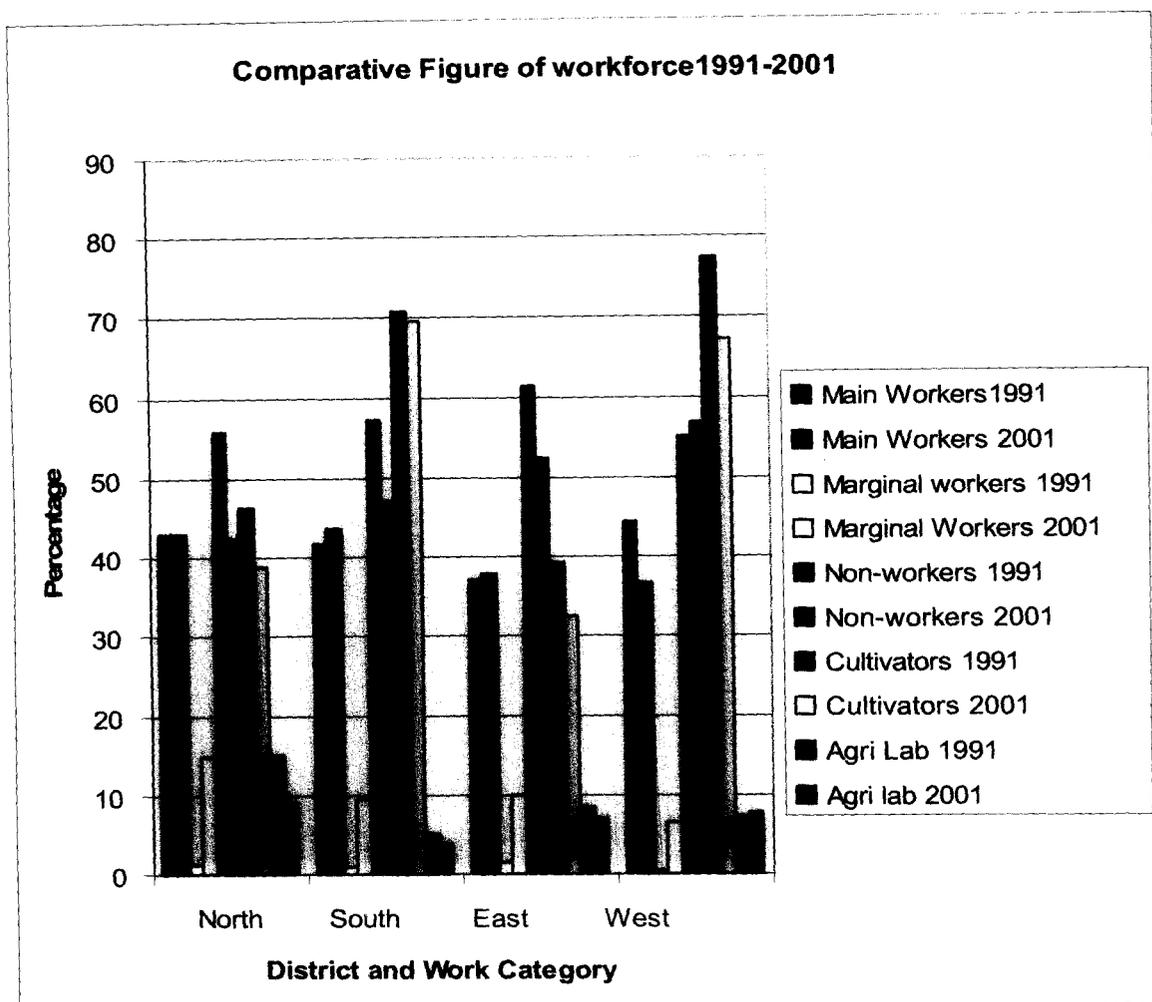
The South district, with an area of 750 sq. km is smallest district in Sikkim. The number of main workers in the district has increased marginally from 41.8 percent to 43.55 percent during this decade. The number of agricultural workers and cultivators has decreased marginally. There is a substantial fall in non-workers and substantial rise in marginal workers, which is same as in North district.

The East district is the most populous district though in terms of area (954 sq. km) it ranks third among the four districts of Sikkim. The percentages of main workers in the district have changed marginally during the last decade. The percentage decrease in cultivators is almost same to percentage increase in marginal workers. There is also decrease in agricultural labourers during 1991-2001. The percentage of non-worker has been reduced substantially, which might be due to increase in opportunity of non-farm activities.

There is a substantial fall in main worker in West district, which is 2nd largest in area (1116 sq. km). The fall in main worker is almost 8% and the increase in marginal worker is almost 6%. The fall in cultivator is almost 10%, which might have been absorbed by non-farm activities. Thus, it can be concluded from the workforce participation figure that the livelihood activity was shifting from farm to non-farm.

In the North, South and East districts the percentages of non-working population have decreased substantially during the last decade (1999-2001). The East district, which had 61.49% non-working population in 1991 has reduced the same to 52.29%. The North district has cut down its non-working population by a margin of 13.48%. The South district too has reduced the non-working population by nearly 10%. The only exception is the West district, where the percentage of non-workers has showed marginal increase. Overall, the state shows a positive shift from high non-working to moderate work-force participation.

Figure 3.1: Comparative Workforce Participation from 1991-2001



Source: Sikkim: A Statistical Profile 2002, DESME, Govt. of Sikkim, Gangtok

3.3 Why Agroforestry?

According to K.F. Wiersum, agroforestry was developed in 1970s and it included two developmental pathways -- one was, incorporation of trees in agricultural cropping systems and the other was, incorporation of crops in forest systems. The first one was most focused and lot of research work has been done. But, the forest vision got little attention in practice and in research works. Of late, people are getting more aware to save the natural forests and practices analogous to major agro forestry systems - Home Gardens and Forest Gardens are getting importance.

Home Gardens: It is predominantly found in fencing of gardens or surrounding of houses planted with trees or fruits, vegetable herbs and annual crops [Kumar and Nair 2004].

Forest Gardens: It is a mixed tree plantation surrounding or at some distant places from villages. It includes a higher percentage of native trees but less intensively tended than the home gardens (Wiersum 1982).⁴

The Agroforestry practices are the call of time and it does not confine to any particular region or area. It has a universal acceptance for its wide scope. The scope and need of Agroforestry is discussed in the following paragraphs:

A) *Agroforestry for Food, Fuel and Fodder*

As population increases, the demand for food and fuel increases proportionately, particularly in developing countries like India. But the production of food and fuel is not enough to feed all. It is also true for livestock, which demands fodder. So there is acute shortage of food, fodder and fuel especially in Asian countries. There is little scope to increase the arable land. So, it is important to develop new land management system so that it could be possible to meet the demand for food, fodder and fuel from the existing land. The agroforestry system could be a possible solution in enhancing the supply of food, fodder and fuel.

B) *Agroforestry for Soil and Water Conservation and Conservation of Production Base*

The surface run-off washes away soil and the land is degraded due to water erosion. This problem is very much acute in our country, particularly in the mountain areas. Agroforestry has the provision to reduce it and save land from erosion and degradation.

Table 3.4: Natural Risk Factors & Environmental Degradation in India

Principal Cause of Land Degradation	Land Area Affected [MHa]	% to Total
Water Erosion	111.0	64.09
Wind Erosion	39.0	22.52
Water logging	8.5	4.91
Soil Salinity and Coastal Dunes	5.5	3.18
Soil Alkalinity	2.5	1.44
Ravines and Gullies	4.0	2.31
Riverine and Torrents Area	2.7	1.56
Total Land Area Affected	173.2	100

Source: adapted from M Velaynthum [1992]

It is found from the above table that the water erosion is the dominant cause for environmental degradation in India. More than 64% percent of the total area in the country is affected by water erosion. Agroforestry can cloth the barren and wastelands of watersheds. Agroforestry plantation on pastures or on agricultural lands will induce more interception of rainfall, more infiltration and lower the intensity of rainfall to reduce the soil and water loss.

C) *Agroforestry and Improvement of Soil:*

The production base of soil can be increased by Agroforestry practices and it also helps to improve the quality of the soil by leguminous tree plantations. The leguminous trees enrich soil by biological nitrogen fixation, composing organic matter and recycling of nutrients. The shade tree *Alnus Nepalensis* (Utis) planted as shade tree for the large cardamom in Sikkim has the highest nitrogen fixing capacity (444 x 1000000 KJ/per hectare/per year).

D) *Agroforestry and Agro-based Cottage Industries:*

Almost 70 percent of the Indian farmers are marginal and many of them live below poverty line. The Agroforestry programme will help to uplift the socio-economic condition of the poor by the agro-based cottage industries, such as, dairying, fruit and fibre industries, piggery, poultry, gum, lac, paper pulp, herbal drugs, cut flowers, bee-keeping, sericulture, production of raw silk, dyes and mushroom industries, etc. These cottage industries will provide gainful employment to farmers, and strengthen the economic conditions.

E) *Agroforestry and Micro-climatic Moderation:*

In semi-arid or arid regions of India (e.g. Rajasthan), the agricultural production is not stable due to poor yields and frequent crop failure by low and absentee rainfall. The system can be stabilized by the help of Agroforestry, as it compensates the failures by giving income from products other than the crops. To moderate the micro-climatic condition in the locale of trees, agroforestry will benefit field crops growing in association with trees. Plantation of tree rows on field borders has valuable influence of wind-breaks in protecting crops. Agroforestry programme provides the farmers with timber and fire-wood for domestic use, fodder for cattle,

agricultural implements and fertilizer for their fields. Thus agroforestry not only makes the farmers self-sufficient, it also supplements income without affecting agriculture.

F) *Agroforestry and Ecological Balance:*

The high population growth and pressure on forests may imbalance ecology. Nowadays, the forests are confined within hilly tracts. As the soils of hills are either rocky or less fertile, when brought under plough, it further aggravates the ecological imbalances.

The agroforestry systems have considerable scope of harnessing advantages of forest by planting trees on marginal lands and terrace boundaries. It can restore the ecological balance without reducing the area under agriculture. The vast non-arable marginal and degraded lands can be brought under agroforestry. The system is very much site and climate specific.⁵

3.4 Types of Agroforestry

There are two basic categories of agroforestry systems found around the globe:

i. *Simultaneous Agroforestry System :*

In this system, crops, animals or trees grow together at the same piece of land at the same time. In this system, trees and crops compete for light, water and nutrients. Spacing and other means are used to minimize the competition. The crop roots should be less deep than the tree roots. The tree should have a small canopy, so they do not shade out too much light from the crops. In this system, the trees appear in a linear arrangement like a row, or in strip for more than one row. Many categories of plantings can be found, in simultaneous agroforestry system, viz.,

- a) Boundary Plantings: Trees are used to delineate plots or farms. These trees can provide wood, fodder or other products.
- b) Contour Hedges: Trees are planted to prevent erosion and form biological terraces.
- c) Living Hedges: Living hedges, live fences and woody strips are all variations on the technique of using shrubs or bushes to form a continuous barrier. These are used

to form animal paddocks but they can provide food and various other products as well.

- d) **Windbreaks:** To protect crops or animals windbreaks or shelterbelts are used. It is also useful for conserving soil moisture, give shelter to the farm home and beautify the site.
- e) **Hedgerow Intercropping (Alley Cropping):** In this system, trees are planted on land along with crops; the crops are grown in alleys between the rows of trees. This system has a specific object to maintain soil fertility by planting nitrogen-fixing leguminous trees or shrubs in areas where shortage of land makes a long fallow period difficult or impossible. But, it is practical only in limited circumstances as there is competition between hedge and crop for moisture and nutrients.
- f) **Parkland System:** It includes combination of trees and crops in which the woody component is a permanent upper storey. Multipurpose trees like fruit trees may be planted in a scattered manner on the crop land.
- g) **Silvopastoral System:** It incorporates a discontinuous trees storey, over a continuous grass cover. The animals can graze in pastureland under trees or they can feed off tree fodder or browse. The fodder from the trees can also be cut and carried to livestock penned elsewhere.
- h) **Agroforests:** It is a special category of agroforestry. It is a plant community that resembles a natural forest in that it is generally multi-strata and contains large, mature trees and shade-tolerant under storey plants. It is a managed system, e.g., home garden, familiar in humid tropics. It contains different plant species of various sizes, types and growth cycles and planted near a homestead. It is useful for providing a wide variety of foods and other domestic needs as well as commercial products.

ii. *Sequential Agroforestry Systems:*

In this system, crops and trees take turns in occupying most of the same space. The system starts with crops and end with trees. The competition is lower in this regard because of time sequence. Crops in this system grow less rapidly and the trees grow

rapidly, reprocess nutrients from bottomless layers, fix nitrogen and have a large shade to help suppress weeds.

This system consists of different agroforestry practices such as:

a) Shifting Cultivation:

This is the most extensive farming system of humid tropics and one of the old and traditional systems, which is also familiar known as slash-and-burn agriculture. In this system, farmers cut, let dry and burn the forest vegetation, then plant crops or pastures, using the ash as fertilizer to enrich temporarily the poor soil. They stay for as long as the soil can support their crops, usually two or three cycles and then let a forest fallow grow for 15-30 years until sufficient nutrient accumulates in the biomass. After 15-30 years, the farmers return in the slash-and-burn site, and the cycle continues.

This traditional system is sustained for long period, because, it is useful for low population pressure with vast range of forest. As the population increased rapidly with shrinking forest, the cycles become shorter and shorter until they are no longer sustainable. The shrinking forests have no time to accumulate nutrients for biomass, thus the fallow periods become shorter and shorter.

b) Relay Cropping:

This system is very promising for single rainy season area. The crops and trees are planted in the same piece of land at the beginning of the rainy season. The crops grow rapidly, and the trees grow slowly, thus minimizing the competitions. The trees grow rapidly after the crops are harvested. During this time, a short time fallow can be seen. The trees drop their leaflets, providing mulch; then the trees are cut and harvested for poles or firewood. To get the benefit from nutrients and improved soil fertility the crops are planted again, while the trees begin to grove and re-sprout from seeds.

c) Multi-Strata System:

It also involves planting annual crops with several species of trees at definite spacing. Trees get established and grow while crops get dominance. The planted

trees are of different eventual size, shape and use from various strata or canopies, with or without simultaneous cropping. To control weeds and for the use of grazing, leguminous type of ground cover is used.

d) Improved Fallows:

To shorten the fallow period and increasing its biomass and nutrient accumulation, these are used in the humid tropics as an improvement of shifting cultivation. These are also used in the sub-humid tropics to occupy land for accumulation of biomass and nutrients in the soil and to smooth the weeds. Normally, improved fallows are planted shortly before or after the harvesting periods. Generally, fast growing nitrogen fixing trees are used as they do not compete with crops.

e) Taungya System:

This is one of the oldest agroforestry systems in the world. In this system, the forest authority allows the farmers to use the forest land planted to young trees. The farmers grow crops for several seasons and also take care of young trees, until the trees grow enough to cover the entire crop area and then the forest authority takes over the plots again.⁶

3.5 Agroforestry Evidences in Sikkim

Over the years, the people of Sikkim have evolved many agroforestry practices that proved to be beneficial to meet their need of food and shelter and also biological needs. As the population increased, per capita land availability decreased substantially. The low land-man ratio, low productivity per unit of land caused the rural people to shift from traditional crops to commercial cash crops. Also, the low cropping intensity due to mono cropping compelled the rural people to change their livelihood patterns. After the merger of Sikkim with India the land-use patterns changed at a faster pace. The imminent need to expand agricultural production while retaining the existing forests has given rise to agroforestry. Since the agroforestry practices are environment friendly, they may thus play an important role in developing more intensive, socially responsive, ecologically sustainable and highly efficient patterns of land-use for the people of Sikkim. Up to 1987, the ICAR identified three distinct agroforestry systems in Sikkim, which were as follows: I) Large

Cardamom + Utis, Chillowani etc., II) Fodder trees with upland crops and III) Citrus + Maize (Ragi); Buck Wheat/ Soya bean/ Beans/ Ginger.

Later, the Indian Council of Agricultural Research (ICAR) identified four types of agroforestry systems in Sikkim. They are sylvi-horti systems, horti-agri systems, and miscellaneous fruit trees in homestead and agri-silvy systems. The main commercial and native spice of crop is large cardamom. In Sikkim, the Lepchas, the first inhabitants of Sikkim, used to collect the capsules from the natural forests. Eventually when the forests passed into village ownership the crop was domesticated. Now, Sikkim contributes about 53% of the world's production of large cardamom. A map of major large cardamom growing areas in Sikkim prepared by Sharma shows that the southern half of Sikkim produced the most of cardamom, i.e. within 600m to 200m or Sub-tropical to Temperate zone (Sharma, et al 2000). The Large Cardamom (*Amomum Subulatum*) is grown under the shade of thinned forest or man-made forest under moist soil with high organic matter content, in the sylvi-horti systems. Up to 1993, 29 shade tree species have been identified which also serve as the main source of fuel, fodder and timber. The predominant shade tree is Utis (*Alnus Nepalensis*), which is a fast growing nitrogen-fixing non-legume. In the horti-agri systems Sikkim mandarins are intensively intercropped with various cereals, pulses and vegetable species. Ginger requires high dose of farmyard, which is also helpful for mandarins, and is the most remunerative cash crop. Guava, banana, drum sticks and few vegetable species like tomato and chili are found scattered over the lands around farmhouses. The agri-silvy system is largely based on fodder and fuel yielding tree species. Fodder trees become important source of fodder during lean period of October to March. Fuel wood is the main source of domestic fuel in Sikkim. Fodder and fuel trees are found growing on terrace risers of uplands and along farm boundaries. 24 fodder trees have been identified of which *Ficus Spp.*, *Artocarpus Lokoocha* and *Litsea Polyantha* are found to be most popular among the farmers. *Guercu Lamellosa* was ranked at number one, followed by *Castonopsis Tribuloides*, *Eurya Japonica*, *Schima Wallichii* and *Alnus Nepalensis*. As such it is in the subsistence level.⁷

Large cardamom (*Amomum subulatum* Roxb.) is a native plant of Sikkim Himalaya and is probably one of the oldest spices known to the mankind. As mentioned by Susruta, it was used in Ayurvedic preparation as early as in the 6th century BC. It was

known to the Greeks and Romans as Amomum. The spice was recorded by the Greek philosopher Theophrastus in the 4th Century BC. The cardamom capsule contains about 3% of essential oil rich in cineole. The indigenous tribe, Lepchas, used to collect the capsules from the natural forests. But later these forests passed into the ownership of villages and the plants have been domesticated eventually. Subsequently, Bhutia landlords, named Kazis, monopolized the cardamom plantations and started to cultivate in their large size land-holdings. Subsequently, the Nepalese community knew about this and they too started to harvest *Amomum subulatum* Roxb. as a cultivated species, but there are five more wild species planted in Sikkim, these are: *Amomum Linguiforme*, *Amomum Kingii*, *Amomum Aromaticum*, *Amomum Corynostachyum* and *Amomum Dealbatum*.

Cardamom is a perennial, low-volume crop, less dependent on external inputs, less infrastructure intensive, high value and non-perishable cash crop planted in marginal lands under tree cover. Normally, it grows in the altitudes of 600-2000m amsl. Humid sub-tropical semi-evergreen forests of mountainous sub-Himalayan regions are its natural habitats. But it is also cultivated in Nepal, Bhutan and Darjeeling hills. The areas receive 2000-3500mm annual rainfall apportioned over 200 days. The higher reaches of the warmer zones and lower altitudes of cooler zones, which have proximity to snow-line, are best for the fast growth of large cardamom. The constant high relative humidity with temperature ranges between 6 to 30 degree C, are experienced in Sikkim. During the time of flowering, both heavy rainfall and frost or hailstorms may damage the growth of the plants and production. It is a shrub by habit and has several tillers consisting of pseudo stems with leaves on the upper part. The spikes appear on the rhizome from the point where the pseudo stems shoots up. It is propagated by raising seedlings from seeds in nurseries and also through separating the rhizomes from the plants. Harvesting of the crops start from August and lasts till November depending on elevations. It is cultivated under various shade trees. But the most familiar shade-tree Himalayan alder, *Alnus nepalensis* D.Don, locally named Utis, is planted in large area, which has both the ecological and economic importance. Intensive studies have been carried out to evaluate the ecological and economic aspects of Himalayan alder.

The post harvesting technology of cardamom is still traditional. The cardamom is processed by using traditional device and indigenous knowledge. The collected capsules are dried in smoke of local Bhatti or kilns. It is a made of smoke-proof stones and mud-walls on all four sides with a small opening in front-side to put fire-wood. The top side is made of bamboo-mats. The capsules are spread on this mat for drying. These are kept for two to three days in continuous smoke for complete dryness. The colour becomes dark brown. Around 300-400kg woods are required to dry 100kg of cardamom capsules. The Spices' Board of India, which was established in 1979 under the Cardamom Act of India, devised a modern fuel-efficient Bhatti for drying of cardamom capsules by passing hot air through. The cardamoms processed in this Bhatti retain their original pink colour and require less fuelwood. But the cultivators have not welcomed it heartily. They have pointed out several reasons behind this. The quantity of cardamom dried in this Bhatti is not so bulky that can affect the market. The original coloured cardamom, i.e., pink, is not accepted with higher price by the traders. This modern Bhatti is established in cardamom producing places, where the cultivators have to bring their products for processing and to wait until their turns. Ultimately, it takes more time and becomes costlier than the traditional Bhatti.

The nitrogen and phosphorus concentration of *Utis* is very high than other mixed trees. As per data available, 65.34 KgN/Ha/Year is fixed in the *Utis* cardamom agroforestry system. The concentration of phosphorus is also much higher than other tree *Utis*, besides its ecological aspects, has economic aspects also. The woods required for the processing of cardamom capsules come from the *Utis* trees. The excess fuel-woods are used for domestic purposes. Experiments show that *Utis Nepalensis* has woody biomass accumulation from juvenile stage onwards and subsequently. The woods amount to 99t/ha in seven year stand and 597t/ha as 597t/ha in 56 year stand (Sharma and Ambasht, 1991).

The sustenance of cardamom is sometimes threatened by viral diseases like Phurkey and Chirkey. These diseases spread because of the practice of cutting through rhizomes. These diseases cause tremendous loss to the harvesters.

The recent study of ICAR, Tadong Centre, Sikkim, which has been published in the Indian Forester (July, 2007), sketched the various agroforestry systems in different

altitudes in a comprehensive manner. According to the study, there are nine major agroforestry systems in the sub-tropical (300 -900m amsl) and mid-hill temperate zones (900-1800m amsl). The systems are – agri-horticultural, agri-horti-pastoral, agri-silvi-pastoral, horti-silviculture, agri-horti-silvi-pastoral, livestock-based mixed farming, sericulture-based mixed farming, sericulture-based farming, bamboo-based farming, homesteads and tea plantation.

Agri-horticultural system: The cultivation of maize and intercropping with ginger, turmeric, buckwheat, beans, pulse-type beans, tapioca and Sikkim mandarin (*Citrus reticulata Blanco*)-ginger/turmeric comprise the system. Recently the practice of mushroom, gladiolus and different type of orchids are getting momentum.

Agri-horti-pastoral: In this system, the Sikkim mandarin, guava, banana, avocado, lemon, gooseberry, ficus sp., broom grass (*Thysolaena agrostis*), *Dolpizium* sp. and other ferns are intercropped with maize, ginger, turmeric, tapioca, buckwheat, wheat, pulses, oilseeds, beans, oat, millets, rice and vegetables. The broom grass is now very popular as it fulfills the fodder requirements as well as fuel-woods.

Agri-silvi-pastoral: This system comprises the crops like maize, wheat, pulses, buckwheat, oilseeds, beans, finger millet and intercropped with *Alnus nepalensis*, *Schima wallichii*, *Prunus cerasoides*, *Terminalia myriocarpa*, *Castanopsis tribuloides*, *Litsea polyantha*, *Macranga denticulata*, *Ficus* sp., broom grass, ferns.

Horti-silviculture: In this system, the large cardamom is intercropped with *Alnus nepalensis*, *Schima wallichii*, *Macranga pustulata* etc. The combination of first one as shade tree with cardamom is most sustainable system in Sikkim.

Agri-horti-silvipastoral: The Sikkim mandarin, avocado, pears, amla, guava, broom grass are intercropped with maize, tapioca, ginger, vegetables, beans, pulses, oilseeds. This system fulfills the requirements of fruits, fuel woods and fodder.

Livestock-based mixed farming: In this system, the common livestock (goats, cattle, pig, poultry etc) are reared with various species of fodder trees like *Cyperus* sp., *Ficus* sp., *Agave* sp. etc.

Sericulture based farming: The Mulberry (*Morus laevigata*) cultivation for silkworm and the interspaces are used for the cultivation pulses, oilseeds, millets, broom grass etc.

Bamboo-based farming: In this system, the various species of bamboo are intercropped with ginger, turmeric etc. The main species of bamboos are *Chimonobambusa sp.*, *Dendrocalamus sp.*, *Bambusa sp.*, *Himalayacalamus falconeri* etc.

Homesteads: The farmers of Sikkim are observed to cultivate various vegetables in the surroundings of their dwellings. Usually, they use the small piece of land for homestead gardens. In this system, the Sikkim mandarin, lime, tomato, guava, papaya, avocado etc are intercropped with vegetables, medicinal plants, orchids, marigold, gladiolus, tuberose and even stall-fed animals like cattle, goats, ducks, pigs etc.

Tea-plantation: Tea is planted in one area of Sikkim (Temi, almost 500ha) by the state government. The wild-cherry (*Prunus cerasoides*) is planted in the boundary area and also used as shade tree.

In the Temperate zone (1800m to 2700m amsl), three type of agroforestry systems are found. These are as follows: Agri-horticultural, Horti-silvi-pastoral and livestock based farming.

Agri-horticultural: In this system, the Sikkim mandarin and apple are intercropped with potato, maize, barley, rice, buckwheat, radish, cabbage, cauliflower etc.

Horti-silvi-pastoral: In this system Sikkim mandarin, apple are intercropped with maize, millets, potato, sometimes large cardamom with some fodder trees like *Alnus nepalensis*, *Quercus sp.*, *Betula alnoides*, *Acer sp.* etc.

Livestock-based mixed farming: The various species of fodder trees are planted with livestock, like goats, pig, sheep, poultry, yak etc. The important fodder species are *Betula uitlis*, *Acer sp.*, *Setaria sp.*, *Rubus sp.*, *Avena sp.*

In the sub-apline zone (2700-4000m amsl), only one type of agroforestry system is observed. As this zone is in high altitudes, the horti-pastoral-transhumance is

practiced here. During November to April in each year the local bhutia community migrates here for such practice. The *Quercus sp.*, *Acer sp.*, *Betula utilis*, *Sorbus sp.*, *Carex sp.*, *Trisetum sp.*, *Allium sp.*, etc are produced with various horticultural crops like radish, peas, potato, beans, maize, cabbage, cauliflower etc

The most high altitude area is alpine zone (more than 4000m amsl). In this high altitude area, transhumance is practiced during certain time of each year. The local Bhutia community usually migrates there and practices the livestock-based mixed farming. In this system, the livestock like yak, sheep, and mules are reared with potato, cabbage, peas and *Poa sp.*, *Agrostis sp.*, *Carex sp.*, *Rumex sp.* Etc. In this area, yak is reared as a main source of livelihood and also used as mode of transport.⁹

The horti-agri system is based on inter-cropping of horticultural and agricultural produces. This system is practiced in low to mid hills. Sikkim mandarin orange is inter-cropped with annual food crops like maize. Ginger is also produced commercially. In the high hills of temperate zone, apple is inter-cropped with potato, barley, radish, cabbage and turnip. But the existing poor health of apple-trees puts doubt about the substantiality of this system.¹⁰

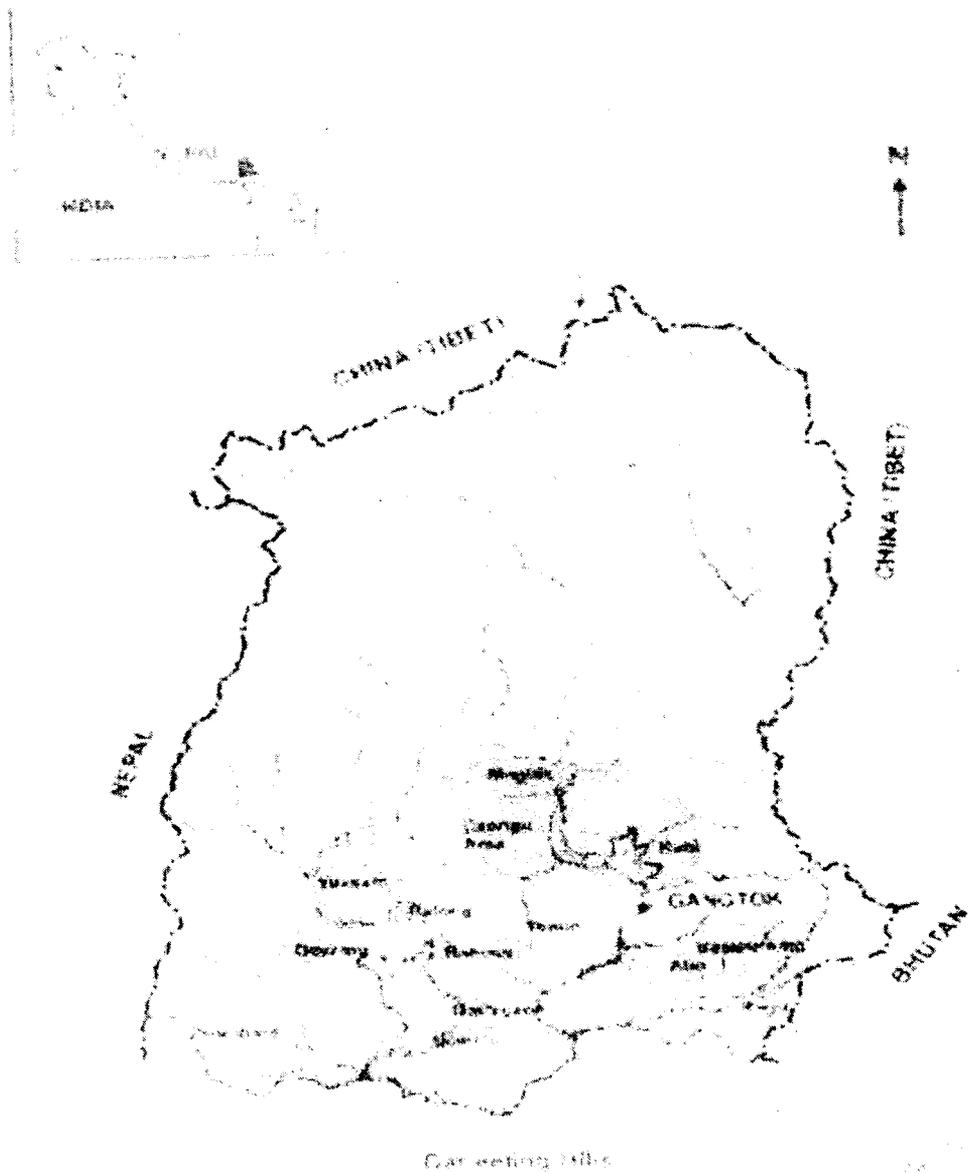
The mixed homestead garden type agroforestry system prevails almost everywhere in Sikkim. Around the homestead, a number of tree species such as tree tomato, guava, banana and some of the fodder trees are grown with crops such as vegetable beans, cucurbits, ginger and turmeric. These are grown for home consumption as well as for commercial purposes.¹¹

Tea plantation exists in a small area between 1500m to 1800 m. altitudes. Wild cherry trees are planted as live borders in tea gardens. The quality of Sikkim tea is rated very high. However, of all agroforestry systems practiced in Sikkim, cardamom plantation has been found to be the most successful and widespread. The indigenous tribes (Lepcha and Limbu) of Sikkim used to collect large cardamom capsules from natural forests. Large cardamom was domesticated in thinned natural forests. The plantations have more than 30 tree species, which provide shade to the crop and fuel for large cardamom drying and domestic use. Among them alder, a nitrogen-fixing tree is most abundant. Local farmers have evolved a classical tree-cutting schedule in plantation area to get continuous supply of fuel wood and fodder without affecting the shade

requirements of large cardamom. Some innovative farmers grow fodder trees as a shade to the cardamom plants. The fodder trees are lopped after harvest of cardamom capsule in November. Large cardamom plantations comprising of trees and perennial herbs resemble a natural forest ecosystem. Sikkim grows 90 percent of the total country's cardamom. There is enormous scope to study the role of cardamom, the chief agroforestry produce, in Sikkim's farm economy.¹²

The large cardamom farming is the main traditional farming system in the Sikkim Himalaya. This system prevails in the marginal lands of forests also. It is very much suited to the environment of Sikkim, because, cardamom cultivation is not only economically valuable but ecologically sustainable. It is not only labour-intensive, but it is a low-volume, non-perishable crop.

Figure 3.2: Map of Large Cardamom Growing Area in Sikkim:



Source: Sharma & Sharma, Mountain Research and Development

Though, cardamom is cultivated in Darjeeling, Nepal and Bhutan Hills, Sikkim contributes 53% of the world's production. It is predominantly farmed in the southern half of Sikkim between 600m to 2000m. i.e., from the sub-tropical to the temperate zone. It is found from the location map of large cardamom production area (which is given above) in Sikkim that the farmed area is continuous from Singhi to Kabi in the North district. In South districts, the production area is scattered in Ralong, Rabong and Namchi area. In the East district, the plantations are situated in Aho and Tumen.

In the West district, the production area is found around Yuksum. There are some other cardamom areas scattered throughout Sikkim. A study was conducted by Sharma et al in 2000 to examine the impact of agroforestry. According to them, a total of 16,949 cardamom holdings have been recorded in Sikkim, of which 70% are smaller than 1ha; 30% holdings are 1-3 ha in size. The most used shade tree in new plantations is the nitrogen fixing alder (*Alnus Nepalensis*) locally known as Utis. But there are several other shade trees, e.g., *Schima Wallichii*, *Engelhardtia Acerifolia*, *Eurya Acuminata*, *Leucosceptrum Canum*, *Maesa Chisia*, *Symplocos Theifolia*, *Ficus Nemoralis*, *Ficus Hookeri*, *Nyssa Bessiliflora*, *Osbeckia Paniculata*, *Viburnum Cordifolium*, *Litsaea Polyantha*, *Macaranga Pustulata* etc.

The total cropped area in the state increased by 106%, while the land under large cardamom increased by 135% in 20 years. Many new large cardamom plantations are on terrace fields that were previously used for cultivation of paddy and other crops. As found from the study, the gross income from large cardamom cultivation in Sikkim has increased from US \$1.9 million in 1975-76 to 5.7 million in 1985-86 and 6.4 million in 1995-96. [Conversion at the current rate of US\$1=Rs.50]

A study that compared two systems – one dominated by large cardamom and the other by maize and potatoes, showed that the household income and per person per day income were almost doubled in the large cardamom system.

Cardamom is almost a closed system in the sense that it does not need any external inputs. To cure the cardamoms capsules 800-1000kg/ha of fuelwood is required; and the shade tree produces 4500 – 5500kg/ha, thus offering a huge surplus for other purposes.¹³

3.6 Livestock – As an Integral Part of Agroforestry:

The cooler hills of the Himalayas have tremendous prospect of livestock rearing, particularly in the high altitude grasslands and meadows. The present rural livelihood system in Sikkim is well balanced from ecological point of view. However, with the increase in population and the limited availability of land, there is already great pressure on the cultivable land and forest and on the environment as well. Many farmers are complaining about the change in environment and decline in soil fertility. Under such situation livestock farming which requires minimal use of land, labour

and capital would be ideal sustainable model for development in such difficult mountainous terrain. The terrace boundary may be used for planting fodder trees, which will be further used as feeds to the stall-fed livestock. The people of Sikkim are already practicing such agroforestry, where the land is used as an integral part of agriculture, forestry and livestock. The grass and legumes planted on steep soil not only provide nutrition but protect the land from erosion and add nitrogen to the soil, which increases fertility of the soil.¹⁴ The potential of livestock rearing as a part of agroforestry is tremendous, which is evident from the secondary data. The following table shows the growth of livestock production in different livestock census.

Table 3.5: Growth of Live-stocks Production:

<u>Name of the Live-stocks</u>	<u>1977</u>	<u>1997</u>	<u>2003</u>	<u>Change(1977-2003)</u>	<u>%Change</u>
Cattle	157546	143024	160932	3386	2.1
Buffaloes	5438	1970	2118	-3320	-61.1
Sheep	16104	5023	5746	-10352	-64.3
Goat	88986	82980	123841	34855	39.2
Yak	3995	4731	5719	1724	43.2
Poultry	220927	219552	321919	100992	45.7
Pig	18596	26975	40938	22342	120.1

Source: Adapted from Sikkim: A Statistical Profile 2003-04, DESME,

Govt. of Sikkim, Gangtok.

The different physical constraints of Sikkim towards the livelihood options compelled the people to think for better alternative which will be sustainable to the hilly environment as well as for the material well-being of the poor people. As an integrated part of the agroforestry system the livestock production in Sikkim grows day by day. The main livestock of Sikkim are Cattle, Buffaloes, Sheep, Goat, Yak, Poultry and Pig etc. It is clear

from the picture that the production of all the live-stocks except Buffaloes and Sheep has increased enormously. This statement can be seen from the below table. Just after the merger of Sikkim with the Indian Territory, the number of all the live stocks was low, but it has been decreased largely in 1997 except Yak and Pig. But in 2003, again all type of live-stocks has increased largely. Especially the production of Cattle, Goat, Yak, Poultry and Pig has increased manifolds. This rise in production might be due to shifting of people from cultivation to this sector and also the increased demand for meats in this area due to large number of visitors from outside as well as for domestic consumption. It is urgent need to think about the production of Sheep to produce wool. Yak is very useful here, especially for temperate zone of North Sikkim. The milk of Yak is concentrated, which is locally called Chhurpi and used as durable food. Many crafts are being produced from Yak. Cattle are used for cultivation as well as for dairy.

Table 3.6: Production of Live-Stock Produce in Sikkim:

<u>Particulars</u>	<u>2000-01</u>	<u>2001-02</u>	<u>2002-03</u>	<u>%Change</u>
Milk(ltrs.)	2682923	3183808	3237778	20.7
Butter(kg.)	10570	10320	8070	-23.7
Chhurpi(kg.)	2071	5166	3563	72
Cream(kg.)	206	922	923	348.1
Paneer(kg.)	2895	5104	5314	83.6
Curd(kg.)	412	458	477	15.8

Source: Sikkim: A Statistical Profile 2003-04, DESME, Govt. of Sikkim,

The milk production as well as other milk produces except butter has increased manifolds in 2002-03. The volume of milk production has increased substantially, which proves that people are engaging more to the livestock production as an alternative livelihood in the hill area. But, the production of butter has decreased gradually. The chhurpi production has

increased seventy-two percent. The volume of cream production is highest in the sense of percentage; it is more than four times. The paneer production also increased highly, it is almost double. The curd production also increased but marginally. Thus, it is clear from the above table that the people switch off their livelihood from traditional system to live-stock.

The above table shows the production of live-stock produce in Sikkim. The milk production has increased 20.7%, but the production from milk, like cream and paneer has increased substantially. But, surprisingly, the production of butter has decreased during the period. The production of Curd has increased marginally. All these products have great potential. If the local needs meted up, it can be exported to Siliguri town, which is just around 70KM from the capital of Sikkim, i.e., Gangtok.

References

1. Ellis,F.[2000]: *Rural Livelihoods and Diversity in Developing Countries*, Oxford University Press, New York, P.21.
2. <http://www.sikkim.nic.in>
3. GoI[2001]: *Census of India*, New Delhi
4. Wiersum,K.F.[2004]: 'Forest gardens as an 'intermediate' land-use system in the nature-culture continuum: Characteristics and future potential', *Agroforestry Systems*, Vol. 61, P. 123-134
5. Singh,M.P. & Tewari,D.N.[1996]: *Agroforestry and Wastelands*, Anmol Publications Pvt. Ltd.,New Delhi, P.37-39
6. <http://www.icraf.org.in>
7. ICAR [1991]: *Status Paper on Achievements (1976-90) and Ongoing Research Programmes of ICAR*, Tadong, Sikkim
8. Sharma,H.R. & Sharma, E.[1997]: 'Mountain Agricultural Transformation Processes and Sustainability in Sikkim Himalayas, India', MFS series no.97/2, *ICIMOD*, Kathmandu,Nepal, P.1-110
9. Avasthe,R.K.;Singh,M. & Srivastava,S.L.[2007]: 'Traditional Agroforestry Systems of Sikkim with Special Reference to Large Cardamom- Alder Relationship,' *Indian Forester*, P. 888-897.
10. Rai,S.C.; Sundriyal,R.C. and Sharma,E.(ed.)(1998): *Sikkim: Perspectives for Planning and Development*, Sikkim Science Society, Tadong, Sikkim, P.445-456.
11. Rai,S.C.; Sundriyal,R.C. and Sharma,E.(ed.)(1998): *Sikkim: Perspectives for Planning and Development*, Sikkim Science Society, Tadong, Sikkim, P.445-456.

12. Rai,S.C.; Sundriyal,R.C. and Sharma,E.(ed.)[1998]: *Sikkim: Perspectives for Planning and Development*, Sikkim Science Society, Tadong, Sikkim, P.445-456.
13. Sharma,E.;Sharma,R.;Singh,K.K.& Sharma,G.[2000]: 'A Boon for Mountain Populations: Large Cardamom Farming in the Sikkim Himalaya', *Mountain Research and Development*, Vol.20, No.2, P.108-111.
14. <http://www.sikkim.nic.in>