CHAPTER -1

INTRODUCTION
CHAPTER - I

INTRODUCTION

1.1 General

Agriculture is the mainstay of Indian economy, it provides raw material for a large number of industries in the country. It contributes nearly 12.3 per cent of gross domestic product, and the total workforce in agriculture sector as per 2001 census was about 58 per cent of employment in the country (Anon., 2012). As rice is the staple food of vast majority of Indian, foodgrains production is equally important as other sectors. In 2008-09, foodgrains production in the country reached record level of 234.47 million tonnes, but in 2009-2010 the production declined to 218.11 million tonnes (Anon., 2011) mainly due to severe drought in several parts of the country.

At present, India is the leading producer of milk and pulses, and second largest producer of rice, wheat, sugarcane, fruits, vegetables, tea, egg and culture fishery in the world (Ravi, 2012); it has a second largest arable land and irrigated area next to China. These achievements in production were made with the right combination of appropriate technology, institutional support, policy and the farmers themselves. However India has the second largest population in the world, about 16 per cent of world population to feed, while economic liberalization and disinvestment policy of the government is gaining popularity
in the Indian economy, agriculture development on the one hand must not be neglected for sustainable and balanced growth.

While sustainable land management and sufficient production are among first priority in agriculture, per unit area production should be enhanced so as to utilize available resources to the maximum. According to a study, while per unit area production of maize and paddy in USA is as high as 8900 kg/ha and 7500 kg/ha, in India per unit area production is 2100 kg/ha and 3000 kg/ha respectively (Ravi, 2012). With the growing population and high percentage of people below poverty line in rural India who are dependent on agriculture; institutional support, credit facilities, appropriate technologies, infrastructural development, etc., may be made available to them so that they will be able to survive occurrence of unproductive years due to unfavourable climatic condition.

The extensive use of land, chemical fertilizer and water resources for achieving high production potential caused various type of degradation of land and water resources (Srivastava and Khan, 2008). According to World Bank estimates, more than 1.6 billion people depend on forests for their livelihoods. The UN’s Food and Agriculture Organization (FAO) estimates that every year 130,000 km$^2$ of the world’s forests are lost due to deforestation, conversion to agricultural land, unsustainable harvesting of timber, unsound land management practices, creation of human settlements are the most common reasons for this
loss of forested areas (Anon., 2005). In 2007, total forest cover in India was 69.09 million hectare which accounts for 21.02 per cent of the total geographical area of the country (Anon., 2009a).

1.2 Land use pattern in North East India

The north eastern region of India comprises the states of Assam, Manipur, Meghalaya, Nagaland, Sikkim, Tripura, Arunachal Pradesh and Mizoram. In all the eight states, permanent cultivation in the plains and shifting cultivation in hills are the two predominant patterns of land use, the cropping pattern remained highly specialized or specific in foodgrains production. In most of the states, jhum cultivators have no land-right excepting the right to use the land for a particular period. Similarly, the average operational holdings are also very small for sustainable growth of agriculture in the region. The major problem in north eastern hilly region is that the available land is subjected to heavy soil erosion and land degradation resulting from deforestation and heavy rains. Unabated deforestation has led to serious degradation of soils, water flora and fauna. India State of Forest Report 2009 highlighted decrease in forest cover in Tripura, Arunachal Pradesh, Assam states in North-East India mainly due to felling of trees for shifting cultivation, and increase in forest cover in Mizoram, Manipur and Meghalaya. The main reason put forwarded by the report for this increase in forest cover is effective protection of forest by Joint Forest Management and regeneration of abandoned shifting cultivation areas.
Valley agriculture is practiced throughout the hilly terrain both at low and high elevations. The land utilization for double or multiple cropping is rather poor and monocropping is practiced in general mainly due to non-existence of irrigation during dry season. Paddy field is usually kept fallow for about six months after harvest of rice crop. However, there are areas where double cropping is practiced with the help of farm manure, fertilizers and artificial irrigation during dry season. Bench terraces are well adapted in some areas more particularly in river valleys and mild slope with assured irrigation facilities.

1.3 Shifting Cultivation

Shifting cultivation is a type of farming system in which the land under cultivation is periodically shifted so that fields that were previously cropped are left fallow and subject to the encroaching forest (fig. 4.9 & 4.10). In India shifting cultivation also known as Jhumming has been widely practiced by tribal communities in Andhra Pradesh, Orissa and tribal communities of north eastern hilly region of India like Garo, Khasi, Naga, Arunachali, Mizo, etc. Agriculture in these areas mostly consists of small farms with intensive production, where varieties of crops are grown in mixtures.

In North-East India the cycle of agricultural operations in jhumming is by and large similar following successive stages, selection of forested hill lands before December by entire village on the basis of rotation of fields; cleaning the
forest tract by cutting down the jungle during December to January leaving felled leaves and twigs to dry till February; burning the dried debris into ashes around February to mid-March before the onset of monsoon and sowing seeds of various crops as mixed cropping by using hand hoe, dao, dibbling stick or sharp knives, followed by weeding, watching, and protecting of crops, harvesting, threshing and storing.

The most significant feature of shifting cultivation is that all essential crops like maize, tapioca, colocasia, beans, pumpkin, cowpea, cucurbits, sweet potato, ginger, finger millet, cotton, tobacco and many others are grown along with rice in the same field as mixed land use. Though rice is the main crop, vegetables and other crops are harvested all-round the year contributing subsidiary income to the farmers during working season. The fire ashes correct the soil acidity and make the soil fertile for a short period thereby improving crop growth. The large number of crop species over both space and time are effectively managed due to sequential harvesting all over the year. Initial opening of forested land, burning of dried forest, weeding are the most strenuous and labour consuming part of shifting cultivation, at least three weedings are necessary.

Men and women participated equally from the beginning. In some society, men in the family would take care of intense hard work like cutting down the forest as site preparation, making fire line and burning of dried jungle.
Utilization of simple tools such as dao, dibbling sticks, small hand hoe, absence of tillage or use of machine, non-existence of artificial irrigation, little initial investments are some other distinguishing features of shifting cultivation making the system simple and manageable even without scientific method. Shifting cultivation supplemented by harvest of flora and fauna from surrounding forests forms a complete unique economic system and a way of life for hill people. The whole social, political and cultural life of the hill people is interwoven with the practices with the result that they are reluctant to change into modern method of cultivation.

During burning of jhumland, accidental forest fire accelerated by dry season sometime caused huge loss of flora and fauna, it so happened many times in the past that human lives not to mention animal were lost in forest fire. The field is used for a year for mixed cropping and subsequently, it is either abandoned or cultivated with one or two select crops; occasionally some residual crops are collected from the abandoned fields. Owing to leaching, erosion and loss of fertility after one or two years, the cultivated area is abandoned, a new piece of land is then selected to repeat the process leaving the old one under forest fallow for years to recuperate. The land area remains under effective control of village authorities, mode of land allotment varies from tribe to tribe. The average size of jhum plot varies from 1.0 to 2.0 ha and the average family consists of two adults and three to four children (Borthakur, 1992).
Under the pure jhum economy in rural areas people hardly offer labour for hire during intense working season and they sell or purchase very little. However, with the awakening of the world in electronic and modern technology, rural economy has also been conscious of money economy gradually leaving barter system. Government servants working in rural areas play an important role in the availability and used of hard cash in rural areas as a medium of selling and purchasing. Selling of farm produce is important as it makes subsidiary income for the farmers, sustaining the need for children’s education, health care, etc.

Several studies were carried out by various workers on shifting cultivation and its impact on rural economy, forest, biodiversity with recommendations. Some workers opined that this system is considered ecologically and economically efficient agricultural practice provided that the fallow period is sufficiently long (Anon., 2009b; Bruun, et al., 2009; Cairns and Garrity 1999; Craswell et al., 1997; Mertz et al., 2009; Ramakrishnan, 1992; Ziegler et al., 2009). However, the length of jhum cycle reported from different regions show decline in jhum cycle from 20 or more years earlier to 4-5 years thereby making the system uneconomical and unsustainable. It has reached critical limit in parts of Arunachal Pradesh, Assam and Mizoram where it is as low as 2 to 3 years even though on the maximum it ranges from 4 to 10 years. This has adversely affected economic yield with gradual decline in yield over a period of time when short cycles are imposed on infertile land (Verma et
There may be several reasons for this; it may be inferred that population pressure, industrial policies, forest policies, injudicious collection of timber, firewood are among the reasons for this shortening of jhum cycle.

It was estimated that even with those with good soil base, the natural forest needs 30 years or more to generate. Apart from losing vegetation and biomass due to the practice of shifting cultivation, one of the serious adverse effects is soil erosion, which is mainly of splash and wash types. As the soils in the upper reaches in a ridge are exhausted in the process, the cultivators move to the adjoining lower elevations, the process continues till the entire ridge is exhausted leaving the land barren and uncultivable. Further, since the forested hill tops and upper catchments are the source of water, deforestation and soil erosion in the hills have led to shrinkage of the sources of water, siltation of riverbeds and causing floods in the valleys. There is a substantial runoff in high rainfall area like Mizoram and the soils get depleted at a faster rate.

1.4 **Shifting cultivation and land use pattern in Mizoram**

Agriculture occupies a very important place in the economy of Mizoram, as per Census 2001 about 53.91 per cent of the people are cultivators and 5.85 per cent are agricultural labourers (Anon., 2002). Those cultivators are engaged in agricultural activities mostly by practicing shifting cultivation; both production and productivity are relatively low. In 2009-2010 Agriculture accounts for 16.17 per cent share of Gross State Domestic Product and per
capita income at current price was Rs. 32,488.00. In 2009-2010 total production of paddy irrespective of kharif and rabi was 66,132 metric tonnes and the area under paddy cultivation was 47,204 ha. During the same year total food grains distributed through Public Distribution System at a subsidised rate was 1,74,832.36 metric tonnes. This shows that Mizoram is not self-sufficient in rice production though it continues to remain the chief food crop and the staple food of the Mizo. Of the total cropped area of 1.33 lakh hectares, 35.43 per cent is put on paddy and only 3,000 ha are sown more than once (Anon., 2010a). The forest production is mainly timber, bamboo, broom-sticks, etc. The common crops grown in the State are paddy, cowpea, mustard, pumpkin, maize, sesame, ginger, etc., and cabbage, mustard, cauliflower, bean, etc., during winter where irrigation facility is available. India State of Forest Report, 2009 shows increase of forest cover in the state during 2005 - 2007 which is most likely due to re-growth in the abandoned shifting cultivation areas and regeneration of bamboo in bamboo flowering areas. In 2009 –2010, Mizoram has a total forest covered of 19,240 km² comprising 134 km² of very dense forest; 6,251 km² of moderately dense forest and 12,855 km² of open forest (Anon., 2010a).

The general landscape of Mizoram is one of the most unique and rather beautiful hilly rugged terrains in north eastern part of India. Shifting cultivation has been the method of farming system practiced by Mizo people as far as history of Mizo is concerned, in the past seasonal intercultural operations were intertwined with festivals and rituals of Mizo people. Even today, customary
distribution of community land to jhum cultivators on year to year basis is being practiced by Village Councils in rural areas. Upland cultivation is usually carried out without fertilizers and irrigation, the land would be abandoned after one year and a new site will be selected again for the same purpose.

Mizoram has a pleasant climate as the state lies in the sub-tropical to temperate zone avoiding extreme climate in winter and summer. The State is marked by numerous freshwater rivers and streams, plenty of monsoon rain put the State vulnerable to frequent road blockage due to landslides during rainy season. The settlement areas are normally found high on the hillside thus creating innumerable inconveniences in gathering basic necessities for a living, water supply, road construction and the like. Farm mechanization is almost impossible due to this reason, small patch of flat lands are found in valley lands, where terracing are being practised.

Agricultural communities with limited land holdings usually supplement their income by collecting minor forest produce and growing vegetables, rearing of poultry, pig, goat, sheep etc. at home scale level. In rural Mizoram, growing of upland paddy has been more like a tradition than for their basic livelihood since the last few years due to the fact that Indian government had launched innumerable poverty alleviation schemes for development of rural India, some of them being livelihood development programmes, wage employment, rural housing, wasteland development through peoples’ participation, self-
employment, etc. While the rural people can go for alternative livelihood activities rather than traditional farming they are very much adhered to the system, complete abandoning of the system is rather a sensitive issue and it will require intensive thematic campaign.

The area under Jhum cultivation in Mizoram during last ten years is presented in the table below.

Table 1.1: The area utilized for Jhum Cultivation during last 10 years

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Year</th>
<th>Area under Jhum in Ha.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1997-1998</td>
<td>68,114</td>
</tr>
<tr>
<td>2.</td>
<td>1998-1999</td>
<td>68,392</td>
</tr>
<tr>
<td>4.</td>
<td>2000-2001</td>
<td>35,798</td>
</tr>
<tr>
<td>5.</td>
<td>2001-2002</td>
<td>40,305</td>
</tr>
<tr>
<td>6.</td>
<td>2002-2003</td>
<td>41,356</td>
</tr>
<tr>
<td>7.</td>
<td>2003-2004</td>
<td>43,447</td>
</tr>
<tr>
<td>8.</td>
<td>2004-2005</td>
<td>40,969</td>
</tr>
<tr>
<td>9.</td>
<td>2005-2006</td>
<td>40,100</td>
</tr>
<tr>
<td>10.</td>
<td>2006-2007</td>
<td>41,465</td>
</tr>
</tbody>
</table>

Source: Anonymous, 2010b

1.5 Need for sustainable farming system in Mizoram

The unsuitability of shifting cultivation begins with the reduction in jhum cycle, land degradation due to soil erosion, runoff, nutrient losses; loss of bio-diversity, deforestation, etc. Shifting cultivation is still prevalent in tribal
areas in different parts of India including North-East India. In the 1993, 1995 and 1997 reports of forest survey of India, it was clearly mentioned that among other factors, shifting cultivation played a major role in the rapid deforestation in North-East India. Nevertheless, studies have shown declining trend in areas covered and number of families engaged in shifting cultivation in Mizoram. The need for sustainable farming system in Mizoram are summarised as below:

1.5.1 Land degradation

The cultivation along the hill slope without conservation measures and rapid loss of tree cover from mountain have rendered the land susceptible to accelerated soil erosion, loss of soil nutrients, landslides and loss of habitat. The rehabilitation of mountains and proper management of its resources, particularly the common resources of forests required special attention in the present situation. It is well recognized that apart from natural causes, improvident and unscientific land and water management practices have resulted unproductive, barren and waste lands. With the same amount of input and effort put in the process, decline in per area production due to unproductive land makes the present farming system unattractive. Farmers have to opt for alternative livelihood activities.

1.5.2 Decline in jhum cycle

The State’s economy is largely agricultural with almost 60 per cent of the total work force engaged either directly or indirectly in agriculture. In the
olden days with availability of vast area of land including forest land, smaller size of population, jhum practice was more or less in harmony with natural cycle. But the impact of increased pressure on forest land for different purposes like dwelling, mini industry, grazing, timber, firewood, etc., have led to shrinkage of jhum cycle lowering productivity and production thus rendering jhum practice uneconomical.

1.5.3 Availability of essential commodities and alternative livelihood options

Various developmental activities also generate avenues for easier livelihood options like chow making, agarbati stick, candle, plantation of cash crops, oilseed crops, etc., under the aegis of Government, and wage earnings from construction works, rural artistry, handloom, handicraft, groceries and other activities different from hard work involved in jhum practices. Transportation of provisions from other states by private vendors and availability of essential commodities at a subsidised rate through Public Distribution System make the jhumming system appears less economical, as a result farmers are subjected to choose alternative options like growing of commercial crops to increase purchasing power. However, scientific and modern intervention is required at this stage as long as land based activities are opted for sustainable income generating activities.
1.5.4 Technical constraints

There are various technical and implementation constraints to agricultural development in Mizoram. Upland farming in different agroclimatic zones does not permit the uniform package of practices for agricultural development. Rather location specific technology and varieties of crops are needed. The rugged terrain and slope creates difficulty in promoting mechanised agriculture on sloping land. Improved varieties of seeds and planting materials are not readily available to farmers.

1.5.5 Declining crop yields

Available reports indicated that the overall soil fertility status throughout the state is poor and the soil in the hills are strongly acidic in reaction (Anon., 2010b). This is compounded by the fact that farming is generally practice on sloping farmlands, aggravating soil erosion and associated nutrient losses and wet rice cultivation in river valley on continual basis. The productivity of farmlands in the upland areas has been recording either a steady decline or stagnation in crop yields. In lowland wet rice cultivation soil fertility is maintained mainly by the application of compost, manure, and fertilizers. Long term use of inorganic fertilizers alone in wet rice cultivation resulted in poor and low inherent fertility thereby causing yield reduction. In Mizoram, irrespective of wet rice cultivation and jhum land, drastic yield declined of paddy was observed in 2006-2007 and 2007-2008 due to bamboo flowering and it associated problems like incidence of insect pest, rodents. The total yield of
paddy in 2009-2010 was still lower than paddy yield before bamboo flowering particularly paddy yield in 2005-2006 (Anon.,2009c).

1.6 Jhum control initiatives

Various attempts have been made by the Government of India as well as State Governments to settle the tribals involved in shifting cultivation. In view of the need to have comprehensive plan for development of wastelands on watershed basis in the country, Integrated Wastelands Development Programme (IWDP) was introduced in 1994 and subsequently revised in 2001 by the Ministry of Rural Development. Likewise the Ministry of Agriculture, Government of India sanctioned watershed development projects under NWDPRA (National Watershed Development Project for Rainfed Areas) and WDPSCA (Watershed Development Project in Shifting Cultivation Areas) as centrally sponsored schemes to cover rain-fed areas and shifting cultivation areas in 1990 and 1994 respectively. The broad objective of Integrated Watershed Management Programme is to treat degraded lands with the help of low cost and locally accessed technologies such as in-situ soil and moisture conservation measures, afforestation etc. through participatory approach.

WDPSCA was particularly launched by the Ministry of Agriculture and Cooperation, Government of India in the seven north eastern states with 100 per cent grant. The scheme aimed at overall development of jhum areas on watershed basis, reclaiming the land affected by shifting cultivation and socio-
economic upgradation of jhum cultivators living in these areas so as to encourage them to go in for settled agriculture. These developmental schemes have however, not yielded the desired results perhaps due to ignorance of the authorities about the socio-economic and agro-ecological conditions of different regions coupled with poor publicity of the programmes. The programmes are implemented by agriculture department, soil conservation, forestry etc., in relative isolation without proper coordination through a multi-disciplinary approach.

In Mizoram, the scheme IWDP started in the year 1999-2000. To further simplify the procedures a new guidelines called Hariyali was issued in 2003 by the Government of India. The IWDP / Hariyali is implemented in all 8 districts of Mizoram, at present there are 52 ongoing projects under IWDP / Hariyali in the State. The guidelines of these programmes being revised and modified according to lessons learnt from past experiences, all these programmes are now converged into Integrated Watershed Management Programme (IWMP) under the common Guidelines for Watershed Development Projects 2008, also known as Integrated Watershed Management Programme. There are 49 sanctioned projects under this new guidelines in Mizoram at present.

Policies have also been formulated by the Government of Mizoram for settled and permanent farming system several times in the past. To name some of them, garden colony, new land use policy(NLUP), jhum control, contour
trench method, Mizoram intodelhna project (Mizoram Self Sufficiency Project), Newly designed new land use policy, etc. However, major changes in rural economic scenario, the likely beneficial result as a whole is perhaps yet to be known. In the past, it was reported that some families were benefited by the scheme particularly NLUP and gave up jhum practices and managed to set up sustainable, alternative livelihood activities (Anon., 2010b). But, it is likely that the controversy may remain whether those families would have possibly successful even without the aid of government scheme or they were genuinely benefited by the schemes.

In general, people in rural Mizoram are attached to traditional method of jhum cultivation, may be due to lack of know-how or unavailability of reliable and sustainable alternative or income oriented systems. Though it is very difficult to say whether the area under shifting cultivation is increasing or decreasing during the last ten years, it can be said that the number of families engaged in shifting cultivation have declined. However, in some areas shifting cultivation continues for production of non-cereal crops like turmeric, chilli, ginger, etc. Therefore, an alternative system to jhum practice, friendly to hill people is necessary for gradual transformation to permanent landuse practices and change rural economy in Mizoram.

1.7.1 Agroforestry as a sustainable farming system

There may be many and diverse methods as alternative to jhumming. As
presented earlier several initiatives were made by the government as a government policy and researchers and scholars have recommended several alternative systems as well. It is crucial to increase food production per unit area to meet the unfulfilled demand of vegetables and food crops of rising population of the state, with practically no scope with shifting cultivation, due attention should be paid to sustainable cropping systems. For such hilly regions the adoption of improved, efficient and sustainable systems like agroforestry system may be an appropriate option to improve the economic scenario of Mizoram.

According to Upadhyaya and Jha (1997), apart from being eco-friendly and sustainable, agroforestry regime is about 18 times as lucrative as shifting cultivation. Various scholars and researchers have defined the term agroforestry differently depending on the focus of work but the general principle have always been land-use systems and technologies where woody perennials are deliberately or intentionally mix or retain and combine with crops/animals production on the same land management. Agroforestry aims at systematic land use systems and practices where positive interaction between crops and trees is maximized.

1.7.2 Use of legumes in farming system

The nitrogen contribution of legumes can be vital for maintaining the productivity of sloping lands over long periods, because this benefits other ground vegetation, both crops and non-crops. To acquire nitrogen-fixing
capability, legumes form symbiotic association with nitrogen-fixing organisms, usually nodule forming soil bacteria of the genus *Rhizobium* or actinomycete of the genus *Frankia* (Partap and Watson, 1994). The results of an experiment conducted on the use of leguminous cover crops in Nigeria revealed that total biomass and litter were three times higher in *Tephrosia candida* plots fallowed for 2 year than in the natural fallow. Nutrient (nitrogen, phosphorus, calcium, magnesium and potassium) yields in leaves of *T. candida* fallow for 2 year were on average 200–300% higher than in leaves of other fallows. Soil chemical changes showed significant increases in nitrogen and carbon concentrations after 2 years fallowing and a year of cropping. Conversely, soil pH, available phosphorous and the exchangeable cations, especially calcium were lower (Ikpe et al. 2003).

Despite their biological potential to fix nitrogen, not all legumes have the capability to fix nitrogen and species vary in their rates of nitrogen fixation. Some are exceptionally good while others are poor nitrogen fixers. Besides, there are several other factors that influence the fixation of nitrogen by a legume. The most common reasons for poor nitrogen fixing by a legume may be absence of appropriate nodulating bacteria in certain cases and adverse habitat conditions for nitrogen fixation. *Leucaena* is poorly nodulated at pH below 5.5. However, there are some species of *Leucaena* which are tolerant to acidity (Anon., 1977). There are legumes like *Mimosa* which bear healthy nodules even
in some of the very high acidic soil of the highlands (Rekasem and Rekasem, 1993).

1.7.3 Principles and functions of hedgerows

The hedgerow in general comprised of tree or shrub either nitrogen fixing tree species or suitable shrub species managed in a shrubby form to be employed as natural or live fence like structure. The main functions are soil fertility maintenance, rehabilitation of degraded lands, natural terrace building through accumulation of top soils and litter fall. In hedgerow intercropping, the hedges provide semi-permeable barriers, thereby checking detached particles of top soils, retain moisture, while their prunings augment soil cover by returning the nutrients back to the soil. In an alley cropping study in Zambia, the soil moisture content was higher under the hedge rows of *Leucaena leucocephala* and *Flemingia macrophylla* than in Maize rows during dry period (Chirwa et al., 1994). It was also reported that the higher yield of agricultural crops under trees was attributed to improvement of soil fertility and conservation of moisture (Puri et al., 1994; Jaimini and Tikka, 1998). Kang *et al.* (1999) also reported greatly enhanced total biomass yield/ha, higher soil organic carbon, phosphorus and potassium levels under nitrogen fixing hedgerow species of *Gliricidia sepium* and *Leucaena leucocephala* in a long-term alley cropping trial undertaken in south western Nigeria.

1.8 Agroforestry models in Mizoram

Many research works on agroforestry have been carried out all over the world with significant results and few have been tried successfully in Mizoram.
Agroforestry models which are regarded to have special relation with the present investigation and experimented in Mizoram are presented briefly in the subsequent paragraphs.

1.8.1 Tree-green hedge-crop farming system or Zo Tech

Jha (2000) had conducted on farm demonstration-cum-trial in four villages which he called ‘Tree-green hedge-crop farming system (T GhCFS)’ or Zo Tech which is reported as a new and alternative to jhum cultivation in Mizoram. Nitrogen fixing tree species viz. Leucaena leucocephala and Cajanus cajan and non-Nitrogen species Manihot esculenta were planted at closer spacing to establish hedges, crops were grown in between hedge rows. The research finding indicates that the TGhCFS may be a suitable agroforestry base cropping system for hill farming system or to rehabilitate jhum land.

1.8.2 Sloping Agricultural Land Technology vis-à-vis Alley cropping system

In southern Mizoram, Baptist Church of Mizoram, having in mind sustainable development of rural people through improved farming system has been advocating Sloping Agricultural Land Technology (SALT), an imported technology from the Philippines by the Church which is one form of alley cropping or hedgerow intercropping system. The salient features of SALT - I for foodgrains production is similar with alley cropping system up to certain extent. The complete system of SALT is rather complicated and intensive integrating foodgrains production, livestock rearing, timber, fruits and plantation crops
production. In SALT system, densely populated double or triple rows of woody legumes or hedge forming nitrogen fixing trees are grown along the contour lines and managed to form hedges which later will perform different functions of hedgerows. The hedgerows are the key element of the entire system (Partap and Watson, 1994).

Alley cropping system involved planting of perennial trees or bamboo or shrubs yielding forage in rows at some distances in association with agricultural crops. It is an agroforestry practice, which emerged as an alternative to shifting cultivation in humid tropics. It is a system in which food crops are grown in the alleys formed by hedge rows of trees and shrubs. The primary purpose of alley cropping is to maintain or increase crop yields by improvement of soil fertility (through legume tree component and mulching) and microclimate (Singh, 1995). Alley cropping with tree rows aligned along contours will prove to be an effective means of erosion control and also impart stability to production. The hedge rows are cut back at planting of arable crops and kept pruned during the cropping period so as to prevent shading and reduce competition with food crops. When there are no crops, the hedge rows are allowed to grow freely or cut to meet the fodder needs.

1.8.3 Contour trench farming system

The contour trench farming system with contour trenching as mechanical conservation measure was initiated in Mizoram by the Department of
Agriculture, Government of Mizoram. The trenches are dug along the contour at an interval varying from 20-50m according to percentage of slope. The trenches are dug normally by cutting a trench of 30cm deep and around 45cm wide. The function of the contour trench is to break the slope and convert surface water into subsurface. Detached top soil due to rain and cultural operations gets accumulated with decayed biomass in the trench, which are scooped out from the trench and utilized as compost manure to the crops (Thansanga, 1997).

As discussed earlier, Mizoram is prone to landslides, soil erosion; high run-off attributed by steep hills, heavy rainfall, land degradation and deforestation due to faulty land management, there has been no known proper information about complete system of any identified model of agroforestry system being in practice in Mizoram until very recently. However, government policy for sustainable development and low returns from the uneconomical practices of farming, people started going for some form of agroforestry since a few years back. Though economic returns from these practices were not systematically analyzed, but subsidiary income have been made from the system which stabilizes income of farmers during lean period.

Scope of the present study

The various farming systems in Mizoram need to be analysed to see how well they protect the land, particularly at the critical periods of the year when erosion risk is highest. It is important to study whether the soil fertility be
maintained over the long term using leguminous crops as hedgerows? Can the crop productivity be maintained by continuously cultivating such lands in this way? Is this practice economically viable? Which nitrogen-fixing shrub species are most appropriate to the different slopes, soil-types and climatic conditions that occur across the region? Properly designed trials with appropriate controls to specifically test species differences in performance on a variety of slopes under the various climates and soil-types that occur across Mizoram are urgently needed. Such trials, if successful, would also be a critically important resource in disseminating this technology to local farmers. Finally, the growth performance of nitrogen-fixing trees viz. *Leucaena leucocephala*, *Tephrosia candida* and *Flemingia microphylla* and their effects on the growth and yield of agricultural crops in hill slopes of Mizoram need to be studied.

**Objectives of the present study**

The present study, therefore, aims to investigate the growth performance and yield of rice and maize as affected by leguminous tree species planting as double hedgerows without external application of fertilizers and manuring in the upland condition of Mizoram. It is expected that the present study would also help in determination of changes in the nutrient status of soil, growth and yield attribute of agricultural crops as affected by tree-crop interactions and growth performance of leguminous tree species.
The present experiment has been designed to achieve the following specific objectives:

1. To study the effect of leguminous tree species on the growth and yield of agricultural crops.
2. To study the effect of pruning of leguminous tree species on the growth and yield of agricultural crops.
3. To determine changes in the nutrient status of soil as affected by tree-crop interactions.
4. To determine the most suitable tree species for contour hedgerows cropping system.
REFERENCES


Anonymous (2010b). Comprehensive project proposals under New Land Use Policy for sustained livelihood development for urban and rural poor of Mizoram. Planning Department, Govt. of Mizoram.


&&&&&&&