CHAPTER – II

REVIEW OF LITERATURE
Studies on shifting cultivation had been carried out by the various authorities including social scientists, agronomists, forestry experts, soil scientists and ecologists from time to time. A good number of articles on this subject had also come out in the national and international journals, research bulletins, weeklies and daily newspapers etc. So far as the North Eastern Region of India is concerned, in Assam, the Agro-Economic Research Center for N.E. India, Jorhat, in Meghalaya North Eastern Hill University, North East India Council for Social Science Research, North East Council and Indian Council of Agricultural Research Complex for N.E. Hill Region had taken keen interest on the study of various aspects of the shifting cultivation.

In this chapter, an attempt is made to review some of the relevant literatures on the relevant issues available within and outside the country on shifting cultivation.

**Economics of Shifting Cultivation**

Sharma\(^1\) (1994) reported that the socio-economic and agro-ecological parameter responsible for the sustenance of shifting cultivation needs to be analyzed objectively in order to prescribe the models for development of tribal and forests. Due to manifold increased in total population in general and tribal population in particular, the human pressure on forests have increased of late, much beyond their carrying capacity. The problem is compounded by the pressure brought about by substantial increase in cattle population. As a result, land resources are no more surplus. Due to the impact of market forces and fact that village economy is no more isolated from national economy and global economy, the barter and subsistence tribal economy is giving way to a monetized one, thereby disrupting the traditional structure. The author also reported that socio-economic constraints such as lack of knowledge, risk aversion, inadequate market and credit facilities, non-availability of inputs, poor soil and inefficient cultural practices have hindered the development of modern agricultural practices in the region. Tribal, in general, believe in instantaneous consumption and live for today only. Therefore, saving habits to tide over any contingencies arising in future are not found among them.

Mukherjee\(^2\) (1980) had conducted a socio-economic surveys of shifting cultivation areas. The survey showed a tendency towards settled agriculture in some regions. For instance, the percentage of land under shifting cultivation, horticulture and homestead of wet paddy cultivation are about 30, 31 and 39 respectively in Banishindua, a Garo village, where a decade back shifting cultivation was the main occupation of the people. The
survey further showed that villagers having small farm sizes, namely 0.5-2 hectares tend to stick to the traditional shifting cultivation, but those having larger farm sizes (3-6 hectares) divert a greater proportion of their land to wet paddy cultivation. Study on Mizo village also showed that shifting cultivation is a part and parcel of the agricultural methods being integrated with settled cultivation, animal husbandry, horticulture etc. The percentages of lands under shifting cultivation, horticulture, livestock and poultry are about 60, 5 and 11 respectively. Several cropping patterns exist depending on the land formation and availability of resources; out of these the pattern involving paddy and maize cultivation is the most general because of its high economic return. Some families started sugarcane farming which showed promise.

Saha (1980) discussed about subsidiary occupation and shifting cultivation. He reported that the shifting cultivation was once a complete economic system with several subsidiary occupations as its adjuncts. Each village was, more or less, self-sufficient in respect of food, clothes, implements and housing materials. But such isolation was possible only during the period when such villages were ruled by independent Chiefs; even now the economic life in the shifting cultivation villages revolves round the system of shifting cultivation. Traditionally, hunting, fishing and gathering from nature's stock are important subsidiary sources of food. Moreover, collection of timber, canes and bamboos for house-building and making house-hold tools and implements remain an important source of income. Each shifting cultivator's household possesses a few domesticated animals like cows or mithuns, pig and poultry birds. Cattle breeding and dairy farming does not have much place in their economy. Weaving is an important female occupation supplying almost all the consumption requirements of dress, but it has now lost much of its grounds to mill-made cloths.

Singh et. al. (1998) conducted a study on shifting cultivation in Manipur. The study indicated that shifting cultivation occupied more than three-fifth of the net cultivated area on which more than two-third of the households were directly or indirectly dependent on their livelihood. A shifting cycle of 10 years was found to be economically viable and ecologically sustainable. Nearly 54% of the shifting cultivators practiced mono cropping while the remaining 46% adopted mixed cropping. Paddy occupied the highest proportion of the total cropped area followed by soybean and maize. The output-input ratio was the highest for ginger (2.54) and the least being 1.13 for paddy plus maize cropping. The
ratio for soyabean + maize was 1.67 followed by soyabean mono, paddy mixed, paddy mono and maize mono cropping respectively. It revealed that ginger and soybean were more remunerative as compared to other crops. Mixed cropping was found to have increased the income as well as maintained the soil fertility.

Sarma and Sarma\(^5\) (1998) reported that the remarkable features of the shifting cultivation are well defined calendar of operations no use for farm tools, observance of rituals and sacrifices after each operation and different taboos. The Lakher's agricultural calendar, begins in December when the chief and elders of the village decide what place/slope shall be used for the shifting cultivation for the ensuing year. Having decided the slopes, the forest is cut in January or February followed by a sacrifice. Sowing of maize, millet, cucumber, pumpkin and other vegetables is done during this period. Towards the end of April, Paddy is sown by scratching the ground with a hoe and about ten seeds being dropped into each scratch. The seeds are left uncovered and the heavy rain soon washes the earth over them. The crops have to be weeded two or three times depending on weather the plant materials have been burnt well or not. At the end of July or beginning of August, maize and millets are harvested. In October, tapioca and spices are gathered and laid out in the sun to dry. From the end of October paddy harvesting begins. The paddy is pulled out by roots, not cut with a sickle. Pulling up of Paddy completes in mid-November. The harvest is not finally gathered in till between the end of December. The lakhers, therefore, are more or less busy the whole year round with agriculture. However, the Lakher method of harvesting is clumsy and labourious. The main crop is rice of which there many varieties like Livanmong, Batanong, Bupinar, Chairo, Zaibenong, Saibainong, Savenong, Buhpui, Knogloing etc.

Kalita\(^6\) (2002) found that the extent of diversification was comparatively more under settled cultivation as compared to shifting cultivation. The results of the economic analysis of the settled and shifting cultivation revealed that higher output-input ratio (2.18) in shifting cultivation while net return was found to be higher under settled cultivation regarding the standard of living of people, it was observed that the Sen's P measure of poverty was more in the case of shifting cultivation than that of settled cultivation. The percentage of people who lived below the poverty line was more in the case of shifting cultivation compared to settled cultivation.
Chakravarti\textsuperscript{7}(1986) reported that, in Tripura about 20,000 tribal shifting cultivators' families still now practice shifting cultivation in the forests for their sustenance, as forestry and tribal economy are complementary, great importance is now given in Tripura to the development of forestry for the rehabilitation of the Jhumias. The promising prospects of rubber plantations in Tripura which practically started only in the sixties of the present century and of the Jhumia resettlement programme undertaken at present have been noted. Coffee plantation was also undertaken a few years back and it was found to be very suitable for Tripura.

Banerjee, et al\textsuperscript{8}(1986) have conducted a study on importance of forests in the economic life of the Jhumias of Tripura. The study was sponsored by the Government of Tripura and undertaken jointly by the Department of Analytical and Applied Economics of the Agartala and the Department of Economics of Calcutta University. They have found the average annual income of a humid household in the sample from shifting cultivation was Rs.184.50 and the average annual incomes derived by a Jhumias family from the collection of bamboo, firewood and sungrass were Rs.185.00, Rs.200.00 and Rs.154.50 respectively. In contrast, non-traditional activities connected with forests yield a higher level of income of the sample Jhumias families. The average annual income of sample Jhumias families from wage employment was being Rs.1790.50. The main sources of wage employment of the Jhumias were the Forest Department, horticulture and plantations crops which provide them employment respectively. In terms of income generation, forests have ceased to play their important traditional role in the economic life of the Jhumias of Tripura. This was not the case in the past when land suitable for Jhumming was easily available and forest products which could be collected by the Jhumias were not in short supply in the state. Jhum lands have sustained a less of fertility, which has led to the reduction of yield from Jhum and a reduction in the income of the Jhumias from Jhumming. In order to compensate for the loss of income from Jhumming, the Jhumias have been forced to fall back on the collection of forest products and felling trees in forest.

Goswami\textsuperscript{9}(1986) reported that utilization of land for shifting cultivation differs from area to area. Moreover, land utilization in such areas has undergone tremendous changes along with the progressive decreasing fertility of the land under shifting cultivation. The green vegetables, if not allowed growing more than a decade, the resultant fertility added by the
decomposed green foliage and retention of the top soil cannot be helpful for rising of cotton. Now-a-days, even the traditional items of crops like chilies, ginger, tuberous roots, maize, and various kitchen garden vegetables do not grow luxuriantly because of the shortening of the Jhum cycle. In some villages near Churachandpur, in Manipur, Jhum is practiced every year in the same plot of land, but there they raise beans which replenish the fertility of the soil, however poor it might be. In Tripura the soil of the shifting-cultivated area is so soft and loose that it becomes easily prone to erosion of the top soil, hence some villagers of Chakma Ghat area did not even get the double of the seeds which they sowed/broadcast. In Tirap in Arunachal Pradesh farmers having the Jhumed area, for plantation of seeds, roots, tubers etc. This is mainly due to loss of fertility. New crops like tapioca, mustard, hill gourd etc. are grown in many shifting cultivation fields.

In those areas where the shifting cycle is around 3 years, the shifting plots are usually used for two years consecutively, after which it is left fallow for regeneration of the green foliage. In Garo hills the first year is known as alal and in the second year the same cultivated plot is called abreng, whereas the fallow period is known as airt. In Meghalaya a new technique of turning the shifting cultivation area into orchards of oranges or banana or pineapple has paid them good dividends as market for such fruits are readily available in the adjoining townships or cities. Attempts at raising cashew nuts have checked progress whereas coffee and tea plantations have held out bright prospects.

Mishra and Ramakrishnan10(1981) studied the economic yield and energy efficiency of hill agro systems, namely, slash and burn agriculture (Jhum), terrace cultivation (both of which involve mixed cropping) and valley cultivation of a monoculture of Oryza Sativa, as practiced in the higher elevations of Meghalaya, and compared their economic yield, and energetic efficiency patterns. A comparatively longer Jhum cycle of 15 year was contrasted with two others of 10 and 5 years. From an economic point of view, a 15 years, cycle was most efficient followed by a 10 year cycle; a 5 year cycle was extremely inefficient, this being further aggravated in the second year of cropping, while the yield from valley cultivation was reasonable, terrace cultivation gave poor returns due to labour cost for terracing and maintenance and also due to heavy cost of fertilizers. Comparing the three shifting cycles, which are very rare now due to increased population pressure and reduced acreage was found to be the most efficient with an output/input
ratio of 25.6 for a 5 year cycle. While the energy efficiency of valley cultivation was high (16.2) as it needs fewer inputs, that of terrace cultivation was very low (1.7) due to heavy labour and fertilizer inputs required to sustain this. They suggested that only a long shifting cycle of 10 years could be sustained along with valley cultivation, both from an economic and energy point of view.

Saikia \(^1\) (1971) made a study on pattern of agricultural production, land and labour utilization of six hills tribal villages in North East India and observed the most of the surveyed farmers were shifting cultivators. Some of them also practised settled farming in the low-lying areas and in areas where facilities for settled cultivation were available. The authors reported that the per hectare production of crops under shifting and settled cultivation was nearly the same except one village, while per hectare labour utilization was higher in shifting cultivation than settled cultivation.

Saikia and Bora \(^2\) (1971) examined the pattern of crop production under shifting and terrace (settled) cultivation in Garo hills, Meghalaya and reported that the farmers raised paddy, arum, maize, millets, sesamum, ginger, cotton, tapioca etc. simultaneously in the shifting cultivation fields. The similar systems of mixed cropping followed in terrace fields also. The average yield of paddy per acre under terrace and shifting systems was 2.77 and 2.07 quintal respectively. The return per unit of land from mixed crops was much higher in shifting cultivation than that of terrace cultivation.

Sharma \(^3\) (1994) reported that Orissa is the worst affected among all the Indian States due to the shifting cultivation. The estimated annual area under active shifting cultivation in Orissa is 5298 Km\(^2\), which constitutes about 8.8% of the total forest area. Nearly 150,000 households depend on shifting cultivation and problem is acute in seven districts of Orissa. Shifting cultivation is legally prohibited inside the reserved and protected forest of Orissa, but it may be allowed in other categories of forests such as unclassed forests with the permission form Revenue Department. However, the practice is quite prevalent even inside the reserved and protected forests, despite punitive actions against the offenders taken by the Forest Department.

Roy and Verma \(^4\) (1980) in their research paper animal husbandry as a subsidiary source of economy for Jhumias reported two basic approaches to the socio-economic problem of Jhumming. First is the Jhumias must be induced to settled framing and second is land classification should be done based on the fact the all lands are not suitable for each and
every purpose and is required to be used profitably. Short Jhum cycle and consistent low agriculture yield, no limited command area of the clans have also created a severe socio-economic problem. When the available land in the vicinity is getting exhausted, the tribes migrate to another location for Jhumming. The migration of farmers and shifting cultivation are thus two problems interlinked. The particular area of a hill for Jhumming is selected by group of experienced clan leaders usually away from the village and all subsequent agricultural activities are in fact very much of a cooperative enterprise. The various agricultural operations such as clearing the forest, burning the Jhum, sowing or dibbling the seed, weeding, fencing and reaping are performed in a religious spirit by the group. The shifting cultivation does not necessarily mean shifting homesteads.

Ganguly\(^{15}\) (1980) reported that Government has taken various Jhum control measures like Jhumias rehabilitation colonies in Tripura where the Jhumias were given individual plots for settled wet rice cultivation and were provided with various extension services. In Assam's Jhum control scheme has been a part of the soil conservation programme undertaken by the forest department and in the Angami and Chakasang areas of Nagaland hill slopes have been terraced where the people practice continuous cultivation. Terrace cultivation obtains in Meghalaya also; it is also being tried in Manipur, particularly in the Tonghul area in Ukhrul Sub-division. In Arunachal Pradesh the main plan on which the Jhum control scheme rests was the introduction of terrace cultivation. Despite the various Jhum control and improvement measures adopted in different parts of the region, it can not be said that the problem of shifting cultivation have been substantially solved in any of the state or Union Territories. On the contrary, the problem is still very much there.

From the above studies, it may be understood that agricultural production system in hilly areas differs greatly from the plough farming elsewhere. The hill areas are generally characterized by undulating terrain, dense forests, difficult communication and low population density. Each tribal people have own customs and dialects usually lived in a compact area. Most tribal people in the hill practised a shifting type of cultivation, which is popularly known as Jhumming. This system is regarded as the first step in transition from food gathering and hunting to food production. Yet this most primitive system of farming is still in vague amongst the tribal and backward people in the North East India. Besides this production system, settled agriculture is also practised in the plains and valley lands and to some extent on foothills and terraced lands in the gentle slopes in the
hilly areas. The productivity in these two production systems differs greatly and thereby causes a serious problem of food availability. The productivity in Jhum land has strong bearing on Jhum cycle. Jhum cycle is the time period between one cultivation periods to another cultivation period in the same plot. Longer the Jhum cycle higher is the productivity. But the population pressure over the years and heavy deforestation has resulted in shrinking of Jhum areas over years. It has been estimated that production from shifting cultivation on an average, could meet about the half of the annual food requirement of cultivators' family. On the other hands, the productivity under settled agriculture is substantially more. Moreover the yield loss in settled cultivation is comparatively lower than the shifting cultivation.

**Environmental Imbalance due to Shifting Cultivation:**

Das\(^{16}\) (1980) reported that hazard of soil degradation and consequent sediment and flood havocs caused by the practice of Jhumming on the hill slopes. The flood in the plains of the North East India is a serious and almost annual. The problem of flood is not so grave due to excessive run off, but more so due to the associated heavy silt load. The flood havocs in the river system of North East India have always been associated with the heavy sediment loads. These sediments come from the hills where shifting cultivation is practised. It is not the erosion and sediment hazard alone. The problem is far more serious. The Jhum cycle, which used to be 30-40 years a few decades back, now ranges from 1-17 years only. The shortened cycle degrades the land at a faster rate and return falls further making the subsistence agriculture even more precarious.

Jain et. al.\(^{17}\) (1980) discussed about the vegetation and flora of shifting cultivation area. The author reported that the shifting cultivation affects the soil mainly in following manner (i) due to removal of tree canopy there is no obstruction to mechanical force rain and falling water dislocated soil, (ii) rainfall causes leaching and acidity of soil increases (iii) increased acidity renders soil unsuitable for plant growth and makes it further unusable and vulnerable to washing away. The humus which would have been created by falling leaves and other vegetable material is not available any more, further adding to acidity. Such disturbances effect micro-flora and macro-fauna of the soil, which in turn affects the flora. The authors have made some observations in changes in flora of Jhum lands in Meghalaya and Arunachal Pradesh.
Jain et al. \textsuperscript{18}(1980) reported that in some spots certain trees and shrubs are scarce, and may become further rare or even eliminated from the flora of the region, e.g., \textit{Tetracentron sinense}, \textit{Michad excelsa}, \textit{Betcula alnoides}, \textit{Taxus baccata} \textit{Cephatotaxus griffithii}, \textit{Cinnamoumum tamala}, \textit{Illicium griffithii}, \textit{Magnolia campbellii}, \textit{Acrcamphellii}, \textit{Acer hookra} are becoming scarce in most of the areas of Arunachal Pradesh where shifting cultivation is being practised. In the process of cutting trees and burning the site many parasites and epiphytes get depleted or eliminated from the flora e.g., \textit{Caleola falconeri}, a saprophytic orchid, (which happens to be one of the largest ground orchids) was collected from the Kameng district of Arunachal Pradesh in the year 1970, but in subsequent visits it could not be located from the same area, as the area under shifting cultivation. After the tree cover is removed many components of ground find the habitat no more suitable for example, \textit{Paphiopedilum fairieamum} in Rupa in Kameng and some parasitic plants like \textit{Balanophora dioica}, \textit{Aeginetia indica} etc. and ferns like \textit{Osmunda}, \textit{cyathea} at other spots. Epiphytic plants like orchids and ferns are particularly becoming rare in the areas where forests are being destroyed, e.g. species, \textit{of Dendrobium cymbidium} and \textit{Vanda}.

Singh et al. \textsuperscript{19}(2000) reported that the shifting cultivation system at present has become not only unproductive but also hazardous to environment. The deleterious effect of the system which involves forest cutting, burning, clearing and dibbling of seeds can be discernible from the fact that it accounts for nearly 3.7 tones/ha of soil material to slide/roll down to foothills annually. Estimates reveal that nearly 181 million tones of soil are lost annually as a result of shifting cultivation in North Eastern Hill Region of India. Soil erosion from hill slopes (60-70\%) under first year, second year and third year (abandoned Jhum/shifting) was reported to be 146.6, 170.2 and 30.2 tones/ha/year, respectively. Exposure of rocks due to soil erosion, heavy silt load of riverbeds and drying of perennial water resources from the areas of shifting cultivation. During shifting cultivation cycle, a large number of edible vegetations were cut and burnt which cause great hardship to semi domestic and wild animals. The author reported that in the process of operations in shifting cultivation, soil materials removed from the slope might be as much as 3.85 tones/ha depending on the steepness of the slope. The magnitude of soil erosion depends on gradient of slopes, soil texture, permeability etc. Nutrient loss in North East Hill India Region seems to be quite alarming due to shifting cultivation,
which is to the tune of 6.0 million tones of organic carbon, 9.7 tones of available phosphorus and 5690 tones of Potash respectively. Singh\textsuperscript{20} (2000) reported that the shifting cultivation, which is a part of the very ethos of the communities dwelling in hilly terrains, leads to degradation of natural resources like forest, soil, water and thus destabilizing the ecology. It has led to extinction of some unique flora and fauna of the region, which in the long run may prove clear to the mankind. Forest denudation which causes (a) extinction of genetic resources of plants and animals along with forest canopies like loss of genes from wild species and primitive cultivars useful intercrop breeding, (b) high run off, hence, poor recharge of ground water, floods, silting of tanks and reservoirs, and (c) removal of vegetation reduces evapo-transportation resulting in change in hydro-geological balance in the area and rise in perched water table causing salinity and cultivation in the hilly areas causes loss of suitable sandy area which leads to increase the sand load manifold and accelerates the mobility of sand towards desertification.

Patiram and Verma,\textsuperscript{21} (2001) in their research paper reported that each year one per cent geographical area of this region is being depleted of forest cover due to large-scale cutting. In between 1995 and 1997 assessments, 1875 sq. km of forest area was lost due to the shifting Cultivation, out of 2030 sq. km total lost. However, 1700 sq. km of abundant cultivation area came under forest cover during the same period as a result of regeneration. Thus tribal for Jhum cultivation causes single largest factor for destruction of forest. The good forests are seen only in reserved forest away from such habitations. Tropical evergreen and deciduous forest are the home of several species of plant and animals; the system of Jhum had resulted loss of biological diversity and the serious depletion of gene pool. With the thinning of forest cover and destructive practices of Jhumming have destroyed the natural forest cover with the result that the volume of silt washed down from the adjoining to Brahmaputra and Barak River had gone up. Huge shifting islands of sands are formed, restricting vegetation. In Manipur, 140 sq. km. Loko lake is silting up with debris from the treeless hill around it. In addition, water hyacinth and floating plants are choking the surface of lake. Sedimentation production rate of rivers originating from these hills is mostly very high. The problem of foot hills is severe, gully erosion, which tends to inundate and swamp cultivated lands with coarse materials rushing down from the barren hilltops.
Arunachalam (1998) conducted an experiment on shifting cultivation and soil degradation at lower altitudes of Arunachal Pradesh and found that the pH of the topsoil (0-10 cm) increased after the burn and gradually decreased during cropping. The soil moisture content declined sharply after burning. Carbon and nitrogen concentration decreased slightly during cropping. There was an up shock in microbial biomass carbon (MBC) and nitrogen (MBN) in the soil as a result of burning. A shifting cycle of 3-5 years, now prevalent in the region, is definitely too short. For example, the soil degradation was more in systems under 3 year Jhum cycle as the C and N concentrations were lower than those of a natural forest. The highly labile fraction of soil organic matter, the microbial biomass, reportedly a soil degradation indicator also indicated that the 3-5 year shifting cycle is harmful.

Effects of burning

Borthakur (1974) reported that burning chemically alters a portion of the plant nutrients supply from an organic form to a mineral form in ash which is often readily soluble. When water runs over or passes through this ash, the soluble components are flushed out and lost from the site in the runoff.

Borthakur (1988) in their study on the effect of burning reported that the organic carbon which was initially 10.6 percent before burning, decreased to 9.8 percent after burning. Total nitrogen content at 0.68 percent before burning increased slightly to 0.69 percent afterwards. Available phosphorus increased immensely with burning from 3 to 20 kg per hectares, while available potassium almost doubled from 480 to 870 kg per hectare and pH changed from 7.7 to 8.0.

Awasthe (1975) reported that in forest areas burn resulted temporary increases in the microbial population of soil, as well as, in the rate of mineralization of nitrogen after burning in the forest zones.

Griffiths (1974) reported destruction of nitrifying bacteria and negligible nitrogen supply for some time after burning. Improvement in physical condition of soils. It had also been reported by several workers from Philippines and Parts of India. The increase in nutrients' supply is only for short period, as these are lost with subsequent showers.

Ramakrishnan and Toky (1981) made a comparison of soil nutrient status between three shifting cycles of 30, 10 and 5 years. Depletion in soil carbon and nitrogen during cropping period extended up to five year fallow. Phosphorus build up after Jhumming.
and fallow started after five years and increased in 10, 15 and 50 years fallows, Cationic concentration in the soil also declined rapidly in early phase of regrowth of vegetation. This decline was most pronounced for potassium. *Dendrocalamus hamiltoni*, a common bamboo species dominated the fallow up to 20 years. This species is heavy accumulator of potassium and plays important role in its conservation. In a 50 year fallow land, calcium and magnesium levels were declining with depth, which is in contrast to that of potassium and phosphorus. Five year shifting cycle generate very low level of soil fertility.

Borthakur\textsuperscript{28} had studied the effect of burning on some soil properties at Burnihat (Meghalaya) which are given below:

**Effect of burning on soil properties.**

<table>
<thead>
<tr>
<th>Soil Properties</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.10</td>
<td>5.50</td>
</tr>
<tr>
<td>Organic Carbon (%)</td>
<td>1.32</td>
<td>1.05</td>
</tr>
<tr>
<td>Available P\textsubscript{2}O\textsubscript{5} (kg / ha)</td>
<td>3.30</td>
<td>3.31</td>
</tr>
<tr>
<td>Available K\textsubscript{2}O (kg / ha)</td>
<td>210.0</td>
<td>570.0</td>
</tr>
<tr>
<td>Exch. Ca (meq %)</td>
<td>7.15</td>
<td>9.46</td>
</tr>
</tbody>
</table>

The above data suggest substantial increase in the contents of exchangeable calcium and potassium in the soil and a corresponding rise in the pH. The litter layer is destroyed by burning with possibly no loss of humidified organic matter from the soil itself. The level of organic carbon decreased due to burning. There are many secondary effects of burning. These arise from the effects of heat on the soil, influence of pH change and nutrient additions on the soil population. The rate of mineralization generally increases on account of burning of the soil.

Thangam\textsuperscript{29} reported that according to estimates made by the United Nations Environment Programme, up to 5,000 km\textsuperscript{2} of land are lost of productive use every month in the world, because of erosion, flood damage, salinization and alkalization, advancing deserts and other causes, In developing countries, potential arable land is not adequate to meet the growing needs of the increasing population. In India, nearly half of the land area is subjected to water and wind erosion. Since irrigation facilities are limited, the choice for the future is limited with relatively small opportunities to bring new arable land under the
plough. This call for a new approach and in this respect agro-forestry could help to produce food and wood while conserving the ecosystem. Das\textsuperscript{30} reported that shifting cultivation has been held responsible for disturbing ecological balance by causing disproportionate deforestation. This in turn has been causing huge soil erosion in the areas where this system is in practice.

From the above studies it can be conclude that at present shifting cultivation system has become not only unproductive but also hazardous to environment. The deleterious effects of the system are forest cutting, burning, clearing and dibbling of seeds. Shifting cultivation leads to soil erosion from hill slopes. During shifting cultivation cycle, a large number of edible vegetations are cut and burnt which cause great hardship to semi domestic and wild animals.

**Evaluation of Shifting Cultivation programme:**

Although various attempts have already been made by the state Governments and various other agencies in weaning the North-East tribal into modern scientific cultivation, but most of these attempts have failed to achieve desirable results.

Borthakur, et. al.\textsuperscript{31}(1997) reported that a few surveys has been made on the success of the schemes under operation although no detailed and through survey has yet been taken up. It is, however, a fact that the schemes have not meet with complete success as was expected in many instances, the Jhumias have either abandoned the new settlements or have carried on Jhuming even after the settlement.

The primary causes for this failure to attract the Jhumias to permanent settlement are:

(i) The new settlement cuts into their socio-cultural life abruptly.

(ii) They are not used to cultivation in terraces using bullocks / implements,

(iii) They find the production to be low in the terraces in the first year due to removal of top soil while developing terraces:

(iv) The production technology for terraces, water management, water conservation practices, etc., is also not properly developed for the region.

A field study by the Department of Sociology and Anthropology of the North Eastern Hill University, Shillong, showed that the tribal hardly used the subsidy given to them for starting a settled way of cultivation. In some cases, they sold the land allotted to them,
and went back to their old life. The study pointed out that Jhumming is an ancient socio-economic tradition that the tribes like to cling to.

Dhar\(^32\) (1999) reported that tribal resistance to change alone is not the only reason for the failure to halt Jhum cultivation in North East India rather the lack of whole-hearted effort on the part of Government agencies and Non-Government Organizations (NGOs) is also responsible for such failure. Field surveys in the Garo Hills of Meghalaya showed that some areas selected for terrace cultivation, as part of the anti-Jhum efforts, were unsuitable for food crops. Seeds were often not supplied on time, leading to delayed sowing and poor harvests. The proper infrastructure facilities required in this connection were also not provided in the resettlement of colonies. Such half-hearted official endeavors will hardly stop jumming's silent march in the North East. Thus under the present scenario, more planning and patience will be required in helping its tribal make the painful switch to settled agricultural existence.

Mathur\(^33\) (1979) reviewed progress of states own programmes of soil conservation which included contour bunding, land reclamation measures, afforestation including plantations and the development of pastures. Terracing and provision of irrigation facilities have also been included to give the programmes a Jhum prevention bias. These programmes have been tried through extension method and initiative comes from the farmer who is given a subsidy. The Departments supply subsidized inputs such as seeds, fertilizers and provide technical know how. The cost as estimated per hectare of area brought under cultivation was found to be varying from Rs.1000.00 to Rs.7000.00. The farmers take up this programme in their free time from Jhum cultivation, therefore, the Jhum was not given up at the time when the programme under taken. It was considered that the farmers would give up Jhum cultivation after the terraces stabilized. Under this programme, out of some 10,000 families in Mizoram who had joined the programmes, only 300 families gave up Jhumming. The others used the terraces for cash crop cultivation and practised Jhum for food crops. Most of the farmers who gave up Jhumming had more than four hectares of land and were located in close proximity of large towns. These farmers have now become new affluent elite in the society and employed hired labour to cultivate their terrace fields, while they themselves have taken other vocations, such as, dairying, pig rearing, etc. The position in Meghalaya and Tripura is similar and out of the 3000 families in Meghalaya only 150 have given up Jhum practice, while the corresponding figures for
Tripura are 7500 and 250. Absence of irrigation with declining fertility in dry terraces was considered the main reason for their dependence on Jhum for food crops. Sharma (1994) reported that the pioneer attempt to settle shifting cultivators was first made by the Orissa Forest Department in 1951 when Khonds were settled in the Girishchandrapur colony in Sambalpur District. This experiment was successful as the tribal who were allotted irrigated lands are still living settled life by practising modern agriculture. Subsequently, special tribal development schemes were implemented during the 5th Five Year Plan in the districts of Koraput, Keonjhar and Phublan with full financial assistance of the Government of India. But these schemes did not yield desired results possibly due to ignorance of the socio-economic and agro-ecological environment of shifting cultivation. Tribal depends on forestry for their sustenance, was completely ignored while implementing the tribal welfare schemes.

It is understood from above studies that, it will not be possible to wean away the traditional age old practice of cultivation completely, but the magnitude of their practice of this type of cultivation is being considerably reduced by diverting and motivating the hill people for accepting a permanent and settled method to cultivation. Thus both the whole-hearted efforts on the part of Government agencies and NGOs as well as the motivational process are equally important to transform this age old tribal agricultural practices into a settled and developed farming practices and at the time of formulation of the plans and programmes for Jhum control, the views of the social scientists should be taken into consideration. The schemes should be implemented in such a manner that the people do not feel apprehensive of losing their tribal identity in the name of development. Monitoring and follow up action should be undertaken constantly by the scheme implementing agencies. Furthermore, evaluation studies should be conducted by an independent organization immediately after the completion of the period of the programme.

**Socio cultural aspects:**

According to Indian Council of Agricultural Research, Barapani, Shillong, shifting cultivation is being a part and parcel of Socio-cultural life of the tribal people in North-East India, all its operations are inseparably linked with their religious rites and festivals, viz, Agalmaka, Miamua, Rongchugala and Ahia om of Garo Hills. In spite of its adverse
effects on the eco-system and low productivity, it is still continuing with them as a necessary evil for the following inherent characteristics –

(a) Bulk of the labour force management and capital comes from the households;
(b) Production is either consumed on the farm or traded in local markets;
(c) The decision making process is hampered by limited access to marketing and political institutions; and
(d) Most of the farmers do not live much above the culturally determined subsistence level.

The rationale behind the persistency of this system lies in its compatibility with the physico-social environment of sparse population, community land tenure system, undulating and steep topography, short crop cycle, rainy season and thereafter, acute moisture stress during post-monsoon period, as well as, meager resources with the farmers and also the only available means of providing moderate calories and protein for the sustenance of families with minimum risk and the least income variability. This sort of socio-cultural equilibrium environment centering round shifting cultivation is, of course, gradually getting slackened under the impact of higher population, low yield, shortening of Jhum cycles, new economic and social goals, as well as, incursion of modern science and technology with the dying out of tribal isolation from the main stream.

Samanta\(^\text{36}\) (1978) conducted two pilot field investigations on socio-agro-economic characteristics and attitudes of tribal farmers towards modern agricultural practice and village leadership pattern for agricultural development. The studies were conducted in the year 1977-78, at ICAR Research complex, Barapani, The study revealed that:

(i) the lower rate of adoption of agricultural innovations and the least favourable attitude towards them by the tribal farmers were found to be due to their lower educational levels, lower socio-economic status, small size of holdings and lower annual income;

(ii) as the village headman plays an important role in all round agro-economic development of the tribal farmers, training to the village headman regarding modern agricultural practices may help in adoption and diffusion of technological innovations.
Ganguly\textsuperscript{37} (1980) found that the hill men are very sensitive about two things one is ownership of forests lands and another is growing of rice which is their staple food. Any schemes which affects either or both of these aspects is resisted by them. In parts of Meghalaya and Manipur there are still the vestiges of feudalistic land ownership. Any attempt to end it may encounter stiff opposition. In Manipur, the act passed to abolish the chief ship some years back was strongly opposed out of fear that this would affect the ownership of land by the tribal people. It is also for the same reason that every attempt at extending the reserved forest areas, or strictly improvements the forest regulations in the existing reserved forest area is opposed by the people who are affected by it. Jhumias are emotionally much attached to producing rice (which is their staple food) on their own farms. They will feel extremely helpless if they do not produce their staple food themselves. Such a vital change in their economic organization cannot be smooth or even readily acceptable to them.

Majumdar\textsuperscript{38} (1980) reported that culture satisfies the basic needs of most of the individuals who are bearers of that culture. All cultures necessarily have intimate links with the mode of subsistence. As in other preliterate cultures traditional Garo religion was nothing but a way to obtain bumper crops and to keep away disease and disasters. All operations of shifting cultivation were performed with religious awe and the series of annual rites and festivals were linked with different stages of shifting cultivation. After allocation of plots each house hold performed a religious rite in the plot. The \textit{agalmaka} rites make burning and planting. The \textit{miamua} rites are performed by the \textit{nokma} (representative of the land owing clam) at the time of fruiting of the rice plants. The rongchugala and ahia rites mark the lifting of taboo on certain plants and vegetables of the shifting cultivation. The agricultural activities of the year culminated in the gand wangala rites and festivities to mark the end of harvest and also to mark the close of the agricultural season. Wangala rites are performed in honors of \textit{Saljong}, the Sun-god, who is the ultimate bestowed of crops. All these rites involve festivities, in which rich man can demonstrate their wealth which adds to their prestige. The author also reported that the importance of traditional rites and festivals in decreasing along with the decline of shifting cultivation.
Sharma,\textsuperscript{39} (1980) reported that shifting cultivation is way of life, training of youths, the whole social and political system, the ceremonies and festivals, their philosophy of life is a product of shifting cultivation system of economy.

From the above studies, it may be concluded that culture and society are susceptible to changes but the ecology offered by the geographical environment could hardly be changed. This speaks well as to why many of the new methods of cultivation recently introduced in the tribal areas are yet to generate the process of culture acceptability. The above author also reported that the cause of continuity of this prehistoric system is linked up with cultural factors.

**Suggestions for streamline the Shifting Cultivation system:**

Mukherjee\textsuperscript{40} (1980) reported that the problems of evolving a suitable alternative to shifting cultivation are many. Resettlement of shifting cultivators in the face of paucity of land, high cost of terracing, and the lack of marketing facilities for commercial produce, becomes an impracticable proposition. The shifting cultivators may be induced to sow seeds of a leguminous crop before abandoning a shifting cultivation area. This would not only act as some kind of a cover crop but also add nitrogen and organic matter to the soil. Sociologist have another viewing angle, according to which shifting cultivation must not be hastily abolished as this step might react sharply with the way of their like. The author also suggested that Tribal Development Agency and the Hill Area Development Programme is to raise the economic level of those who are engaged in shifting cultivation through agricultural and allied occupations, such as cattle development, dairying, piggery, sheep, goat rearing poultry, duck keeping, fisheries, bee keeping and sericulture etc. In order to successfully implement these programmes the strengthening of cooperative and marketing infrastructure is essential.

Ganguly\textsuperscript{41} (1980) suggested that industrialization programme is a necessary and unavoidable part of overall planning for development of this region. Without an industrialization programme agricultural improvement programme cannot be succeed. Apart from providing inputs to agriculture and demand for agricultural and forest products industrialization programme would provide employment to surplus farmlands. This will cause a fall in the pressure of land. Thus industrialization programme would indirectly help soil conservation programme. The author also suggested the 3-
dimensonal forestry, i.e. combining silvi-culture and horticulture, with animal husbandry. Various quick-growing tree species have also been suggested for introduction in the region by the author.

Bordoloi (1980) reported that soil fertility is greatly enhanced by the algal growth in the soil and soil composition is thus changed to a considerable extent, bringing it to the fertile side. One of the most significant changes brought about by algae is the increase in total phosphorous in the soil. Other organic substances like carbon, calcium, etc., were also found to increase considerably due to the algal growth. Algal ability to fix free atmospheric nitrogen in the soil, which makes soil rich in nitrogen, it is so vitally important for any plant growth. There is a great potentiality lies in the mass use of algae not only in rice cultivation but also in the cultivation of other crops. Algal species, therefore, are to be cultural enmass in the nearby scientific laboratories of soil conservation or forest laboratories and Jhum fields should be inoculated with these cultures for a quick growth of algae which will then take care of the problem of soil conservation by reclaiming such soil. While selecting algae species, for culturing, algae with the nitrogen fixing ability should be chosen carefully. Some of the strong nitrogen fixtures are *Aulosira fertilissima*, *A. implexa*, *Anabaena circularis*, *A. variabilies*, *Tolypothrix tenuis*, *Oalothrix brevissilna*, species of Nostoc, all belonging to the Blue-green algae.

Das (1980) suggested that the problem of controlling shifting cultivation should viewed not only as a soil and water conservation problem, but also a necessity of altered way of living suitable to the changing circumstances. Therefore, the elements of the plan should be such that it progressively provides better return from the limited areas with lesser working force involved in the management. The plan should also endeavor to maintain the mixed way of living comprising agro-horticultural activities, livestock keeping and utilization of resources from forest in selective manner, the plan should also ensure adequate work for each member of the family who opts for the land use management in the integrated plan towards the replacement of shifting cultivation. The speed of implementation of any such plan has to be appropriate so as not to create any disruption in the socio-economic living of the people and further development in that respect. The development of permanent agriculture will call for necessary soil conservation and water management practices as well as introduction of suitable agricultural tools, implements,
machineries and storage facilities. The expanded livestock programme will also bring changes in their feeds and housing and also modification in the homesteads of the families in the region.

Bhowmick (1980) reported that most of the times tribal suffer because of lack of proper marketing facilities and communication facilities. They have to travel a long way for collecting some bare necessities of their life, and a portion of whatever little they earn is wasted on the way. The Government can make arrangement for making the necessities of the life available to them through micro-growth centers like Andhra Pradesh Tribal Development Corporation. Tribal groups should be given training in raising tree protecting plan and trees. Cottage and Small Industries and indigenous handicrafts should be developed in tribal areas. One should see to the fact that the tribal people get jobs there and they are not exploited. They should be given an education, which is in tune with the eco-techno system they belong to. Their love for nature and forest should be reinforced through the education. It should be ensured that they could utilize the education and training they received for enriching their life.

Singh et. al. (2000) reported that North-East India promise for potential development of agriculture including horticulture, fishery, forestry, animal husbandry etc. The present agricultural activities in this region are not exposed by adequate scientific base in circumvention the land degradation process and scientific exploitation of water resources. There is therefore, an urgent need to develop sustainable agricultural strategy for hill areas of North-Eastern Hill Region to conserve soil, water and ecology while carrying out various agricultural practices. The author suggested that shifting cultivation system should be so designed as to meet the various needs of the farmers. The latest and most effective land and water management techniques i.e. Watershed Management Programme integrating soil conservation measures, land development, agriculture, plantation crops, horticulture, animal husbandry, fishery and forestry should be considered as vital and most important. The alternatives are horticultural and plantation crops land use system, Agri-horti-silvipastoral land uses system, multi-storied cropping land use system, livestock-based land use system and water harvesting for irrigation and fish production unit.

Singh, et. al (2000) reported that as the shifting cultivation is no more a profitable and self-sustaining proposition, agro-based industries can help bringing about prosperity to
people in the rural areas. Establishment of rural based agro industries may lead to improvement the infrastructure facilities in backward areas and may create potential for development of subsidiary industries. The different agro-based industries viz; agar wood oil, turpentine oil, cinnamon leaf oil, citronella oil, lemon grass and ginger oil etc. and fruit based industries, spices and plantation based industry, agro-based and sericulture based industries can be effectively developed for curbing the traditional shifting cultivation practices in the North Eastern Hill Region. The authors also reported that the establishment of agro-industries in the rural areas might reduce the migration of people from rural areas to urban areas.

Patiram and Verma,\(^{47}\) (2001) discussed about the cultivation system, importance of shifting cultivation; degradation of natural resources, reformed shifting cultivation for sustained productivity and finally they have suggested that agro-forestry, contour hedgerows, improved fallow, plantation crops, livestock farming are as alternative to shifting cultivation. The authors suggested that the introducing of plantation and horticultural trees like rubber, coffee, tea, black pepper, cashew, banana, citrus species, pine apple etc. on the shifting fields on sloppy hills are the promising alternatives. In this regard, first step should therefore be of determining with degrees of firmness to the kind of plantation that would be taken up in any areas. During the establishment of plantation crops, immediate plan for resettlement of shifting cultivators on permanent settled terrace cultivation and sufficient employment of families to be assured in the programme, so that they are able to provide food and other essential for themselves. For achieving this goal, it would be necessary to give free food for some time to gain confidence. Action should be simultaneously taken to discourage whatever possible to prohibit the practice of shifting cultivation in the project area. The success of the strategy would depend on whether the plantation can ultimately provide sufficient income to the families to buy their own food and sufficient surplus for better economic conditions. The local people without breaking their tradition can achieve this through a reasonable share of profit after processing and marketing. Tree and bush crops would represent a relatively replacement of original forest land put under Shifting Cultivation and can sustain large number of people through the generation of cash income with which food may be purchased without loss of land resources.
Banerjee, et. al (1986) observed that not only are the shifting cultivators facing serious economic problems because the forests in their traditional economic role are unable to sustain them, but society as a whole is also having to pay a price for the extensive deforestation in the state in the form of soil erosion, floods and droughts. Therefore, any well-designed forest policy will have to wean the shifting cultivators away from shifting cultivation by providing them with alternative occupations in the long run while in the short run, it will have to ensure that the shifting cultivators can derive a higher income from their forest based occupations. Both long and short term measures have a two-fold aim—to protect the forests and to improve the economic condition of the shifting cultivators. The two aims are complementary because forests cannot be saved without improving the standard of living of the forest dwellers and vice-versa.

Banerjee, et. al. reported that any policy to be successfully implemented has to be acceptable by the people for whom it is designed. A survey was carried out in the course of their study on shifting cultivation in Tripura to find out the shifting cultivators themselves regarding their preferred occupations. They have found that although the shifting cultivators are aware of the problems of shifting cultivation and the low economic returns derived from shifting cultivation, the majority of them are not willing to give it up at least in the short run. Although only 234 out of 1999 respondent families indicated that they want to carry on shifting cultivation as their main source of livelihood, roughly three quarters of the respondent households indicated that they wish to continue shifting cultivation as one of the sources for earning a living. The reason for this seemingly inconsistent preference pattern was also investigated. It was found that 1217 households wish to carry on shifting cultivation because shifting cultivation provides them with a supplementary source of income while 1016 households in the sample feel that shifting cultivation is a way of life and should not be given up. However, only 162 out of the total 1999 respondent families expressed a desire to earn their living from the collection of forest products. This is indicative of the extent of deforestation that has taken place in the state and points to the need for under taking a massive programme of afforestation to renew this depleted natural wealth of the state. Only 290 Jhumias households appeared to be interested in opting for wage labour as a source of earning has an uncertain prospect and also because the shifting cultivation are averse to becoming wage labourers and losing their 'independence'. However, the other forest based
occupations like plantations of coffee and rubber proved to be very attractive as a source of earning a living for the shifting cultivation. More than 50 per cent of the respondent households showed an inclination to take up these occupations for earning a living. Block authorities were asked to give their opinion, regarding suitable occupations, for the shifting cultivators living in their jurisdiction for increasing their level of income. It was found that 14 out of the 15 block authority voted for wage labour, three for shifting cultivation and none at all for the collection of forest products.

Lalthanzama\textsuperscript{50} (1986) mentioned that the North East Council has initiated watershed management project in all the constituent units as measure against the evil of the practice of shifting cultivation during the sixth plan and this is intended to be continued in seventh plan also.

Ramkrishnan\textsuperscript{51} (1986) suggested that we must design packages of development suited to each unit areas. Horticulture, agro-forestry systems, development of medicinal and aromatic plant cultivation suited to the region, could be considered. Social forestry systems would have to receive much emphasis. All these would help in strengthening the shifting cultivation cycle to at least 10 years or more, which could make the shifting cultivation system ecologically and economically viable. The forestry system should be bases on indigenous tree species-the region had indeed a rich variety of tree species available. Indigenous trees could also be used for regeneration for desertified areas, if planned in the basis of an understanding of germination and establishment of native trees and their subsequent tree architecture. Only a multi-prolonged approach could ensure economic well being for the tribal people, while providing maximum ecological security. Dutta\textsuperscript{52} (1986) suggested that the shifting cultivators should be rehabilitated in the protected forest area and allowed them to participate in the regeneration scheme and be encouraged to develop horticulture as means of livelihood and thereby weaning them away from the age old practices of shifting cultivation. Forest planning and policy should be so framed as to provide maximum employment and income to the tribal people. The cultivation of rubber holds out a big promise. The case of rubber plantation is made stronger in view of the sufficient availability of hillock lands, its short gestation period in Tripura and also its foreign exchange saving role.

Sharma\textsuperscript{53} (1994) suggested that a holistic and participatory approach of integrated development, encompassing Government interventions at almost all the levels of vicious
circle, needs to be adopted, such interventions may include labour-intensive agro forestry practices (with indigenous species), soil conservation measures including mulching, credit and subsidy, development of marketing facilities, nutritional improvement, population control measures, and ownership of land and trees.

Roy and Verma (1980) reported that among the people of N.E. India Region who practise shifting cultivation, do not generally keep animals to improve their economy. Moreover the agricultural technique of shifting cultivation is not high enough to produce surplus food. To get extra income and to patch up the shattering economy of shifting cultivation, particularly in N.E. India Region, livestock and poultry rearing are perhaps most promising and untouched field. Animal husbandry may be best insurance against economic and social risk. The livestock can protect shifting cultivators against uncertainty of rainfall and destruction of their harvest by pests. Sale of animal products like milk, butter, ghee, eggs, mutton, pork, beef and birds etc can give additional income to shifting cultivators. There is a bright scope of expansion of shifting cultivation areas for cultivation through maintenance of livestock. The extent of cultivable shifting cultivation area is also directly connected the number and unit of livestock kept by shifting cultivators for direct and indirect source of income. The author also suggested that to be viable animal units, a strong co-operative amongst shifting cultivators is needed to supply necessary inputs of housing animals with indigenous materials, supply of feed, land and fodder developments, storage of extra fodder in the form of silage, hay or straw for lean periods. The state Government Veterinary and Animal Husbandry Department may also assist in providing health guards for animals and other technical guidance. Once the animal unit is economically viable, it will be a standing source of income for the shifting cultivators besides meeting the domestic requirements of milk, meat, egg etc.

**National Environment Report on Shifting Cultivation:**

In the environment report submitted by the Union Environment Ministry to the United Nations in 1992, has mentioned about the practice of shifting cultivation among the tribal people of the Northeast. The report reasoned out why the old practice became unviable and damaging. The report also stated that the increasing population and decreasing availability of land and the fall in the crop fallow period in shifting cultivation have
affected the cultivation process, reducing the cycle to more five years from more than 20 to 40 years in the past.

However, the study paper suggested that the new technologies need to be explored and interim mechanism be applied before replacing the old system, because the report added, "Changing practices is a slow process." The national paper also stressed on alternative farming in the hilly region, the report noted that the Department of Agriculture in Nagaland had identified experts who were said to have guided farmers in different parts of the state.

Terrace method is adopted by the Nagaland farmers to suit the hilly terrains by constructing terraces. The report explained: "During the monsoons, the fields are flooded. Rainwater is used for irrigation, canalized through indigenous bamboo conduits. Young rice plants are transplanted to the terraces, locally known as 'panikheti' from the nurseries.

**Bio-diversity of North Eastern Region of India:**

According to famous Botanist Kunjilal (1940) the climatic factors of North East Region (NER) are high humidity (80-90%), frequent and heavy rainfall and moderate to mild temperature without extremes of heat or cold. The average rainfall is heavy but varies from 2,000 to 12,700 mm. The Brahmaputra flows through to the whole length of Assam valley with alluvial deposits on either sides. The NER is an area of rivers, hills and plains, extraordinary rich in vegetation: a part of the Khasi hills above the pine zone (2,000 m) is considered to be the richest, not only in India, but perhaps in the whole world. North Eastern Region is a genetic paradise, which is also recognized globally as an area of mega biodiversity. It is considered to be home for some crops and secondary center of origins for others. Unfortunately, this region is also classified as 'hot spot' area with regard to threat to biodiversity. Fire and agriculture practices in the form of shifting cultivation have influenced the forest and bio-diversity of the region for past 9000 years. (Sharma, 1976). The region is a store house of bio-diversity with its species richness of flora and fauna. The NER represents a wide range of physiography and eco climatic conditions and is endowed with vast and luxuriant vegetation ranging from tropical to alpine with rich gene pool of both wild and cultivated plant species (Chauhan and Wadhwa, 1988). This calls for urgent steps for collection and conservation of the diverse
flora to halt genetic erosion. Among the cereals, pulses and oilseeds many of which have originated in this region; rice, rice bean and soyabean are the most important. Among others, considerable variability has been recorded in the germplasm of maize, millets, beans, cotton, pigeon pea and perilla.

**Extensive Destruction of Forests in North East India Region:**

A recent report released by the Dehradun based Forest Survey of India (FSI), based on satellite data and extensive field surveys shows Assam to be the main victim of shifting cultivation in the recent years. In the early 1990s, the state lost about 243 sq. km of forest to Shifting cultivation. In the same period, Shifting cultivation further deforested 100 sq. km in Meghalaya, 28 sq. km in Arunachal Pradesh and Manipur and 10 sq. km in Tripura.

In the past, the gap between successive shifting cultivation cycles used to be around 25 years, giving enough time for the forests and soil to regenerate. Today the lag is down to a few years and thus the regeneration become impossible.

Renewed cultivation has permanently rendered the land waste. Studies show that the topsoil loss in the shifting mode of cultivation is 40 tones per hectare, compared to a mere three tones per hectare in conventional farming. Further, severe soil erosion on the hilltops and catchments areas causing silting of reservoirs and streams below.

As for example, in Meghalaya, unabated Shifting cultivation has turned the once thick evergreen forest belt of Cherrapunji a place, which used to record the highest rainfall in the world, into a dry, brown scar. The Shifting cultivation practice has caused extensive in to climatic changes in the state and destroyed rare flora and fauna.

**Shifting Cultivation and Environmental Degradation:**

The swidden agriculture is blamed for most of the forest fires since uncontrolled flames during the field burning often burn 10 to 20 times the intended area. The fires do not only destroy protective vegetative cover, but also cause the loss of soil organic matter and associated soil structure decline.

Shifting cultivation also causes serious land degradation problems and prevents natural forest regeneration. The depletion of soil nutrients was due to over-cultivation of the shifting cultivation practice. Sedentary shifting cultivation with the rotating lands that
annually cover up to one million ha is the most expensive cause of the evolution of barren lands and land degradation in many parts of the world.

The traditional Shifting cultivation, in the condition of low population density and the absence of the market economy, presented itself a sustainable cultivation method and did not cause the inverse consequences to the environment and the society. However with in population density this status no longer exists. The actual consequences of shifting cultivation with reference to environment are described below;

**Deforestation:**
The most severe deforestation by shifting cultivation can be happened by two ways. Firstly, the new appeared pioneer shifting cultivators who transfer the land under fallow to people for money and then continue clearing forests for further cultivation. Secondly the forest fires are caused by uncontrolled flames during land clearance for shifting cultivation. Together with the social changes, the prevention measures against forest fire have been fallen into oblivion. The lands for shifting cultivation now are scattered, the forestland is no longer the ancestral property of the village, and therefore no punishment is applied for deliberate forest fires by the community. As a result, forest fires occur more frequently.

**Hydrological regime disruption:**
The forests in the up streams of watershed contribute to the regulation of the hydrological regime in the region as the trees can help to increase the water retention of the soil in rainy season and reduce the evaporation in dry season. It has been well established that the forest loss increase the flood peaks and decreases discharges of the stream flow during dry period.

**Downstream effects:**
The soil erosion and hydrological regime disruption in the upper watershed are going to result in a range of downstream effects for its lowland and coastal region. More frequent and more serious flooding, more rapid siltation of irrigation channels and deposits of gravel as well as silt in delta areas have the effects in agricultural productivity and outputs of the lowland farmers and thus on their standard of living as well.
**Weed Potential:**

Weeds in agro ecosystems are generally considered to be plant that are out of place, that adversely affect crop growth, and that for a variety of reasons are difficult to control. Since weeds are often considered competitive with crops for limited resources that are available in the system, much of the research effort have been directed towards looking at the decline in crop yield due to weed-crop competition. Extensive studies on crop yield decline, in any case seem to suggest a world average loss of about 10 per cent due to weed growth.

The presence of weeds may cause rapid depletion of resources often resulting in reduced crop yield. The shading of crops by weeds is also an important factor. The reduction in monetary yield of 1.9 times under a 5 year shifting cultivation cycle compared to a 10 year cycle (yield per 5 year cycle versus yield per 10 year cycle) may partly be related to the weed problem along with poorer soil fertility recovery under shorter cycles.

As cultivation has to be done on young forest soil after short periods of fallow, the soil impoverishes the weed pressure increases, which require more labour input for weeding, and the rice yields are lower.

**Desertification and land use:**

Although shifting cultivation is the traditional land use of the Khasis of Meghalaya and their staple diet is rice and fish, the people living in Tytiang close to Cherrapunji have abandoned this land use system because of large scale desertification that has occurred. In many areas in the Khasi hills of Meghalaya, where forest have almost disappeared and the land is being desertified because of the reduction in Shifting cultivation cycle length to less than 5 years, the Khasis have adopted a fallow system of agriculture in which the burning operation of shifting cultivation is eliminated. The new system may cause even more rapid desertification of the landscape due to rapid depletion of soil fertility such that the fallow/sedentary agricultural systems often become uneconomic. This is because, the fallow regrowth is only herbaceous weeds that are ploughed back into the system and this alone is inadequate to sustain soil fertility.
Culture:
Majumdar (1978) who paved the way for study of culture change in the North East by taking two Garo Villages of Meghalaya for study. The study grew out of his field work in the Garo Hills of Meghalaya since 1953. He selected two villages namely Metchakolgiri and Wajadagiri. He found that to a certain extent, the phenomenon of change observed was ecologically determined. The main reason for culture change was found to be impoverishment of shifting land and adoption of wet paddy cultivation. Several forces were found to have jointly acted to impel a change in the method of cultivation in Wajadagiri and in the change over to other methods of earning a livelihood in Matchakolgoro. He found that in Wajadagiri in spite of a vital change in the system of agriculture, the people did not face a major crisis. Their society could be described as in a state of "eunomia". On the other hand, there was no such major change in any of its vital aspects of culture in Matchakolgori; it was in a state which would be termed as "dysnomia". Majumdar gave a fine and solidly grounded account of all aspects of culture change, giving precise data on such topics as crops, land tenure and harvest and suggesting implications of changing subsistence patterns of the household, for extended kinship groups and for the village as a whole. He depicts how the whole situation he observed totally changed after a lapse of about a decade due to urbanization and modernization.

Socio-cultural aspects of shifting cultivation:
Shifting cultivation is being a part and parcel of socio-cultural life of the tribal people in North-East India; all its operations are inseparably linked with their religious rites and festivals. The festivals of tribes of N.E. India related to Shifting cultivation are given in the table. In spite of its adverse effects on the eco-system and low productivity (Borthakur et al, 1979), it still continues with them as a necessary evil for the following inherent characteristics as revealed in its analysis elsewhere (Abalu and D'silva, 1979):

1. Bulk of the labour force management and capital comes from the households;
2. Production is either consumed on the farm and/or traded in local markets;
3. The decision making process is hampered by limited accesses to marketing and political institutions; and
4. Most of the farmers do not live much above the culturally determined subsistence level.

The rationale behind the persistency of this system lies in its compatibility with the physico-social environment of sparse population, community land tenure system, undulating and steep topography, short crop cycle, rainy season and thereafter, acute moisture stress during post-monsoon period, as well as, meagre resources with the farmers and also the only available means of providing moderate calories and protein for the sustenance of families with minimum risk and the least income variability. This sort of socio-cultural equilibrium environment centering round shifting cultivation is, of course, gradually getting slackened under the impact of higher population, low yield, shortening of shifting cycle, new economic and social goals, as well as, incursion of modern science and technology with the dying out of tribal isolation from the main stream. In this context, the results of two pilot field investigations on “Socio-Agri-Economic” characteristics and attitudes of tribal farmers towards modern agricultural practices and village leadership pattern for Agricultural development” carried out by ICAR Research Complex, (Samanta, et. al.; 1978) in Meghalaya state in the year 1977-78 are worth mentioning:

1. The lower rate of adoption of agricultural innovations and the least favourable attitude towards them by the tribal farmers were found to be due to their lower educational levels, lower socio-economic status, small size of holdings and lower annual income;

2. As the village headman plays an important role in all round agro-economic development of the tribal farmers, training to the village headman regarding modern agricultural practices may help in adoption and diffusion of technological innovations.

The momentum of this change ushers in settled cultivation to prevail in some tribal communities, which is visible with three tribes of Angami in Nagaland, Apatani in Arunachal Pradesh and the Garos in Meghalaya.

Regarding rites and rituals and their connection with shifting cultivation clearly reflects that adoption of any new farming system may not provide facilities to worship the appropriate Goddess. The shifting cultivation is a traditional way of life itself. Hence the
introduction of settled cultivation among the tradition bound shifting cultivation will be a long process because it will contain itself the seed of a vital change of in their lives. Shift from shifting cultivation to settled cultivation may not only get cent per cent adoption when new cropping system is blended with the traditional festivals that are linked with shifting cultivation. Thus, we should search cropping systems that conform to the traditional system, with ability to control over biophysical problems as well as increase in productivity on sustained basis.

**Alternative Systems/techniques for shifting cultivation:**
Various alternatives farming systems, techniques have been developed by farmers themselves, scientists in different parts of the world to control shifting cultivation. Some of the techniques are given below:

1. Fallow management strategies used by shifting cultivators in South East Asia as recommended by Dennis P. Garrity and Chun K Lai
2. Agro-forestry system developed by ICAR
3. Alternative farming system to Shifting cultivation developed by I.C.A.R Barapani, Meghalaya
4. Suggestion made by Ramakrishnan et.al.

**Fallow Management:**
Since shifting cultivators usually create one or more new fields every year, a household usually possesses a number of fallow fields of different ages and at different stages in the natural succession of the forest community. Thus the diversity of available useful resources is very high, probably even higher than in an undisturbed forest. This has a lot to be done with the fact that the fallow vegetation is being "managed". A fallow field is anything but "abandoned". In addition, most shifting cultivators in Southeast Asia have relatively poor upland soils and cannot draw on the type of nutrient stocks available to farmers working on relatively rich alluvial lowland soils. They are therefore strongly dependent on the ecological processes involved in the species succession of fallow vegetation. Good fallow management, therefore, is vital to them.

Fallow has the following important effects:

* Eradicates weeds;
* Restores soil fertility and brings back soil life;
* Provides forage land for livestock;
* Is a source of domesticated, semi-domesticated or wild food plants, and of protein from large or small wild animals;
* Is a source of herbal medicine, raw material for all kinds of domestic tools, crafts and other products of potential commercial value.

Spectrum of fallow management strategies have been used by the shifting cultivators in Southeast Asia.

* **Burning** of vegetation for easy clearing and nutrient activation also used to rejuvenate rangeland vegetation.

* **Slash and mulch** of fallow vegetation as an alternative to slash and burn to start a new production cycle.

* **Green manure / cover crops** for inter-and-relay cropping and seasonal fallows in annual systems to improve soil productivity: viney and non-viney legumes, composite and others.

* **Improved fallows:**
  
  – **Accelerated fallows:** Natural fallow vegetation improved with (N-fixing and non-N-fixing) trees, shrubs, legumes, and others to improve soil productivity.
  
  – **Enriched fallows:** Natural fallow vegetation improved with trees and shrubs of economic value.

* **Inter planted fallow:** N-fixing and non-N-fixing trees or shrubs for soil productivity improvement inter-planted in annual or perennial crops, for example, dispersed trees, alley's bushes, field borders in 'cut and mulch' or 'cut and carry' regime (with Alder trees)

* **Intercropping economic trees:** (timber and non-timber) with annual crops or shrubs for cash, shade or increased soil productivity, for example, taungya and other systems.

* **Analog (agro) forestry:** Consciously making use of the ecological processes involved in natural forest regeneration such as natural species succession and natural rejuvenation: annual crops, economic shrubs and trees, introduced pioneer (fallow) vegetation (N-fixing and non-N-fixing) and natural fallow and forest vegetation.
* Managed and enriched fodder fallow to intensify livestock production: trees, shrubs, legumes and grasses.

**Agro-forestry Systems:**

Agro-forestry has the potential to contribute directly to sustainable improvements in rural income and welfare, to reclamation of degraded agricultural lands, and to the conservation of tropical forests, through a role in expanding sustainable agro-forestry alternatives to slash and burn farming. Its primary aims are the production of food and wood and conservation and rehabilitation of soil resources needed for future production, at the same time maintaining and improving the quality of the producing environment. In the coming years growing population combined with increasing pressures on finite areas of agricultural land will make the food supply situation even more precarious. Sometimes it is said that agro-forestry is suitable only for marginal and brittle ecosystems. In reality it can be practiced on all types of agricultural lands, as it enables better utilization of the nutrients and water available in the soil as well as of solar energy.

**Definition:**

There are variations of the definition of agro-forestry system, but the most widely accepted definition is of the International Council for Research in Agro-forestry (ICRAF). According to it, Agro-forestry is a collective name for land-use systems and technologies where woody perennials are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agro-forestry systems there are both ecological and economical interactions between the different components. There are two main components in this definition. The first is the deliberate integration of trees with agricultural crops and/or animals on the same piece of land, and the second is the ecological and economical interactions between woody and non-woody components. The systems that lack of one from these two components cannot be classified as agro-forestry. Based on the ICRAF's definition, shifting cultivation itself, thus, is the oldest and most widespread form of agro-forestry.

Agro-forestry has been defined by Indian Council of Agricultural Research (ICAR) as "Sustainable land management system which increases the overall yield of the land, combines the production of crops (including tree crops) and forest plants and/or animals simultaneously or sequentially, on the same unit of land, and applies management
practices that are compatible with the cultural practices of the local population". Though agro-forestry is not new, during recent years its importance has increased dramatically especially as regards its potential for optimizing land use in the tropics

Agro-forestry systems can be classified into three basic categories based on their structure and functions

*Agrisilvicultural systems* are combination of crops and trees. They include Shifting cultivation, alley cropping, taungya, multilayer tree gardens, multipurpose trees and shrubs on farmlands, home gardens, windbreaks and shelterbelts, live-hedges fuel wood production and integrated multistoried mixtures of plantation crops.

*Silvopastoral systems* are combinations of pastures and/or animals and trees. They include protein bank (multipurpose fodder trees on or around farmlands), live fences of fodder hedges and shrubs, trees and shrubs on pastures as well as integrated production of animals and wood products.

*Agrosilvopastoral systems* are combinations of crops, pastures and/or animals and trees. They include home garden with animals, multipurpose woody hedgerows and integrated production of crops, animals and wood.

**Impact of Agro-forestry on shifting cultivation:**

Agro-forestry can be effectively practiced on lands subjected to shifting cultivation, on mountain ecosystems denuded of vegetation from biotic causes and in arid and semi-arid tracts. In agro-forestry two essential and related aims are:

a) The conservation and improvement of the site, and

b) The simultaneous optimization of the combined production of a forest crop and an agricultural crop.

Through proper selection of tree species, it should be possible to minimize soil erosion, to tap nutrients from deeper levels than those reached by the roots of agricultural crops, and to replace through leaf fall and fixation of atmospheric nitrogen the nutrients removed in the crop. However, success of this system depends on the incentives given, social amenities and services provided and marketing facilities arranged. So, like any other rural development scheme, an agro-forestry programme has to be considered with relevance to the social and economic development of the people. For successful implementation of agro-forestry, the institutional requirements are also important. The curricula and syllabus in training and educational institutions need to be properly oriented by making changes.
What is essential is that scientists and institutions should be "people oriented" and they should develop systems that are appropriate to the physical, biological and socio-economic conditions that prevail in the country.

**Alternative farming system to Shifting Cultivation developed by ICAR, Barapani, Meghalaya:**

Five years studies on Alternative farming system to shifting cultivation by ICAR, Barapani indicate that agriculture with bench terrace and contour bunds as conservation base can provide stable alternative to switch over from shifting to permanent agriculture system provided maintenance of conservation measures is properly done. Agro-horti system of land use with subsidiary source of income through live stock rearing provides most favourable indication in favour of adopting mixed land use system as an alternative to shifting cultivation on steep hill side. Such a system will certainly be technologically feasible, sociologically acceptable, ecologically sound and economically viable. Based on above facts and production behaviours, the land use pattern considered for hill slope is given below:

**Table 2.1 : Land use pattern for hill slopes as an alternative to Shifting cultivation.**

<table>
<thead>
<tr>
<th>Slope</th>
<th>Portion of total area</th>
<th>Land use</th>
<th>Conservation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower portion</td>
<td>1/3 rd</td>
<td>Agriculture</td>
<td>bench terracing</td>
</tr>
<tr>
<td>Mid portion</td>
<td>1/3 rd</td>
<td>Horti-pastor</td>
<td>half-moon terracing for horticultural plants and contour bunds.</td>
</tr>
<tr>
<td>Top portion</td>
<td>1/3 rd</td>
<td>Agro forestry</td>
<td>Contour bunds.</td>
</tr>
</tbody>
</table>

**Source:** Report on Shifting Cultivation, ICAR, Barapani

While considering the design of land use pattern of the kind mentioned above, the following advantages were the main points in its favour.

- Soil and fertility loss can be checked.
- Productivity can be adequately increased in the 1/3 rd terraced area by way of introducing improved crop production technology.
- Nearly same production can be obtained from 1/3 rd terraced area, what is obtained from entire area if under Shifting cultivation
- Subsidiary source of income can be generated form livestock rearing, meeting 100% feed requirement from by products and silvi-pastoral land use.
The 1/3 rd area can be terraced by the family labours of the Shifting cultivation farmer.

Development efforts of the Government will be greatly helped as more area can be covered within available resources.

Since horticultural crops will be grown, the farmers will have long term interest in the land and when round the year cropping with good yield can be obtained from the lower terraces, a gradual attitude for permanent settlement will be induced. Even the farmers may eventually like to terrace the other areas themselves.

The system will least interfere with their socio-cultural system. Even, the system can be adopted from the year when shifting cultivation farmer abandoned the shifting land. This will reduce the efforts required on land clearing.

The system will help in preserving the ecology of the region.

The system can be implemented in micro watersheds for proper management of resources.

The Shifting Agriculture (Jhum) and Sustainable Development for North-eastern India:

For improving the system of land use and resource management in North-eastern India, the following strategies suggested by Ramakrishnan, P.S and his co-workers are based on a multidisciplinary analysis. Many of these proposals have already been put into practice.

1) With wide variations in cropping and yield patterns under shifting agriculture practised by over a hundred tribes under diverse ecological situations, transfer of technology from one tribe/area to another alone could improve the Shifting cultivation, valley, land and home garden ecosystems. Thus, for example emphasis on potato at higher elevations compared to rice at lower elevations has led to a manifold increase in economic yield despite low fertility of the acid soils at higher elevations.

2) Maintaining a shifting cycle of maximum 10 years (this cycle length was found critical for sustainability, when shifting was evaluated using money, energy, soil fertility, biomass productivity, bio-diversity, and water quality as currencies) by greater emphasis on other land-use systems such as traditional valley cultivation or home gardens.
3) Where shifting cycle length cannot be increased beyond the five years period that is prevalent in the region. Therefore, redesign and strengthen this agro-forestry system incorporating ecological insights on tree architecture (e.g. the canopy form of tree should be compatible with crop species at ground level so as to permit sufficient light penetration and provide fast recycling of nutrients through fast leaf turnover rates). Local perceptions are extremely important in tree selection, for introduction into the cropping and fallow phases of shifting, as is being done in Nagaland.

4) Improve the nitrogen economy of shifting cultivation at the cropping and fallow phases by introduction of nitrogen-fixing legumes and non-legumes, like the Nepalese alder (*Aldus nepalensis*). Another such example is the lesser-known food crop legume *Flemingia vestita*, traditionally used by tribal as an important species when shifting cycles decline below five years.

5) Some bamboo species highly valued by the tribal, can concentrate and conserve important nutrient elements such as nitrogen, phosphorus and potassium. They could also be used as windbreaks.

6) Speed up fallow regeneration after shifting cultivation by introducing fast growing native shrubs and trees.

7) Condense the time-span of forest succession and accelerate restoration of degraded lands, based on an understanding of tree growth strategies and architecture, by adjusting the species mix in time and space.

8) Redevelop village eco-systems through the use of appropriate technology to relieve drudgery and improve energy efficiency (cooking stoves, agricultural implements, biogas generation, small hydroelectric projects, etc.). Promote products based on leather, bamboo and other woods.

9) Strengthen conservation measures based upon the traditional knowledge and value system with which the tribal communities could identify, e.g. the revival of the sacred grove concept based on cultural tradition which enabled each village to have protected forest.

10) In the ultimate analysis, have an integrated approach for land use development in a given ecological and cultural landscape; base on short-term sustainable livelihood strategy on traditional ecological knowledge and technology and long term sustainable development on ecological and economic combinations to avoid social options.
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29. Thangam, E.S. Agro-forestry in shifting cultivation control programmes in India. (Downloaded from internet http://www.icimod.org/chapter 10. html).


49. ibid, pp. 29-30.