

Chapter - 1

INTRODUCTION

1. Introduction: The Farm Economy

1.1 Importance of Farm Economy

Industrialisation is the process that is technology dependent and assists in furthering economic development of a country. While the transition from less developed state to advanced economy state is determined by the nature of industrial growth, it is primarily because less developed economies are predominantly agrarian by nature. But there is no reason to undermine the farm economy since it is this sector that feeds the industrial economy. Thus, the farm economy is the pillar of a healthy nation, on which the other economy is built. Naturally, the question of healthy and wealthy nation is synonymous to the healthy farm economy. Indian agriculture generates about 27 per cent of gross domestic product (GDP), and agriculture products account for more than 65 per cent of private final consumption expenditure of more than 80 per cent of households. Indian economy employs nearly 60 per cent of its workforce in agriculture. No other country employs such a higher percentage. The aggregate purchasing power of the economy is determined comprehensively by the agricultural income. It explains the geographic dispersion and statistical distribution of household incomes. Therefore, any change in the Indian farm economy is expected to have an impact on the rest of the economy.

The farm economy of the plains and hills are not the same. Agriculture in the plains is in more favourable condition than the hills in the way of further development. While land is inelastic by nature, it is still possible to expand agricultural area in the plains by upgrading fallow land and wastelands. Agricultural productivity can also be increased through irrigation modernized agricultural techniques. All these are undertaken to meet the needs of the people. But, such measures are not sufficient to sustain the flow of agricultural products.

In a study by NSSO, it is found that the farm economy in the hilly area is at a subsistence level because it has to encounter natural bottlenecks towards the way of

development. It could not streamline with the other plain farming economy. So, the economy as a whole could not develop to a great extent in the hill areas.

1.1.1 Environmental Challenges of the Mountain Economy and Mountain Agriculture

Mountains are an important source of water, energy and biological diversity. Moreover, mountains are a source of minerals, forest products and agricultural products and of recreation. Mountain environments, which are most complex and interrelated ecosystem of the planet, are essential to the survival of the global ecosystem. The rapidly changing mountain ecosystems are vulnerable to accelerated soil erosion, landslides and rapid loss of habitat and genetic diversity. On the other hand, there is extensive poverty among mountain inhabitants and loss of indigenous knowledge. So, most of the mountain areas in the world are experiencing environmental degradation and the people residing there are mostly poorer. Therefore, proper management of mountain resources and socio-economic development of the people deserves immediate attention.

The broad definition of mountain agriculture covers all land-based activities such as cropping, animal husbandry, horticulture, and forestry and their inter linkages as well as the support-systems. About 10 per cent of the world's population depends on mountain resources. A much larger percentage draws on other mountain resources, including and principally water. Mountains are a warehouse of biological diversity and scarce species.

Almost fifty percent of world's population is affected in various ways by mountain ecology and the degradation of watershed areas. About 10 percent of the world's population lives in higher slopes of mountain areas, while about 40 per cent occupies the contiguous medium and lower-watershed areas. The serious ecological deterioration prevails in these watershed areas. For example, a large portion of the farming population is now faced with a rapid deterioration of land resources in the hillside areas of the Andean countries of South America. Similarly, the mountain and upland areas of the Himalayas, South-East Asia and East and Central Africa, which make vital contributions to agricultural production, are threatened by cultivation of

marginal lands due to growing population. In many areas this is accompanied by excessive livestock grazing, deforestation and loss of biomass cover.⁽¹⁾

The sustainable mountain development strategies comprise of viable and sound development programme and proper implementation. As poverty increases, less people find fewer accessible resources to meet the needs of food, fodder, fuel and fiber. At micro-level, the hill development characterized by some closely related variables such as: shifting of production from the subsistence level to market oriented production, sale of processed or semi-processed goods, shifting of self-employment to wage-employment, and so on. But, at macro level, the structural changes are associated with shift from agriculture to industry and services, along with migration from rural to urban areas.

Agriculture is the mainstay of the hill economy. Thus any development process in the hills must commence with the development of agriculture. To discuss the developmental aspects, one needs to discuss the role of agriculture in hill development, the relationship of agricultural development with environment, and the opportunities of off-farm development. Till date, the contribution of agriculture is almost 80 percent of NNP in almost all the hill states of India and in Nepal. So, it is evident fairly that higher labour-force is engaged in agriculture both directly and indirectly. The exporting goods of the hill areas obviously are agricultural produce, e.g. Cardamom in Sikkim. Thus, from the point of view of income and employment, agriculture plays the leading role in the hill states.

Environmental changes such as rainfall, mass wasting, land-slides - all these are natural while, deforestation, overgrazing are human induced. The pressure of increasing population in the hills creates pressure on forest and pastures to meet the increasing needs of firewood and household needs for timber and construction. It also exerts pressure on marginal lands to cultivate more and the increased use of water-bodies to meet the resultant increase in the food requirements. All these lead to deterioration in the environment of the hill area. Again, off-farm employment and earning is also closely related with the agricultural income and employment generation.⁽²⁾

1.1.2 Constraints of Mountain Farming in the Himalayas

Himalaya is a vast mountain system covering partly/fully eight developing countries of South Asia, including Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. Agroforestry land use, covering 20 percent of the total geographical area of the Indian Himalaya, is distributed as patches in the matrix of forests covering 52 percent area.

The constraints of the Himalayas are similar to other mountain areas. The climate of the mountain is most sensitive to the atmosphere. The terrain is the main constraint of the mountain farming system. There, it is very hard to extract any plain land for cultivation. The farmers through their hard labour try to make the terrain suitable for cultivation. Inaccessibility leads to the slow pace of development in the high altitudes. The forests are plagued with overgrazing and over-exploitation. The lack of management of the forest area causes depletion of forests. The grasslands are affected by the overgrazing and results in low quality of fodder. There is rarely any irrigation facility for the betterment of agricultural production. The links to markets are generally very poor, which is the main constraint for the accessibility of agricultural produces. The high rate of male migration causes excess load on the woman. The livestock of the mountain area receives very low volume of fodder. The breeding and extension programme is also not sufficient for the livestock development.

The practice of subsistence farming is the determining factor of land-use in the hill area. The individual farm is the basic unit of this subsistence farming, which consists of the farm household, the land it cultivates, the livestock it holds, and accessible environment that includes non-privately owned forests, pastures and other lands. The extensive environmental damage has made the large portion of the hill economy virtually stagnant. The output produced by the household is not sufficient to support family food needs. [Sedden, 1987]

The constraints in almost all key resources are -

a) Problem of Cultivated Land: The distribution and ownership of land reveal to a large extent the levels of incomes, consumption and employment in an agrarian economy.

i) As reported by M. Banskota (1989), the average size of land-holdings is about half a hectare and almost 10 percent households are landless. The land distribution in the hill area is more uneven than the plains but it is interesting that the number of owners is higher than the plains, which means that the size of land-holding is very small.

ii) As the hill environment is heterogeneous in nature, the productivity varies widely. The declining productivity of cereal grains can be followed as moves from lower to higher altitudes. So, the mountain farmers sometimes change their crop-combinations to offset these locational disadvantages, but to maintain the productivity level is a major problem. [Schroeder, 1985, p. 31-34]

iii) Agricultural density is much higher in hills than in the plains but cultivable land is scarce. So, hill farmers compelled to use marginal and fragile lands more intensively. It causes serious consequences to the environment.

iv) To support agricultural needs, hill farmers of every major agro-eco-zones depended on the use of public land [HMG/SATA, 1980]. But recently, the access to these public lands (pastures or forests) has been restricted strictly, which caused the small farmers to reduce the total production and the income.

v) The problem with the diffusion of improved technology is a big problem in the hill economy. As the hill area is characterized by large-scale variation in climate, soil and other environmental conditions, the land-augmenting technological possibilities are more limited.

b) Problem of Access: Generally, the communication system mainly (roads) in the hill area faces many problems due to topography. The high land-elevation creates problem to construct road for proper and timely access of agricultural produce in the market. It costs much higher than the plains.

c) Fertility Constraints: Chemical fertilizers are not being used intensively in the hill areas. Rather, they depend on the traditional process to maintain the soil fertility. The plant-nutrient recycle system consists of livestock, forests biomass collected by farm labour. Their components are closely related. The decreased volume of forest reduces the supply of leaf litter and fodder, which further lowered the livestock manure. To

make compost and organic manure, farm-labour is very important. At least three hectare of forest lands is required to maintain each unit of adult livestock as opined by some researchers. Similarly, it has been argued by another group that as much as 50 tonnes/ha of leaf-litter is necessary to maintain current fertility levels.

d) Irrigational Problem: The development of irrigation projects is very hard in hill areas. The watershed management system can be developed but it has negligible role of the individuals. The hill-farmers used traditional irrigation systems that are functionally well.

e) Environmental Problem: Deforestation, soil erosion and problem of water-management are the three major areas of environmental concern. Hill agriculture is strongly related with these problems. Deforestation also causes problems to the growing food, fodder and firewood needs of hill households [Bajracharya, 1983; Yadav, 1984]. Soil erosion increased manifold due to cultivation in marginal lands, deforestation, abandonment of old terraces, livestock management system and other cultivation practices. The increased problem of water management caused due to forests and vegetation cover which increased run-off and reduced soil-moisture.⁽³⁾

Despite various constraints, the mountain climate provides opportunities for exploiting niche for vegetables, fruits and medicinal plants for cultivation. As the Himalaya has large forest cover, it provides many opportunities for forest-based enterprises such as medicinal-plants, bee-keeping, JFM etc. As Himalaya is a source of large variety of vegetable and fruit germ-plasms, it has great potential for vegetable cultivation, horticulture, floriculture etc. The fodder and grasslands availability extends the great opportunity for livestock production. Prevalence of steep terrain and denuded lands suggests that development of sound land-use systems should be based on the concept of mixed plants.

1.1.3 Mountain Economies of the Eastern Himalaya

Eastern Himalayas comprises a part of northeastern India, Bhutan and Tibet. Within India the Eastern Himalaya includes Darjeeling hill area of West Bengal, the seven north eastern states, and Sikkim. The North-Eastern states neighbouring Sikkim have similarities in many aspects, especially, the natural resources available at Sikkim and

natural bottlenecks to the development are to some extent similar. So, the comparative study with North-Eastern states and Sikkim is quite necessary.

North-Eastern states comprises of the seven states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. It is separated from Tibet by Macmahon line. The Northeastern states are connected with the rest of the India through a narrow corridor in Northern part of West Bengal (familiar by the name of 'North Bengal'). This corridor is known as 'Siliguri neck' or the 'Chicken's neck'. This region has international importance on strategic ground, as it comprises 90percent of India's international borders. China is in the north and Bangladesh is in the southwest, while Bhutan is in the northwest part and Myanmar is in the east. This region has distinct climate variations. The climate changes within short distances due to rapid changes in topography. In the western portion of Mizo Hills, in the plains of Brahmaputra and Barak Valley as well as in Tripura the daily temperature in January lies around 15°C. It rises from April and except the southeastern portion of Mizo Hills and Shillong, in July, the mean temperature ranges between 25 °C to 27.5 °C. In the hilly areas, during October, the mean temperature ranges between 20 ° C and 25 ° C, whereas in the western portion of the Mizo Hills, in Tripura and in the Brahmaputra and Barak Valley it is above 25 ° C. In the upper Himalayas in Arunachal Pradesh the lowest temperature is experienced below freezing point.

Among the north eastern states there are many differences with respect to their resource endowments, industrialization and infrastructural development. In Assam, the industry is based on tea and timber, and in other parts of the region it is based on mining, sawmills and plywood. The economy is still based on agriculture and the full potential is yet to be exploited. Employment pressure is on the service sector. Except Meghalaya and Nagaland, the contribution of agriculture to state domestic is much higher. In case of Meghalaya, mining and forestry in case of Arunachal Pradesh are important contributors. The construction sector is also higher contributor in this region.

With interstate variations, about 54percent of the geographical area in the northeast is covered by forest. The highest is in Mizoram (75.59percent), and lowest is in Assam (39.15percent). In Arunachal Pradesh it is 61.55percent just preceded by Manipur (67.87percent). In Tripura it is 60percent just followed by Nagaland (52.02percent)

and Meghalaya (42.34percent). In the interior of Nagaland and Mizoram timber and minor forest produce are the principal livelihood option. In many tribal areas there are immigrants and denudation of shifting or jhum cultivation. The forest ownership pattern also differs in different states. The portion of reserve forest is low in the hill areas due to the fact that the ownership rests on the local communities. The extreme situation of forest timber extraction causes alarming situation of deforestation. Though there is a blanket ban on logging and non-forest activities but the situation is going to be alarming for ecological balance.

The overall land-man ratio is quite favourable because of lower density of population. In view of majority of hilly area the average size of operational holding is quite small. The main obstacles in raising agricultural production are high incidence of shifting cultivation, pre-dominance of small and marginal farmers besides smallholdings. There is also lack in the adoption of improved agricultural technologies such as use of high yielding varieties, chemical fertilizers, modern equipments etc. The total geographical area of northeastern regions is 25.51 lakh hectares of which 22.48 lakh ha. is the reporting area for various types of landuses (CMIE, Agriculture, September, 1999). The forestland is scored highest with 52.38 percent, whereas in all India it is 22.57 percent. The area not available for cultivation is 19.61 percent. The uncultivable land is 7 percent. The fallow land is 3.63 percent. The net sown area is 17.38 percent, whereas the national level is 46.64 percent.

Arunachal Pradesh covers an area of 83,743 sq.km. Its climate varies from alpine in the north to sub-tropical in the south. More than 60 percent evergreen forest covers the state. It has numerous streams, roaring rivers, deep gorges, lofty mountains, snow-clad shining peaks and thousand of species of flora and fauna. It is the largest state in the northeast with a very low land-man ratio. It is known for its forest resources. This hilly state is based on rural economy of which 75 percent of total workforces are engaged in agriculture (mainly shifting cultivation). The forest based industries and handicrafts especially carpet making is considered as secondary sector. The tertiary sector employment is mainly government jobs, which is emerging gradually. The per capita income is highest among the northeastern states and is also higher than the national average.

Sikkim, located in the Eastern Himalayas, is a state where these problems are common. Sikkim covers a small area of the Eastern Himalayas, having hilly terrain spread over 7096 sq km with elevations ranging from 250m to 8595m above mean sea level (amsl). The average annual rainfall ranges from 210 mm to 2500 mm. Temperature in middle altitudes varies from 4.5 degree C to 18.5 degree C. The climate of the state varies from cold temperate and alpine in the north, northwest and northeast to sub-tropical in the south depending on the altitudes. There is a common characteristic of land use in the eastern Himalaya. The lower elevated land is wetland. The high-elevated land is covered by forest and the middle of these two elevations is completely dry land. So, this portion is not suitable for cultivation. The lower elevated wetland is useful for cultivation.

1.2 Statement of the Problem

The evolution of the society is responsible for the evolution of the land-use. In the late-Mesolithic age, human beings learnt to herd and to grow crops. In the subsequent Neolithic society, they domesticated both plants and animals. But in those days, human society was limited in numbers. As days passed, population increased and different societies evolved. All tried to capture land first. In this way, various land-use systems evolved. Among the different land-use systems, mountain land--use is one of the most difficult systems. Mountain area is designed by some specific conditions - inaccessibility, fragility, marginality, diversity, niche and adaptive mechanisms. Despite these constraints, human society settled in the mountain areas and they fought against nature for their survival. They started cultivation for their livelihood by building terraces. In the forest areas of the Eastern Himalayas, *Jhum* cultivation prevailed from the very beginning. Till today, most of the people of the Eastern Himalayas depend on agriculture for their livelihood. It can be found in the forest areas also. In certain places such agricultural practices create environmental problems by deforestation. In recent times, the threats on environment as well as deteriorating conditions of the people compelled academics, researchers, environmentalists and economists to take a serious look. There is a need to develop an understanding pertaining to the linkages between growing population, agricultural sustainability and degradation of natural resources. Systematic study on the inter-relationship between populations, natural resources and land in mountain areas are still hard to come by. It

is obvious that failure to achieve household's basic minimum needs will result in an escalation of degradation in mountain environments.

The steep terrain and denuded lands of Sikkim suggest that the development of sound land-use system should be based on the concept of plant associations of trees with other annual and perennial plants along with livestock to resemble natural ecosystem. Considering this objective, agroforestry can be an ecologically sustainable and economically viable land-use system for Sikkim. The study attempts to identify factors responsible for the changing land-use system in Sikkim where over the years agroforestry has emerged as an alternative livelihood option for the rural population of Sikkim.

Agroforestry is defined as: "... a dynamic, ecologically based, natural resources management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels."⁽⁴⁾

As per the report of ICFRE (Indian Council of Forestry Research and Education), the forest ecosystems are facing acute forms of degradation. Most of the ecosystems are threatened by following factors *viz.*,

- (a) Loss of forest land to agriculture, irrigation, industries, mining and human settlements.
- (b) Loss of forest land due to multipurpose projects, construction of roads, erection of transmission lines, quarrying for minerals, slashing for shifting cultivation and clearing for encroachments etc.
- (c) Degradation due to illicit felling, lopping for fodder and fuel wood, overgrazing, forest litter removal, forest fires, over felling etc.
- (d) Human and cattle population explosion around forest land.⁽⁵⁾

1.2.1 The Study Region

Total geographical area of the state of Sikkim is about 710,000 ha, of which 257,000 ha (36.20 percent) are under forests and 270,000 ha are not available for cultivation.

Permanent pasture and grazing land is 69,000 ha (9.72 percent). The land cover under miscellaneous tree crops and groves is 5,000 ha (0.70 percent). The area under culturable wasteland is 1,000 ha (0.14 percent). The Fallow land other than current fallows is 9,000 ha (1.27percent). The area under current fallows is 4,000 ha (0.56percent). Net sown area is 95,000 ha (13.38 percent). In the year 1990-'91, net area sown in the state was 63,254 ha which increased by a margin of more than 30,000 ha in six years time (1990-91 to 1996-97). The area under fallow other than current fallow was 9,204 ha which reduced by a margin of about 200 ha.

The per capita availability of net cultivable land in Sikkim was 0.31 ha in 1971 that decreased to 0.27 ha in 1981 and in 1991 further decreased to 0.17 ha. The per capita operated area for agricultural use was 0.38 ha in 1971, decreasing to 0.35 ha in 1981 and further reduced to 0.28 ha in 1991. The per capita land under pasture and culturable wasteland was 0.40 ha in 1971, decreasing to 0.24 ha in 1981 and further decreased to 0.18 ha in 1991. Even the per capita forest area declined to 0.65 ha in 1991, which was 1.26 ha in 1971 and 0.83 ha in 1981.⁽⁶⁾

Presently, there are 447 inhabited villages, 8 towns and 4 districts in Sikkim with a population of 5,40,493 in 2001. The population growth was 3.29 percent annually during the period of 1991 and 2001. The agricultural allied sector contributed the maximum share to the net state domestic product. It used to be as high as 80 percent in 1975-76 that came down to 39 percent at present. The evolution of agriculture in Sikkim is worth dwelling upon. The original inhabitants led a very primitive life with limited knowledge of farming. They maintained their livelihoods by gathering wild roots, fruits, hunting and fishing. The Bhutia community first started sedentary farming. They ploughed only the flat segments of land. Later, the Nepali immigrants started terrace cultivation and settled agricultural practices in the gently sloping mountains of Sikkim.

1.3 Literature Review

Mountain Farming Systems vis-à-vis Agroforestry

A regional Asia-Pacific Agroforestry Workshop held in Bangalore on 17-20 December, 2003, organized by the Ministry of Environment and Forests, Government

of India, provides multiple dimensions of agroforestry practices. The important aspects have been discussed below.

In Asia and the Pacific, Agroforestry has been increasingly practiced to promote sustainable land management and to accrue more benefits to the local people. It has also been used to optimize moisture availability, prevent water/wind erosion and protect crops/vegetables from excessive temperature/radiation, and improve soil quality. The agroforestry promotes biological diversity conservation as well as carbon sequestration thus mitigating climate change pressures that are also global environmental benefits.

i) To increase productivity, Agroforestry plays a vital role. The income of rural farmers could be enhanced and diversified with the help of Agroforestry practices by improving supply of food, fodder, fuel-wood, timber and non-timber forest products, thus accruing economic benefits to the rural farmers. This economic benefit attracts other farmers to promote alternative sustainable livelihood. It also helps to improve the soil quality and empowers rural community particularly vulnerable population groups including women and promotes their participation in productive activities.

ii) The medicinal and aromatic plant cultivation and biomass energy source development have been given increasing attention to generate high value of agroforestry produce. The technical and financial resource constraints have to be mitigated to fully materialize the benefit potential.

iii) To support the agroforestry practices it is necessary to change the policy, planning and institutional frameworks. In this process, the multidisciplinary and multi-institutional approaches are essential and thus policy convergence and inter-agency coordination/collaboration are becoming increasingly important.

iv) Agroforestry have been supported by the national and international funding schemes but, there is still a significant gap in the support of such funding schemes among various districts, provinces and countries as many countries haven't yet developed effective funding schemes and partnership.

v) The lack of marketing and communication facility poses constraints towards the growth of agroforestry practices.

vi) To promote agroforestry in the dry and/or degraded lands there is a need to evolve sustainable mechanism and there is a vast scope for private sector participation in the agroforestry as well as farm forestry sector. Due to the lack of effective network mechanism, traditional knowledge, innovative practices and improved technologies for Agroforestry have not yet been sufficiently disseminated.

The workshop also suggests following recommendations for the betterment of agroforestry for the people:

1. To promote agroforestry there is a need to enhance the public and private partnership. For promoting agroforestry, consideration can be given to providing incentives to farmers and stakeholders, adopting economic instruments, increasing fiscal support, reviewing land tenure and benefit sharing schemes.
2. The collaboration among farmers and academician must be further enhanced. The most pro-active support and on-farm research on agroforestry must be enlarged for applying prospective agroforestry practices to farming systems.
3. The partnership and network building of farmers, cooperative, end-users and professional groups on particular ecosystem agroforestry systems should be promoted.
4. To achieve enhanced resource mobilization for agroforestry the scope of public-private-partnership (PPP) should be encouraged and mobilized further.
5. The quality planting and value-added agroforestry produce for commercialization should be enhanced by setting proper priority of research.
6. The use and value addition for Medicinal and aromatic plant, it is necessary scientific examination with a view to sensitizing consumers and stimulating market demand that can be cultivated in agroforestry systems.
7. To make clean development it is necessary to overcome externalities of initiating and promoting biomass energy use. Information exchanges should be promoted particularly on biomass development.
8. To prepare a status regional report on agroforestry an ongoing study on agroforestry practices and techniques in Asia and the Pacific under the

UNCCD/TPN2 (Asia Thematic Programme Network on Agroforestry and Soil Conservation in Arid, Semi Arid and Dry Sub-humid Areas) must be completed through possible on-line consultations as early as possible. It must be launched at an appropriate occasion in the near future and it should be prepared in a way that will be more appropriate for farmers and community based stakeholders.

9. To create awareness among the stakeholders, the extension/publicity activities should be strengthened.

The workshop outcome focused on different forms of agroforestry practiced in the respective countries of the distinguished speakers. While alley cropping, shade-tree combination and home gardens are adopted in Cambodia, hedgerow intercropping, homegarden, silvipasture, and improved fallow are some agroforestry measures practiced in Laos. New dimensions of agroforestry are also being explored in countries, on experimental basis. Agro-tourism in Republic of Lebanon is one of the innovative approaches towards the promotion of agroforestry. Case study for Lebanon where an integrated approach of organic farming and agro-tourism had been undertaken was elicited.

Agroforestry practices is also expected to counter natural hazards which can be found in countries like Jordan, Yemen, Kyrgyzstan, Uzbekistan, Mongolia, Vietnam, etc. Agroforestry practices have been successful in prevention of wind and soil erosion as well as soil conservation in countries of Jordan, Yemen and Mongolia, it has prevented desertification in Kyrgistan, Uzbekistan, Vietnam, etc. Such conservation and preservation of forests is possible only through agroforestry that ensures planting of forest trees and bushes as well as plantations. The latter is evident in Kyrgyzstan where collaborative forest management (CFM) and private plantations plans have been undertaken by which the interests of the local people towards forest conservation options are being developed. The primary target of the plans is the conservation of the walnut-fruit forests which are being grown as the agroforestry species in Kyrgyzstan.

Vietnam presents a notable example of integrated development where agroforestry practices are used to conserve biodiversity. A case in hand is that of Ho Chi Minh city where various initiative have been taken to improve soil quality and the socio-economic situation of the community. Further success stories are also found for

example in Bangladesh which successfully encouraged local initiatives by farmers towards agroforestry through ventures like Homestead and Farmland Agroforestry systems.

Agroforestry practices are getting its due importance around the globe. Many international institutes have been formed to make further study on it. Since it is a dynamic concept, most of the countries (both developed and developing) are adopting this for better land-use system. The first ever world congress on Agroforestry was held in 2004 in the USA. As illustration of the important role of agroforestry, it is found that effective herbicide weeds control increased coffee yields by 50percent in USA. The coffee plants are intercropped with lime-bean (*Phaseolus funatus*), cowpea (*Vigna unguiculata*), soyabean, groundnut and pigeonpea (*Cajanus cajan*). Such examples of success stories of agroforestry practices are found throughout the world. Some of the agroforestry practices in the world are exemplified below to understand the modes and practices adopted in these countries to improve on land-use and enhance the economic condition and well-being of the local populace.

Guan Junwei and Zhang Hongkiang of Beijing Forestry University, in their article named 'Oriental Value and Agroforestry Development in China', has described the role of agroforestry in combating severe problem of food, clothing and environmental degradation in China.⁽⁷⁾

The agroforestry practices of Australia have been documented in a report of Australia in 2000. The potential benefits of agroforestry have been discussed minutely, which include adding to the national supply of timber, essential oils and other tree-based products, diversification and increase of farm incomes, synergistic effects on crop, pasture and animal production, amelioration and containment of land degradation; conservation of biodiversity; and sequestration of greenhouse gases. The extension of agroforestry programme and the obstacles faced are also treated lucidly in the report.⁽⁸⁾

The north-eastern Indian Americans practiced sequential agroforestry practices where alluvial soil is available and they grew annual crops of corn beans and squash and perennial crops of berries. They practiced simultaneous agroforestry system in the uplands. They grew perennial crops of berries and nuts, which were harvested by the

Indians themselves as well as by the animals they hunted; upland soils also produced crops of fuel-wood and other products important to humans and wildlife. Many researches on modern agroforestry have been done and they have adopted various species which are more productive and more insect resistant.⁽⁹⁾ *In case of the developing countries in South Asia, studies are found for agroforestry experiences in Pakistan, Sri Lanka, Nepal, Phillipines, Malaysia, Indonesia, China etc.* The forests of Pakistan (5.4 percent) are under great stress due to heavy demands of timber, fuel-wood and grazing. About, 41.1 percent of timber and 90 percent of fuel-wood demand is annually met from farmlands (Amjad and Khan 1988), which indicates that there is a tremendous scope for raising trees on farmlands through agroforestry practice in Pakistan. Many studies pertaining to shelter-belts and a few on irrigated agricultural land with Polars and Eucalyptus tree species are also found.

The farmers of Sri Lanka practiced number of Agro-forestry systems such as Chena (a form of shifting cultivation), Taungya, i.e., inter-cropping under coconut, Kandy Gardens or Home Gardens, growing tea and coffee under shade of trees, windbreaks and shelter-belts, etc. The most significant agroforestry system is coconut based coffee and tea plantations. A study of Agrarian Research and Training Institute, Colombo (Anonymous, 1976) showed that inter-cropping in coconut increased 300 percent on farm employment in Sri Lanka.

The common agroforestry practices found in Nepal are, shrubs for live fencing around farmland, pasture (grazing) in forest area and use of strips of multipurpose trees and shrubs around the sloping (40 to 70 percent fields), which protect soil from erosion and provides much needed fodder, firewood, fence posts and other type of farm timber.

Homestead gardening is an important agroforestry system in Bangladesh. The trees on homesteads are also an important source of fuel-wood, fodder, building materials and other form of wood. A study by Leuschner and Khaleque (1987) showed that multipurpose trees and women participation in the farm operation enhanced the success of this programme. The common homestead species are mango, jack-fruit, betelnut, coconut (fruit trees), renoli, koroi (timber), etc., Mandar, Shimul (fuel trees), Barak, Muli, (bamboo), etc.

As China is a large country, its climate varies from cold-temperate in North-East to sub-tropical and tropical in the South with annual precipitation ranging from near 2000mm in the South-East to less than 50mm in the North-West, causing a vast area unsuitable for agriculture. The environmental, biological and social characteristics have promoted the development and prospects of agroforestry practices. The existing agroforestry practiced in China are - a) Agro-silviculture system, b) Silvo-fishery system, c) Agro-silvo-fishery system, d) Silvo-medicinal systems, e) Agro-silvo-medicinal system.

Thailand adopted several agroforestry practices of which planting trees in paddy fields, mixed plant system in uplands, *taungya* system, tree intercropping, homestead gardening, etc., are widely prevalent. The most common trees planted in the homestead land are bamboo, *mangifera indica*, etc. Various vegetables and perennials are also planted in the homestead land under the trees.

The primary agroforestry system of Indonesia consists of tree gardens located in the slopes in-between villages and the forest reserve (Michon *et al* 1985). These gardens make up 50-80percent of the agricultural land and are known as parks. Home gardens of villages are also found here. Raisin producing tree *Shorea Javanica* is also found in some forests of Sumatra.

Wonosobo of Java was the most fuelwood demanding area for tobacco production. Earlier, this area was fully forested. But due to this practice, the forest disappeared gradually. In 1915, the wastelands were given to the villagers on free loan on the condition that they would plant and maintain a wood crop. The villagers adopted various species starting from local ones and introduced the agroforestry practice to improve land efficiency.

In 1950, *taungya* system was introduced in Malaysia, by the forestry department in association with the reforestation programme. Many intercropping systems with cash crops were introduced. Cropping along with livestock keeping was also practiced here since it was found economically feasible.

Agroforestry practices in Philippines took several forms. They are -



- i) Spatially interstitial support trees: In this system fast growing legume trees producing fodder and charcoal and fruit-tree are planted in contours.
- ii) Agroforestry Rotations: Fast growing legume trees and crops are mixed in a common area.
- iii) Field and Grove System: Combinations of wood-trees and fruit trees are planted.
- iv) Agrisilviculture: Fodder and charcoal species and/or fruit trees are planted with food crops.
- v) Silvipasture: Fodder from trees.
- vi) Incipient Aquasilviculture.

In Vietnam, the main agroforestry system reflects an intensive use of land which combines both rice and fuel-wood production.

South American countries of Brazil, Columbia and Mexico also experimented with various agroforestry practices to improve the economic condition of farmers. For example, in the Amazon Estuary (Brazil), people domesticated the *pejibaye* palm as a part of indigenous agroforestry system. The *pejibaye* & coffee mixed-cropping is experimented in Costa Rica with success. It has significant potential for the small farmers. While the *taungya* system was found suitable in Colombia, the homegardens of Mexico was found to have ecological, technological and productive advantage. The home garden animals mainly pigs fed from forage species found in the home gardens.

(10)

Agroforestry in the Himalayas

Over the years, the people of Sikkim have evolved many agroforestry practices that proved to be beneficial to meet the need of food and shelter and also biological needs. As population increases day after day, per capita land availability decreases 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 has compelled the rural people to change their livelihood patterns. After the merger of Sikkim with India the land-use patterns are changing at a faster pace. The need to expand agricultural production and at the same time retain the existing forests has given rise to agroforestry. Since the agroforestry practices are environment friendly, they may play an important role in developing more intensive, socially responsive, ecologically sustainable and economically efficient patterns of land-use for the people of Sikkim.

The ICAR has identified four types of agroforestry systems in Sikkim up to 1990s. They are agri-silvi system, horti-agri system, mixed homestead gardens and tea and cardamom plantations.

The agri-silvi 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, along farm boundaries. As such it is in the subsistence level.

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.

The mixed homestead garden type agroforestry system prevails almost everywhere in Sikkim. Around the house, 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.

Tea plantation exists in a small area between 1500 to 1800 m. altitudes. Wild cherry trees are planted as live borders in tea gardens. The quality of Sikkim tea is rated very high.

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 resembles 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.

The available land and forest resources have to be used efficiently for equitable development of the region. In resource economics the efficient resource allocation means a situation in which it is not possible to reallocate available resources so as to achieve more or one objective without accepting less of other. In the productivity sense, the yield from all these resources should be optimum so as to achieve equitable development.

Singh and Tewari in their book on Agroforestry and Wastelands provide data on land-use and forest cover of all states and union territories. They provide definitions of agroforestry, both earlier as well as recent. The need and scope of agroforestry have been discussed too. Different types of Agroforestry practices in India have been discussed briefly. They have stated that according to Mr. Ranganathan, agroforestry can increase the GNP of the country by 10,000 crores, provides employments up to 20 million people (1979). Agroforestry systems in various countries include Africa, Asia, Europe, America and Oceania. Later chapters deal with wasteland managements. They have accounted for environmental as well as social aspects of agro-forestry and wastelands.⁽¹¹⁾

Young (1998) in *Land Resources Now and for the Future*, deals with the present problems of land resources and has provided suggestions for future land management. He also mentions agroforestry as effective land management practice. The uses of agroforestry for conservation of soil and water have been discussed. He also suggested agroforestry practices for maintenance of soil fertility.⁽¹²⁾

According to Young (1981), agroforestry has great potential to solve the land-use problem, which can be of two types: problem of farmers and problem of the land. Farmers face several problems such as shortage of subsistence level of foods including seasonal and recurrent, the shortage of feed for livestock which includes seasonal and quality, the shortage of domestic water supply, the shortage of energy from fuel wood and charcoal, the shortage of shelter making materials for housing, compounds and also for fencing the shortage of raw materials for domestic industry or services. The most important is shortage of income and savings sometimes, shortage of power to fulfill social needs. The problems of land are of manifold. The most common problem is soil erosion by water and wind. The other problems are decrease of soil fertility, forest clearance or incursion, forest degradation, pasture degradation, river degradation and weeds, pests or diseases.⁽¹³⁾

Goswami (1982) in his article titled 'Agroforestry – Practices and Prospects as a Combined Land-use System' has stated that Agroforestry is the new name for an old practice. It describes common Agroforestry practices of some countries of humid tropics. He referred to the Taungya system, an age-old Agroforestry practiced by foresters in many countries. But it has been modified for meeting requirements of agricultural lands and preventing forest depletion. In Thailand it has been considered as main instrument for rural development. Many researches have been done so far for the development of trees and crops together. Nowadays it has become a viable alternative for obtaining maximum benefits from scarce resources.⁽¹⁴⁾

Taragi *et al* (1989-90) focus on land-use disparities in the Himalayas based on case study of Kumaon Himalayas. They argued that inter and intra regional differences are caused by physical factors. They have taken three distinctive typical locations viz., valley, slope and upland. It has been found that the valley area is best suitable for agricultural activities especially for cultivation.⁽¹⁵⁾

Singh and Singh (1995) in their article deals with changing land-use pattern of Meghalaya. They have tried to examine the emerging general land-use patterns of Meghalaya plateau in CDBlock level for showing its regional disparities. The upper part of this region (the Khasi and Jaintia Hills), which is dominated by hilly slope, have higher percentage share of land under cultivable waste. The relatively lower part (Garo Hills) is forest dominated. They marked that the land-use types have been

changing on account of changes occurring in the socio-economic factors. In the conclusion they have suggested for watershed management approach.⁽¹⁶⁾

In a regional conference on Sustainable Development of Fragile Mountain Areas of Asia, organized by ICIMOD, in 13-15 Dec 1994, Tony Djogo of Indonesia presented a paper on the role of Agroforestry. He focused on the need of the two sectors namely Agroforestry and watershed. He said that initially the tendency of Agroforestry was to focus on only tree crops or timber crops or food crops but it actually needs integration of all purposes. He has described various aspects of Agroforestry practices to focus more on ecologically sustainable options.⁽¹⁷⁾

Sankrityayana (1997) highlights the evolution of land-use with the change of human society. He has given various data on Eastern Himalayas. The comparative land-use has been studied within Eastern Himalayas. The forest cover in different locations with authentic explanations is given. Though the emphasis is on Darjeeling Himalayas, Sikkim is also referred. The author has studied the paradoxical situations of Darjeeling Himalayas in the context of environment and development. He has suggested for an Integrated System Approach for restructuring the land-uses. According to him, "In the Darjeeling Himalayas the first intervention according to the land management plan has to be made through institutions of ecologically sustainable Agroforestry systems, which protect both local people and trees".⁽¹⁸⁾

Prasad and Negi (1999) discuss the methodology for setting forestry research priorities for India. How the Indian Council of Forestry Research and Education (ICFRE) and Indian Council of Agricultural Research (ICAR) are working to develop forestry research and agro- forestry research are stated. The methodology has been shown by a line-diagram.⁽¹⁹⁾

Mughal *et al* (2000) have jointly studied an area in rural Srinagar of Kashmir Valley where people practice Agroforestry. But due to inadequate technology and research, Agroforestry practices are still very inefficient. People do not meet their requirements of food, fodder and fuel wood for full year from these practices. So they have suggested for better scientific models that should be socially acceptable and economically feasible.⁽²⁰⁾

Minj and Quli (2000) have studied the Palamau district of South-Western part of Bihar. They have taken 100 respondents to fill-up the Questionnaire and collected information on socio-economic parameters like education, type of family, occupation, land-holding etc. Finally t-test was applied with these data to reveal the level of significance of Agroforestry implementation. The study established that Agroforestry is helpful in overall improvement of socio-economic condition of respondents.⁽²¹⁾

Basavaraju and Gururaja Rao (2000) have analyzed very important aspects of Agroforestry practices, viz. tree-crop interaction. They have pointed out that integration of trees in Agroforestry systems results in positive or negative interactions between tree and crops. The balance between these negative and positive interactions determines the overall effect of interactions in a given Agroforestry practices. In this regard they have suggested that selection of suitable tree species for Agroforestry is very important. It also envisaged about the management of Agroforestry systems.⁽²²⁾

Hussain (2000) in his article on land management in the hill ecosystem, studied the area of Yangse valley in the Kameng Himalaya. He said that in recent times the flat lands in the mountain ecosystems have become important from the point of view of development of settled cultivation. The studied area was also reclaimed this purpose but failed due to some socio-economic, technological, environmental reasons. After cultivating for 2-3 years with the help of govt. they could not continue it. Despite these problems there were vast potentials for horticultural and dairy farming excluding agriculture for the due development of the region.⁽²³⁾

In the State of Forests Report of 2001, it has been pointed out that the culturable wasteland and fallow other than current fallow are the potential areas on which forest cover can be extended through afforestation programme. In addition, they suggested innovative Agroforestry practices in those areas.⁽²⁴⁾

Gill and Lal highlight the relation between Agroforestry and environment. They have explained how Agroforestry could be an appropriate measure to curb disaster and to protect the environment. They also highlighted the role of Agroforestry for developmental activities.⁽²⁵⁾

AERC, Assam Agricultural University has studied Terrace Cultivation and its Impacts in North-east India in Nagaland. The land-holding and individual rights to use lands

are determined by customary laws. There are only 13.42 percent area are under-cropped. The trend of Jhum cultivation showed a steady declining during 1990-91 to 1994-05 and increasing since 1995-96. But people are gradually oriented towards settled cultivation. The suggestions include the horticultural and agroforestry schemes should be taken up in the up-hill regions. Now it is the policy of the state govt. to totally stop Jhuming by providing some better alternatives. In conclusion they have written that adequate research knowledge and practical experience are very much needed for efficient allocation of resources and integrated hill area development programmes.⁽²⁶⁾

Mughal and Bhattacharya (2002) have conducted a study to find out the Agroforestry practices in Kashmir Valley of Jammu and Kashmir. They studied the area in 1996 and found the following type of Agroforestry practices: Boundary Plantations, Agri-Silviculture on Sloping Lands, Agri-Silviculture in Plains, Horti-Silviculture, Horti-Silvi-Pasture, Horti-Silvi-Agriculture and Kitchen Garden.⁽²⁷⁾

Avasthe *et al* (2007) have conducted a field survey in Sikkim to study the household income of two most commonly used agroforestry system. The systems are large cardamom and agri-horti (Maize-potato) system. As per their study, the Large Cardamom based agroforestry system generated fifty percent more annual income from one hector production. The agri-horti system generated Rs.48000/-, whereas, the large cardamom based agroforestry generated Rs.92700/-. Similar observations were reported by the Sharma and Sharma (1997).⁽²⁸⁾

Manas Dasgupta (1980) has given a very clear picture of the structure of Sikkim's economy. He has given sufficient data on land-use, population, forest-cover etc. from the Census of 1971 and analyzed the economic situation of Sikkim in pre-merger period.⁽²⁹⁾

Debnath (1980) studied the agricultural situations of Sikkim in pre-merger period (before 1975) when nearly 95percent of the population depended on agriculture. In 1965-66, the proportion of contribution of agriculture including animal husbandry and forestry to the net domestic product was about 80percent. The important cereal crops were maize and paddy and still these are dominating. He briefly described the

production situation of millet, cardamom, mandarin orange and potato etc. The paper gives an overview of agriculture in Sikkim.⁽³⁰⁾

Om Prakash (2007) has studied the west district of Sikkim. He has described the socio-economic and environmental aspects of this district by using questionnaires on socio-economic status and environmental aspects. He has given various data to analyze those aspects minutely. According to him the gigantic problem of this district is soil erosion. He has suggested some important measures to combat soil erosion and restoring ecological balance. He has advocated the introduction of garland rows of trees of fruits, fodder and shrubs after every four or five terraced benches. Also he has given special importance on social forestry.⁽³¹⁾

Subba (1989) has studied the agrarian social structure of Sikkim in different time period. He has analyzed the agrarian society of Sikkim in three phases- pre-British, British and post-British.⁽³²⁾

Ghose (1992), in his article elaborates on off-farm employment generation in Sikkim and the Darjeeling hill areas. He has given a comparative analysis on physical features, climatic conditions and population profiles. Authentically he made his suggestions for increasing off-farm employment to develop the regions. Considering the constraints, he has attempted to show the way of flourishing some sectors that have great future potentials. He briefly highlighted the following sectors: dairy farming, tourism, small-scale industries, poultry farming, horticulture, sericulture, floriculture and finally tea.⁽³³⁾

Research studies conducted by ICIMOD, deal with differential status of mountain agriculture in the Himalayas. Sikkim, one of the study regions in the Eastern Himalaya, for example has adopted the cultivation of high-value crops such as off-season vegetables, orchids, flowers, horticultural crops and medicinal plants as their long-term development strategy. The relation between population and land-use is also outlined while focusing on food-security concepts in mountainous regions. It has also dealt with the role of social science research for sustainable mountain development.⁽³⁴⁾

Sundriyal and Rai (2001) studied the trend and production potential of pulses, its monetary gains and nutritive values. They have given sufficient data to describe the same. For this study, the authors have surveyed the pulse farming areas. They

observed during their survey that mixed cropping is practiced all over the mountain areas and farmers depend on both maize and pulses as basic staples in the Sikkim Himalayas.⁽³⁵⁾

In a discussion paper on Mountain Farming System in 1997 (ICIMOD), emphasis has been laid on the loss of genetic resources in mountain farming systems, - "If the crop fails, not only will valuable genetic resources be lost but the survival of the entire Agroforestry system would be threatened".⁽³⁶⁾

Subba *et al* (2001) have analyzed the situation of food security in Sikkim. It has been stated that the food requirements of the whole population are far below actual production. But Sikkim has a favourable environment and scope for growing a large number of fruits like mandarin orange, guava, litchi, apple etc.⁽³⁷⁾

Sharma *et al* (2002) have opined that large cardamom has great potentiality both economically and environmentally. They also envisaged the population growth and consequent fragmentation of farmland in Sikkim.⁽³⁸⁾

Coelho (1970) in his book *Sikkim and Bhutan* has stated that the main sources of Sikkim's wealth are agriculture and forests. Rice and Maize are the main monsoon crops. The other subsidiary crops include millet, buckwheat, barleys, dhal etc. The cardamom plantations are of importance due to its export potential. The cultivation of potato is also getting importance. Tea plantation is a new venture. Apples and pineapples are also grown and these are supplied to fruit preservation factory at Singtam. The cattle of local breeds, yaks, sheep and goats are found throughout Sikkim. He has highlighted the prospect of paper pulp production.⁽³⁹⁾

Subba (1984) has stated in his book *Agriculture in the Hills of Sikkim* that the agricultural backwardness of Sikkim is caused by several factors. He has pointed out some factors, such as, limited area of cultivable land, low productivity, low irrigation facility, limited agro mechanization, slow adoption of high yielding varieties, cultivation of traditional crops, lack of post-harvest technology etc are the basic hindrances on the way of agricultural progress. For rapid growth of agriculture and rural hill economy he has suggested cultivation of commercial crops in the mixed cropping, relay cropping, multiple cropping, orchard and garden land cropping, mixed

farming and Agroforestry. He has mentioned that no system of land utilization classification is followed in Sikkim.⁽⁴⁰⁾

Dasgupta (1992) in his book *Sikkim: Problems and Prospects of Development* has written on land reforms and development in Sikkim. The land revenue system of Sikkim has undergone various changes. The question of land tenures since 1948-49, changes in land tenure system and the problem of ethnicity have been discussed briefly. The book deals with the problems and prospects of agriculture in Sikkim. The changes of land-use system in Sikkim since 1958-60 to 1980-81 have been given but not analyzed. The district-wise cropped area have been given with necessary description. The then agricultural situation of Sikkim and its limitations has been discussed. The book highlights the mixed farming system of Sikkim. It narrates how the poor people of Sikkim supplement their income through the livestock industry. He has given various aspects of mixed farming system keeping in mind the agro-climatic conditions. The problems of mixed farming system have also been analyzed and the problems and prospects of non-cereals crops (cardamom and oranges) of Sikkim have been discussed. Besides, the author has commented on forest management and economic development and rightly revealed the causes of deforestation and failure of forestry to integrate with development in other sectors. Lastly the problems of resource mobilization have been discussed at length.⁽⁴¹⁾

Rai *et al* (1998) in *Sikkim Perspectives for Planning and Development* deals with various aspects of Sikkim. In the book, Singh described the existing agroforestry practices of Sikkim. He has also suggested the enhancement of productivity and better resource management through agroforestry. The existing agroforestry practices in Sikkim are: large cardamom plantation, agri-silvi system, horti-agri system and mixed homestead garden and tea plantations. Paljor sketched the feed and fodder resources of Sikkim. He has given emphasis on animal husbandry as an integral part of Himalayan farming system. Pradhan highlighted the prospects of tea plantations in Sikkim with the help of tea-production figures and profits reaped by the tea garden at Temi in Sikkim. Balaraman has dealt with the land-use figures of Sikkim and explained its merits as well as limitations. He analyzed land-use pattern incorporating livestock rearing. He has recommended some measures for better livestock rearing in the hills of Sikkim.⁽⁴²⁾

International Centre for Research in Agroforestry (ICRAF), a non-profit making organization with a mission is to improve welfare and enhance environmental resilience through Agroforestry practices have categorized the entire Agroforestry practices into two systems – Simultaneous and Sequential. They are conducting Agroforestry researches in Kenya and also around the world. At present they are pioneer in Agroforestry researches. Their website disseminates valued information on Agroforestry.⁽⁴³⁾

The 1st World Congress of Agroforestry in Florida, USA, recognized agroforestry as a sustainable land management option all over the globe because of its ecological, economic and social attributes. The objective of this Congress is to provide a global forum for Agroforestry professionals to share knowledge, experience and ideas; to plan future strategies in Agroforestry research, education and training and development.⁽⁴⁴⁾

Zhaohua *et al* studied the agroforestry systems in China. In an article the authors have analyzed the urgency of agroforestry. To combat soil erosion, siltation, flooding and desertification and to meet the demands of timber the policy makers suggested combining agriculture and forestry. These included the terms like *stereoscopic agriculture, stereoscopic forestry, multiple ecological systems of agriculture and forestry*. All these terms are synonymous to agroforestry. The aim was to provide the best ecological and economic benefits to the farmer. They have narrated the history of agroforestry practices around the China. China started an Agroforestry system in 1978 that was the biggest programme around the globe. The main forms of Agroforestry were farmland shelter belt and forest networks, intercropping agricultural crops with trees and planting trees around the houses, along the roadside and river banks. A workshop on agroforestry was held in October 1986, and more than 500 papers on Agroforestry were published so far.⁽⁴⁵⁾

Wenshi and Quingrong in their article titled “*Three Norths*” *Forest Protection System and its Benefits* explores the method adopted in China to protect sandstorm damage, minimize soil erosion and improvement of ecological conditions and promote overall development of agriculture, forestry and animal husbandry. They found that the shelter belt system of 1978 was very much effective for the above. The

benefits in ecological, social and economic aspects have also been analyzed in the article.⁽⁴⁶⁾

Zaifu in the article *From Shifting Cultivation to Agroforestry in the Mountain Areas of Yunnan Tropics* has mentioned the common problems of mountain farming systems. It was found in this region that *Taungya* System was an age old system, and Tai people of Yunnan in China called it Tanghai. The people were practicing cash crop plantation, like rubber. It has been developed quickly and became an important pillar of the mountain ethnic economy.⁽⁴⁷⁾

In the executive summary of Indian Council of Forestry Research & Education, the growing pressure on forests has been discussed. They have recognized the alternative and better use of bio-resources to meet the growing demands. The adverse impact of shifting cultivation has compelled the researcher for evolving suitable Agroforestry models. In the objectives and expectations of National Forestry Research Plan, they have recognized that till now no information are available on the land area under different Agroforestry models, nor on its economic performance. International forestry research organizations have prioritized Agroforestry researches under the natural resource strategies and policy, and for domestication of Agroforestry trees.⁽⁴⁸⁾

In this article the authors have shown that the impact of agroforestry is very high and positive in the sense that it generates income for the low income group. The people who practiced subsistence farming also have potential to earn more by adopting some agroforestry practices. The agroforestry practices also combat the land degradation. Several studies showed that the farmland of hill slopes of Nepal loses 8-12 tons/ha/year soils, in addition to this, the inadequate use of fertilizer decreases the fertility of the hill soils. In Thailand, the agroforestry system of eucalyptus (*Eucalyptus camaldulensis*) and leucaena (*Leucaena leucocephala*) intercropped with cassava (*Manihot esculenta*) or mungbean (*Vigna radiata*), was reported to be financially preferable to traditional monocrops (Wannawong, et al., 1991).⁽⁴⁹⁾

In this note, the past and present agroforestry of USA has been discussed briefly. As per the authors, the agroforestry is not a new concept but a new technology. It was practiced in USA since the 1900's. Russell Smith, an economic geographer at Columbia University, advocated the use of permanent tree-protected systems to maximize production on arable lands in 1914 but some political and agricultural groups opposed his ideas of radical

change in methods of food production. The Great Depression of 1930 and “Dust Bowl” spurred political leaders to reconsider current policies and support research in this area.⁽⁵⁰⁾

In this article, the author has described some pre-conditions for adopting spontaneous agroforestry practices in Vietnam. These pre-conditions are really necessary to keep in mind before introducing anything new technology. The pre-conditions for poor households to adopt any spontaneous agroforestry technology are as follows:

- ease of access to markets for the forestry products;
- benefits (economic and other) from agroforestry are higher than from alternatives;
- a viable forestry production technology is available and known to farmers;
- farmer access to sufficient areas of land and security of tenure to that land; and
- farmer confidence in being able to control risk, such as fire, pests, theft.⁽⁵¹⁾

1.4 Research Questions:

Further study will focus on these questions.

Landuse pattern changes over the years everywhere. In case of Sikkim where land is characterized by marginality, fragility and niche, it is important to study the landuse changes. It is the reflection of the entire economy. So the obvious question is - **How the land-use pattern changes over the years?**

Most of the people in Sikkim depend on agriculture for their livelihood. It is the mirror of the economy. The change in economy is reflected through the changes in livelihood patterns. So the important question arises - **How the livelihood patterns have been changed over the years?**

Till date, the study on agroforestry of Sikkim is quite inadequate. The Indian Council of Agricultural Research (ICAR) has identified some agroforestry practices but it has not been ever studied about the area of agroforestry practices in Sikkim as well as the total production. So the question is –

How far the Agroforestry practices are extended in Sikkim?

Sikkim is tiny hill state with very inadequate land for cultivation and surprisingly the economy is based on agriculture. So the study on the socioeconomic aspect is very much needed. It is also needed to study the area where agroforestry practices are present and the area where absent for comparative study. How the agroforestry plays role for economic development and could play role for future development. So the next question is - **What role can Agroforestry play in Sikkim's economy or What is the significance of agroforestry in Sikkim?**

As land is not sufficient, people produce agroforestry products and agricultural products in the same piece of land. The fodder needed for animals are produced in the agroforestry systems they practiced. They have their own system for continuous supply of fodder throughout the year without hampering the production of agroforestry. So the second question is - **What is the interrelationship between Agroforestry, Agriculture and Animal Husbandry?**

It is well known to us that all the agroforestry practices are not sustainable for various reasons. There are so many factors responsible for viable and sustainable agroforestry practices. So the next question is - **Are the existing Agroforestry practices sustainable?**

It has been discussed in many articles that agroforestry practices of Sikkim have great potential. Especially the cardamom cultivation has been given emphasis. But there are another agroforestry practices in Sikkim, which are not discussed as their legitimate importance. So the fourth question is - **What is the future potential of the Agroforestry practices in Sikkim?**

Mountain landuse system is most difficult one for its fragility, marginality and niche. It is important to model suitable landuse system in the hill of Sikkim for the integrated development of agriculture, agroforestry and animal husbandry. Whether the existing system is efficient or not is the matter of study. So the next question is - **How the integrated development programme of Agroforestry, animal husbandry and agriculture can be the more efficient land-use system in Sikkim?**

Every society has its own anthropological aspects. The agricultural as well as agroforestry system of Sikkim is obviously developed throughout the ages. Many communities came into Sikkim for their livelihood and settled there. They adopted and further accumulated the then practices and consequently developed their own practices. So it is interesting to study the following question-**What are the ethnological aspects of agroforestry?**

1.5 Research Methodology

Sikkim is a small hill state with greater land elevation ranging from 270m. to 8580m. The altitudinal differences across the state caused variation in nature in all aspects. Administratively, the state is divided into four districts, namely, North, South, East and West. These four districts belong to different altitudinal locations. It can be called a Stratum. It is assumed that in a stratum, all people are homogenous in nature. So, the sample collected proportionately from each stratum. This type of sampling is literary known as Stratified Sampling. Data is collected from each district and the place is selected on the basis of secondary data. The data on land-use for various years have been collected to analyze the change. Accordingly, the data on livelihood patterns for different years have been collected to analyze the change. The village level data of land-use is not available for all districts except North district. So, the District level data will be analyzed. It is also necessary to correlate the data of land-use and livelihood activity. The secondary data of socio-economic status of a region, demographic data and other agricultural and livestock data are being collected and analysed for such work. Suitable statistical and econometric methods will be applied for analysis.

1.6 Chapterization:

The first chapter sketches the economics of farm economy. The study concentrates on the economy as well as on its resource endowments. Importance is given to landuse and livelihood options of Sikkim, as well as that of Eastern Himalayas. Sikkim is the area of study for its distinct features of landuse, economy, agriculture and different resource endowments. The importance of agroforestry as an alternative option for livelihood is discussed using literature related to agroforestry. Different agroforestry

practices in various countries are discussed briefly to reflect the wide-use and importance of it.

The second chapter deals with the physical geography of Sikkim along with the economy of Sikkim. The climate, the riverine structure, the topography and the watersheds are briefly discussed in this chapter.

The third chapter considers the concept of livelihood in theory as well as in practice. The different aspects of agroforestry are discussed in detail with a focus on Sikkim.

The fourth chapter deals with the theory of resources. The question of efficiency is emphasized in relation to Sikkim's agricultural production. Time series data of different crop production is analysed to obtain a trend in the production of cash crops vis-a-vis traditional crops. The productivity data is also analysed to comprehend agricultural efficiency. Livestock data is also taken into consideration since it forms an integral part of the agroforestry system.

The fifth and sixth chapters are empirical chapters relying on information derived from primary survey conducted in certain villages of Sikkim. Data analysis is undertaken in these chapters to obtain answers to the research questions.

The seventh and the final chapter summarises the findings of the earlier chapters and provides policy measures that may be undertaken to improve on the existing land use system and the livelihood practices of the rural population of Sikkim.

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