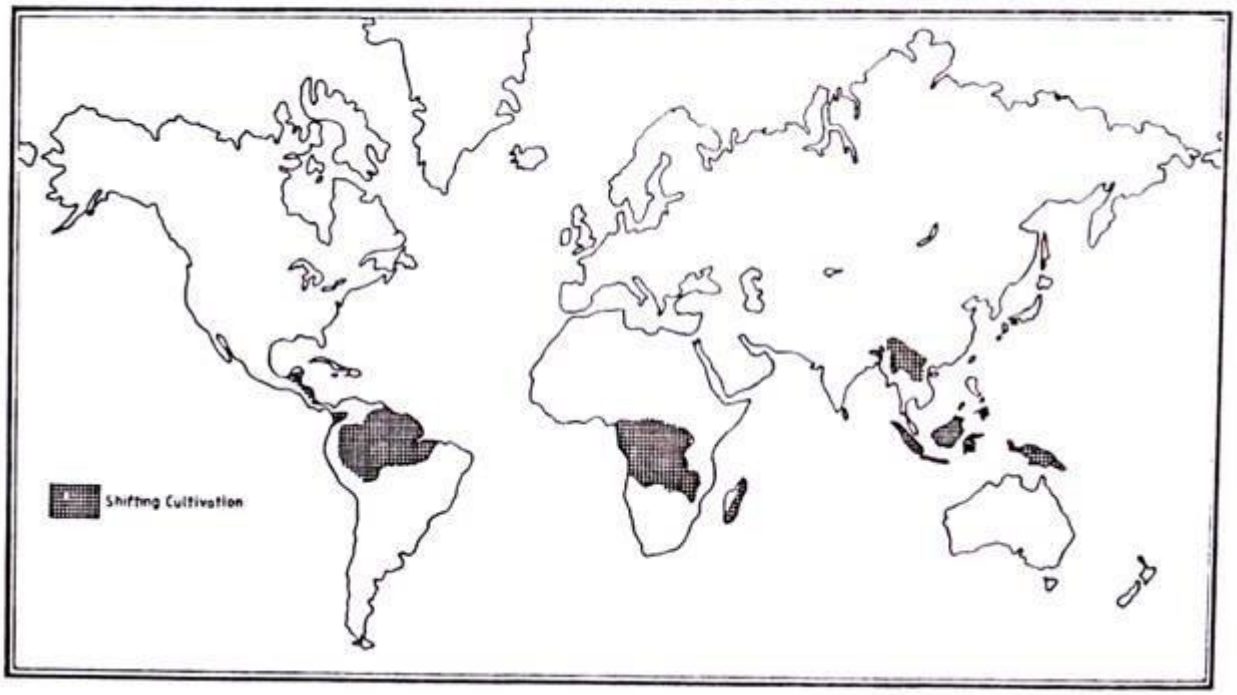
SHIFTING CULTIVATION

The history of shifting cultivation is as old as the history of agriculture itself. On the basis of archaeological evidences and radio-carbon dating, the origin of shifting cultivation could be traced back to about 8000 BC in the Neolithic period which witnessed the remarkable and revolutionary change in man's mode of production of food as from hunter and gatherer he became food producer.

The prehistoric shifting cultivators used fire-stone, axes and hoes, while in the present- day shifting cultivation the stone tools have been replaced by digging sticks, iron tools, iron digging sticks, daon, hoe and knives.

Shifting cultivation is the primitive form of soil utilization, usually of tropical rain forests and bush areas of Central Africa, Central America and Southeast Asia (Fig. 5.3). The farmers grow food only for his family in this agriculture system. Some small surpluses, if any, are exchanged or bartered (exchange of commodity for commodity) or sold for cash in the neighboring markets. The shifting population is thus self-reliant with a high degree of economic independence and the resultant economy is almost static with little chance of rapid improvement.

Figure 5.3
World:Shifting Cultivation



Shifting cultivation is called by different names in different parts of the world. It is generally known as 'slash and burn' and 'bush fallow' agriculture. It is variously termed as Ladcmg in Indonesia, Caingin in Philippines, Milpa in Central America and Mexico, Ray in Vietnam, Conuco in Venezuela, Roca in Brazil, Masole in the Congo and Central Africa.

It is also practiced in the highlands of Manchuria, Korea and southwest China. It is known as Jhum or Jum in the hilly states of Northeast India, as Podu, Dabi, Koman or Bringa in Orissa, as Kumari in Western Ghats, as Watra in southeast Rajasthan, as Penda, Bewar or Dahia and Deppa or Kumari in the Bastar district of Madhya Pradesh.

Shifting cultivation has been described as an economy of which the main characteristics are rotation of fields rather than rotation of crops, absence of draught animals and manuring, use of human labour only, employment of dibble stick or hoe, and short period of occupancy alternating with long fallow periods.

After two or three years the fields are abandoned, the cultivators shift to another clearing, leaving the old one for natural recuperation. This explains the use of the term 'shifting cultivation'. It, however, does not imply that the homestead is also shifted to the new site along with the shifting cultivation. More often than not, the homesteads are not shifted.

Shifting cultivation, though a rudimentary technique of land and forest resource utilization, represents an intricate relationship between ecology, economy and society of a region. The jhum fields, their surrounding forests and natural areas provide two alternative sources of subsistence to the dependent population. In case the jhum crops are not good, the forests could be trapped by them for augmenting their food supplies. Moreover, the shifting cultivators keep pigs and swines which feed on the vegetable wastes and inferior grains.

The pigs function as buffer stocks which are used during the periods of scarcity and they are also used at the time of festivals and feasts. Shifting cultivation is a great catalytic force for community life. In such societies, natural resources (land, forests, water) belong to community and not to the individuals.

The social organization of the people is built around the concepts of community ownership, community participation and communal responsibility. The basic axiom of life is "from each according to his capacity and to each according to his needs". Thus, in the society of shifting cultivators, the old, infirm, women, widows and children have an equal share, and each member of the society plays a role according to his physical and mental abilities.

In the hilly tracts of Northeast India, jhuming is the dominant economic activity. Over 86 per cent of the people living in hills are dependent on shifting cultivation. In 1980, about 1326 thousand hectares were under jhuming which increased to 1685 thousand hectares in 1990.

At present (1994-95), about 1980 thousand hectares are affected by jhuming. The distributional pattern of shifting cultivation in Southeast Asia has been show in Figure 5.4, while Figure 5.5 shows the jhum or forest blank areas of Northeast India. It may be observed from Figure 5.5 that in Manipur, Mizoram, Meghalaya, Nagaland and Tripura there are vast tracts affected by jhum cultivation.

In the northeastern region of India, comprising the states of Assam, Manipur, Meghalaya, Nagaland, Tripura, Arunachal Pradesh and Mizoram, shifting cultivation is largely practiced in the hilly areas.

Almost all over the tropical world, especially in the hilly tracts of the northeastern region of India, agricultural operations in shifting cultivation are marked by the following stages:
(i) Selection of the forested hilly land

(ii) Clearing the forest tract by cutting down the jungle

(iii) Burning the dried forest wood into ashes

(iv) Worship and sacrifice

(v) Dibbling and sowing seeds

(vi) Weeding and protection of crops

(vii) Harvesting and thrashing

(viii) Merry making and feasts

(ix) Fallowing

The usual process demands the selection of a plot on or near the hill side or jungle. The selection of land is made in the months of December and January by the village elders or clan leaders. The fertility of the soil is judged by the colour and texture of the soil. In some tribes, community as a whole is collectively responsible for the clearing of the selected piece of land while in others the cutting of trees and shrubs is made by the respective family to whom the land has been allotted. At the time of allotment of land the size and workforce in the family are taken into consideration.

The area allotted per family varies between half hectare to one hectare among the different tribes, regions and states. The land is cleared of all its undergrowth and the branches of trees are lopped off. The cleared growth is allowed to dry on the field. This process of clearing which takes over a month is labour intensive, being undertaken with indigenous and primitive equipment's.

The dried growths as well as the trees standing in the clearance are set on fire in March. The cultivators take care that the fire should not spread into the forest. After the burning is complete, the un-burnt or partly burnt rubbish are collected in one place for the complete burning. The fire kills the weeds, grasses and insects. Then, the ashes are scattered over the ground and dibbling of seeds begin in March before the advent of pre-monsoon rain.

Before sowing starts, evil spirits are worshipped and sacrifices are made for a good crop and prosperity to the family. It is believed in the interior parts of the Garo and Khasi hills that if the throat of a cock is half cut and left walking in the field and in the process it dies lying on its right, the field will bring a bumper crop and prosperity to the family and vice versa. But now sacrifice before sowing the crops is not a common practice.

On the day of sowing which is a ceremonial day for the whole village, it is interesting to observe that the male members of each family on reaching the jhum field in the morning engage themselves in preparing the digging sticks. The seeds are sown either by broadcast or dibbling.

The dibbling and planting of seeds is an exclusive job of the female members. The male members broadcast seeds of crops like millets and small millets, whereas crops like maize, pulses, cotton, sesamum and vegetables are dibbled by females. While dibbling the seeds, the woman walk over the field with a digging stick or bill-hook in hand, make a hole in the ground, sow a few seeds and cover it over with earth by pressing it down with her toe.

At the advent of rains, the seeds begin to sprout. Thus, the soil is never ploughed and no artificial irrigation is made. After sowing the crop, farmer pays cursory attention to the crop and to remove weeds from the field. The crop is, however, protected from stray cattle and wild animals by fencing the fields with bamboo. Many Jhumias construct a hut in the field to look after the crop properly.

Cropping Patterns in Jhuming:
So far as the cropping patterns in jhuming are concerned, the Jhumias adopt mixed cropping. The mixture of crops varies from tribe to tribe within a region. The shifting cultivators grow food grains, vegetables and also cash crops. In fact, the grower aims at growing in his jhum land everything that he needs for his family consumption. In other words, the choice of crop is consumption oriented.

Among the food grains the coarse varieties of rice, followed by maize, millet, Job's tears and small millets are the principal crops. Cotton, ginger, linseed, rapeseeds, sesamum, pineapple and jute are the important cash crops grown in jhum fields. Among the vegetables, soya-bean, potato, pumpkins, cucumbers, yams, tapioca, chilies, beans, onion, arum are cultivated. Tobacco and indigo are also grown. By and large, the cash crops are sold in the neighbouring markets or to the middleman who are generally Marwaris.

In the mixed cropping, soil exhausting crops, e.g., rice, maize, millets, cotton, etc., and soil enriching crops, e.g., legumes, are grown together. This practice has many direct and indirect advantages. These crops harvest at different periods, thereby providing the tribes with varied food for nearly six to nine months in a year. The same jhum land is cropped by the community for two or three years, thereafter, the land is abandoned to recuperate. Occasionally, some residual crops are collected from the abandoned fields.

Jhum Cycle:
The jhum cycle is influenced by the pressure of population, nature and density of forests, terrain, angle of slope, texture of soil and the average annual rainfall. Areas of sparse population generally have longer jhum cycle (15-25 years), while areas with high density of population have shorter jhum cycle (5-10 years).

The patches of land for shifting cultivation are not selected in any given order or sequence. There is always a room for choice. The period of consecutive cropping and fallowing differs from region to region and from tribe to tribe. We do not know after what length of time the primitive inventor of shifting cultivation had to come back to the same plot because he had vast areas to move about.

But our present generation, with the increase in population and being somewhat staked down to smaller areas, a shifting cultivator has not got much choice left to shift about. His world has become small, he has to be content moving about in narrow circles and the circle is becoming increasingly smaller with the passage of time.

In brief, in the earlier decades, the period before which the Jhumias returned to cultivate the same plot was quite long. This was partly due to the limited population and partly to the better fertility of soil which used to be rested for nearly thirty to forty years.

Table 5.1

Northeast India : Jhum Cycle, Period of Occupancy and Duration of Fallowing

Tribe	*Average annual rainfall (in cms)*	*Duration of cropping*	*Fallowing period*
Ao (Mokokchung Dist.)	150 cm	one year	5-8 years
Garo (Garo Hills)	125 cm	one year	5-10 years
Hmars (W.Manipur)	130 cm	one year	5-10 years
Idu-Mismi (Lohit)	250 cm	two years	5-10 years
Jaintia (Maghalaya)	250 cm	one year	4-8 years
Khashi (Maghalaya)	300 cm	one year	4-6 years
Konyak (Nagaland)	140 cm	one year	5-10 years
Lakhar (S. Mizoram)	125 cm	one year	6-12 years
Lotha (Nagaland)	145 cm	two years	10-15 years
Lushai (Mizoram)	185 cm	two years	8-15 years
Mikir (Mikir Hills)	150 cm	one year	5-7 years
Pawi (S.C. Mizoram)	210 cm	one year	8-10 years
Rengma (Nagaland)	150 cm	tow years	7-15 years
Sema (Nagaland)	155 cm	two years	6-10 years
Sherdukpen (Kamang)	125 cm	two years	6-10 years

The period of consecutive cropping also varies from tribe to tribe. In Arunachal Pradesh, for example, a clearing is generally cultivated for two years. As one patch every year is abandoned, a new patch is cleared. Thus, two patches are cultivated simultaneously every year, and these two patches are generally quite at a distance from each other.

This involves long arduous journey to and from the field. The jhum cycle, the period of occupancy and duration of fallowing of some of the tribes of the hilly tracts of northeast India have been given in Table 5.1. An examination of data shows that excepting Idu-Mismi (Lohit district), Lotha, Rengma, Sema (Nagas), Lushai (Mizoram) and Sherdukpen (Kemang) most of the tribes of the region occupy jhum land for sowing only for one year.

The main cause of abandoning the fields is the rapid depletion of soil. The fallowing period is less than fifteen years. In the territories of Aos, Kha- sis, Mikirs, Jaintias, Garos, Semas and Hmars, it is less than eight years. The tribes in which the jhum cycle is around five years are facing serious problems of undernourishment and their ecosystems are fast losing their resilience characteristics.

Rotation of Crops:

Information about the rotation of crops adopted by the Jhumias of the northeastern region of India was collected during fieldwork in 1978- 84. Some of the important rotations have been presented below in Tables 5.2 to 5.8.

Table 5.2

Arunachal Pradesh : Rotation of Crops

	First Year		*Second Year*	
	Kharif (summer crops)	*Rabi (winter crops)*	*Kharif (summer crops)*	*Rabi (winter crops)*
(i)	Maize, arum, yam, millets, ginger, tobacco, potato, vegetables	—	Paddy	Short duration paddy or small millets
(ii)	Papayas, paddy, maize, millets, beans	—	Paddy	Millets and vegetables

Table 5.3

Assam : Rotation of Crops

	First Year		*Second Year*	
	Kharif	*Rabi*	*Kharif*	*Rabi*
(i)	Rice, maize, millets, arums, tapioca, cucumber, ginger, sorrel, *mejak*, castor, tobacco, bean	—	Small millets mixed with short duration paddy and vegtables	—
(ii)	Millets, maize, tapioca, beans, brinjal	—	Paddy and vegetables	—

Table 5.4

Garo Hills (Meghalaya) : Rotation of Crops

	First Year		*Second Year*	
	Kharif	*Rabi*	*Kharif*	*Rabi*
(i)	Millets, maize, cotton, sweet potatoes, vegetables, pegion-pea	—	Short duration paddy, tobalchu, tapioca, lac	—
(ii)	Paddy, maize, millets, sesamum, yam, hilly cucumber, brinjal, pegion-pea	—	Small millets, pegion-pea, vegetables	—

Table 5.4a

Khasi Hills (Meghalaya) : Rotation of Crops

	First Year		Second Year	
	Kharif	*Rabi*	*Kharif*	*Rabi*
(i)	Maize, rice, millets, *kri* (small millets), sweet potatoes, pumpkins, cucumber, ginger, tapioca, beans	—	Short duration paddy or millets or both mixed	—
(ii)	Maize, beans	Potato	Maize, mixed paddy vegetables	Potato
(iii)	Potato	Cabbage	Potato	Potato

Table 5.5

Manipur : Rotation of Crops

	First Year		Second Year	
	Kharif	*Rabi*	*Kharif*	*Rabi*
(i)	Paddy, maize, millets, arums, linseed, *chakwai* (pulse), ginger	—	Short duration paddy and vegetables	—
(ii)	Millets, maize, cotton. beans, pumpkins, sweet potatoes, squash, *munghwai* (pulse)	—	Millets and vegetables	—
(iii)	Paddy, mustard, arum, sesamum	—	Small millets and vegetables	—
(iv)	Maize, millets, sesamum, chilly, pumpkin, cotton, sweet potatoes, pulses, beans, mustard, groundnut	—	Vegetables, pulses, millets, chilly	—

Table 5.6

Nagaland (Sema Tribe) : Rotation of Crops

	First Year		Second Year	
	Kharif	*Rabi*	*Kharif*	*Rabi*
(i)	Paddy, soyabean, kachu, maize, sesamum, vegetables.	—	Short duration paddy or maize or small millets	—
(ii)	Paddy mixed *nagdal* or maize mixed nagdal	—	Small millets	—
(iii)	Lobster, maize *nagdal*	—	Small millets mixed *nagdal*	—
(iv)	Potato	—	Potatoes or early paddy or millets	—

Table 5.7

Nagaland (Ao and Angami Tribes) : Rotation of Crops

	First Year		Second Year	
	Kharif	*Rabi*	*Kharif*	*Rabi*
(i)	Paddy, mixed maize, kachu, chillies, sesamum, paddy and vegetables	—	Short duration paddy or small millets	—
(ii)	Paddy mixed *nagdal*, chillies, vegetables and sesamum	—	Paddy or millets	—
(iii)	Maize mixed paddy vegetables and sesamum	—	Paddy	—
(iv)	Maize mixed small millets, ginger and vegetables	—	Paddy	—
(v)	Potato	—	Potato	—

Table 5.8

Tripura : Rotation of Crops

	First Year		Second Year	
	Kharif	*Rabi*	*Kharif*	*Rabi*
(i)	Millets, maize, vegetables, cotton, sesamum, pegion pea, ginger	—	Maize, paddy, jute, vegetables, ginger	—
(ii)	Paddy, vegetables, cotton	—	Millets, maize vegetables	—
(iii)	Maize, millets, jute, vegetables	—	Small millets, vegetables	—

Thus, it is evident from the above that in all the rotations a mixture of a several crops is sown in the kharif season of the first year. In the kharif season of the subsequent year some short duration cereals of inferior quality are sown mixed with beans and other vegetables.

Intensity of Cropping:

Over 5 lakh tribal families are dependent on shifting cultivation in the Northeastern region of India. The region has the largest area under jhum cultivation in the country. Out of the total reporting area of 33 million hectares, about 3 million hectares are under cultivation and out of this 2.6 million hectares are under jhum cultivation.

Table 5.9 depicts that the area available for cultivation is not cultivated at the same point of time. Only about 16 to 25 per cent of the jhum land is cultivated annually. The proportion of the area varies in different states and within each state also, depending on the size of population in a particular tract. Nagaland and Mizoram have the largest area under shifting cultivation, i.e., 6.08 and 6.04 lakh hectares respectively, while Manipur has the least area, i.e., about one lakh hectares under jhuming.

Table 5.9

Cultivated Land in Northeastern Region of India

(in lakh hectares)

State	*Reporting area*	*Net area sown*	*Area available for jhuming*
Arunachal Pradesh	57.93	0.70	2.48
Assam	78.81	21.98	4.98
Manipur	22.11	0.79	1.00
Meghalaya	27.79	1.58	4.16
Mizoram	16.54	0.61	6.04
Nagaland	13.51	0.47	6.08
Tripura	10.66	2.36	2.21
Total	227.35	29.49	26.95

The tenurial pattern of land, whether owned by a clan, community or individual, also influences the cropping patterns. Where the land belongs to a community or clan, there appears to be little interest on the part of individual tribal family to improve the fertility of soil. In the northeastern hilly region, the jhum land belongs

to the community and, therefore, it is difficult to check the practice of jhum cultivation or to increase the fertility of land.

An examination of Table 5.10 reveals that Manipur has the lowest area under jhuming in northeast India. At one point of time, it, however, has the maximum area under jhum crops. Manipur and Tripura have only about 10 per cent of their jhuming land under crops in agricultural year.

Table 5.10

Situation of Shifting Cultivation in Northeast Region of India

(in thousand hectares)

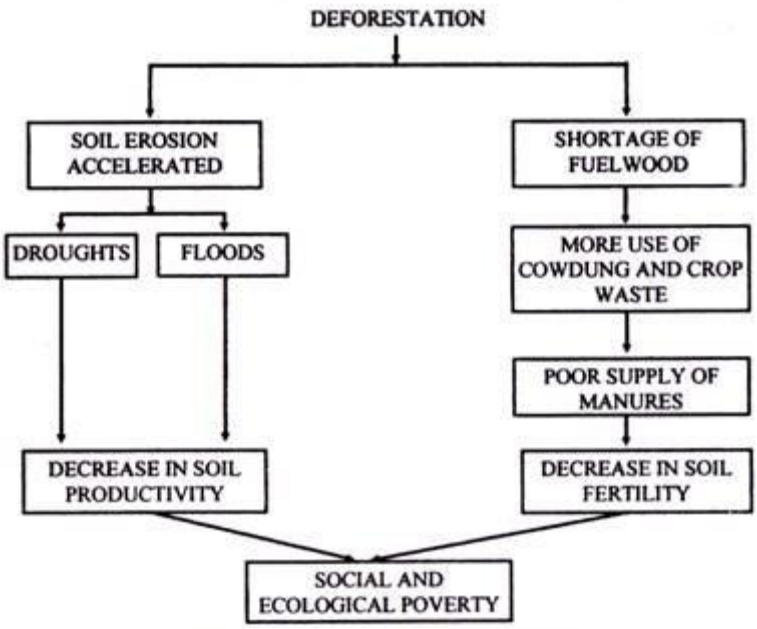
State/Union Territories	*Area affected by jhum*	*Area under jhum at one point of time*	*Number of tribal families involved (in thousands)*
Arunachal Pradesh	248	92	148
Mikir Hills (Assam)	415	54	45
North Cachar Hills (Assam)	83	15	13
Manipur	100	60	50
Meghalaya	416	76	69
Mizoram	604	61	45
Nagaland	608	73	80
Tripura	220	22	43
Total	2694	453	492

Shifting Cultivation: Problems and Prospects:

Clearing of jungles is the prerequisite of shifting. The felling of trees and clearing of bushes, however, accelerate soil erosion and accentuate variability of rainfall which may lead either to droughts or floods. The overall impact is the decline in soil fertility. The ecosystems lose their resilience characteristics. The population dependent on shifting cultivation faces the shortage of food, fuel wood and fodder. Consequently, the nutritional standard goes down. These processes culminate into the social poverty and ecological imbalance (Fig. 5.6).

Figure 5.6

Deforestation and Soil Depletion

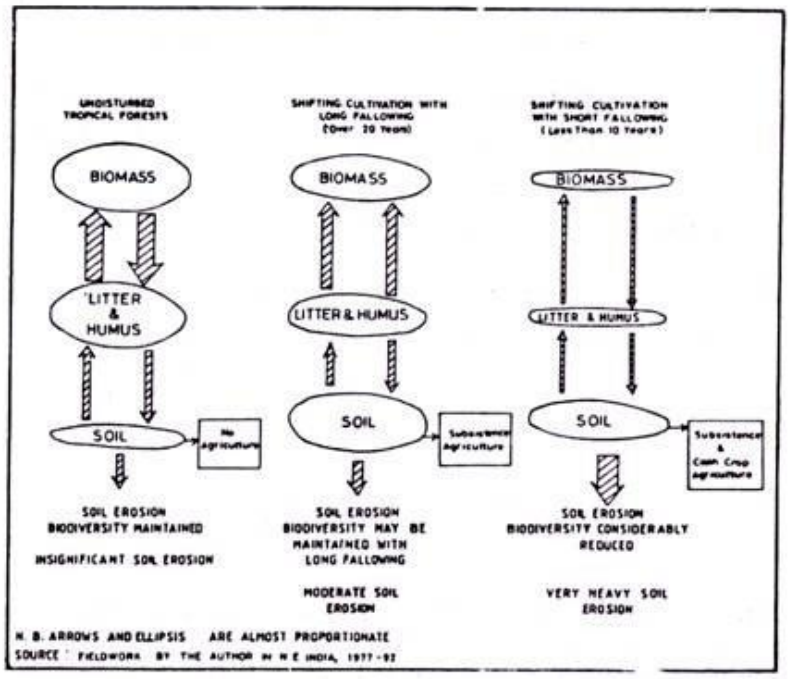


DEFORESTATION AND SOIL DEPLETION

The impact of shifting cultivation on biomass and soil erosion has also been shown in Figure 5.7. From there it may be observed that as the cycle of shifting cultivation becomes shorter, the biomass on which depends the humus of soil declines and the biodiversity is considerably reduced. The subsistence agriculture disappears and the relatively strong cultivators start acquiring community land. They also start engaging laborers which goes against the gamut of their society and mode of life.

Figure 5.7

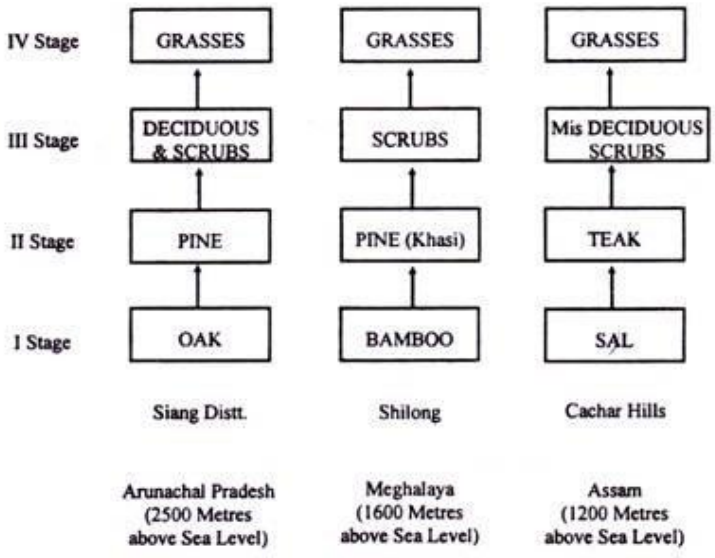
Shifting Cultivation, Biomass and Soil Erosion



The transformation of natural vegetation as a consequence of shifting cultivation has been shown in Figure 5.8. It may be observed from this figure that in the Siang district of Arunachal Pradesh good tracts of Oak forest have been transformed into pines, scrubs and grasses, while in Shiliong (Meghalaya) and Cachar Hills (Assam) bamboo and Sal (teak) forest have been transformed into deciduous scrubs and grasses. Thus shifting cultivation is gradually reducing the forest wealth and damaging the ecology beyond redemption in Northeast India (Fig. 5.8).

Figure 5.8

Shifting Cultivation and Transformation of Natural Vegetation



There are divergent opinions about the evil and adverse effects of shifting cultivation on the ecology and environment of the region. Many of them hold the view that it is primitive and depletes the forest, water and soil resources. Since jhuming damages the ecosystems, it should be stopped completely.

According to the opposite views, supporting the continuance of shifting cultivation with necessary and effective reforms, it does little damage to soil erosion as the high humidity and heavy rainfall in the region do not permit the soil to remain uncovered for long. Some form of vegetation immediately covers the top soil which checks the soil erosion.

During the agricultural operations also, as no ploughing, hoeing and pulverization of soil is done, the soil remains compact. Moreover, jhuming lands are generally steep slopes on which sedentary cultivation cannot be developed easily. In fact, jhuming is a way of life, evolved as a reflex to the physiographical character of land under special ecosystems. It is practiced for livelihood and not without the knowledge of its adverse effects.

Assessing the fact that jhuming system cannot be stopped altogether, it is necessary to make the process more productive so that it may sustain the growing pressure of Jhumias population at a reasonably good standard of nutrition. For a change in jhuming typology it is essential that the Jhumia is provided with land where he can cultivate and derive profits permanently.

Once the retrain ability of soil is ensured, then the question of augmenting the soil fertility through the addition of manures and fertilizers could be meaningful. Measures should be taken to see that Jhumias are trained in other types of occupations. They should be given training in raising trees, orchards and plant protection, cottage and small industries, and indigenous handicrafts.

Moreover, they should be trained in the development of dairying, piggery, sheep-rearing, poultiy, duck-keeping, fisheries, beekeeping, agriculture, etc. For the effective implementation of these programmers, extension service, cooperative and marketing facilities are essential. The establishment of forest based small industries may also help in boosting up the economy of the tribes.

New crops of economic importance have to be developed and their diffusion should be extended in the isolated hilly areas. In fact, a cropping pattern with higher inputs (the inputs be provided at the subsidized rates by the government) will enable greater yields to be obtained per unit area and that will help in detracting the Jhumias from the uncertain way of life of shifting cultivation.

The main approach to overcome the evil of shifting cultivation should be to change the jhuming lands into sedentary farms. In the hilly kreas, one of the most common measures that has been adopted in many small tracts with success is the construction and development of terraces.

Different types of terraces can be adopted to fit in with a particular type of ecosystem. These terraces have a definite advantage towards achieving sedentary farming in the areas of shifting cultivation. It has been accepted by most of the planners that terracing has to play a major role if agricultural land use in the hilly tracts is to be made more efficient.

There are, however, many techno economic problems in the development of terraces. Terracing, apart from being a costly measure, requires adequate irrigation facilities which in the mountainous areas cannot be provided easily. It, therefore, may not be feasible to go for large scale terracing. The human energy input used in the jhuming, however, can be used for the development of small terraced farms. In several tracts on the northeastern hill region, terraces have been developed with the help of local human energy input involving very little direct monetary input.

Small demonstration centers in various pockets, providing technical helps, development of road connections and taking the farm community leaders on field visits to terrace cultivation area may probably help in avoiding huge capital expenditure for large scale terracing. This would provide productive use of human energy for land resource development.

So far as the scope limit for the development of terraces is concerned, it is difficult to prescribe any slope limit, unless detailed evaluation of existing terrains in the region is made and other technical details are experimentally studied. A slope of 20 degree can be terraced and in the steep slope areas partial terracing can be done. Once soil is properly developed with the help of manures and crop rotation practices the shifting typology will gradually get transformed into sedentary system.

Apart from terracing, other soil conservation measures like bunding, trenching, gully plugging, etc., can be adopted according to the need of the area. Equally important is the development of protective covers, like forests or fruit trees, suitable cash crops, grasses and leguminous crops especially on steep slopes. In short, land use planning and practices should be based according to land capability and suitability.

The shifting cultivation is a way of life and there are cogent reasons behind the customs and practices of the tribal people. The climates, the terrain, their food habits, their needs, their self-reliance— all have a say on shifting cultivation. The whole gamut of primitive society is interwoven with the means of food production. In other words, their way of life, training of youths, social and political systems, the ceremonies and festivals and, in brief, their philosophy of life is the product of jhuming system of economy.

This is why many of the new methods of cultivation, recently introduced in the tribal areas, are yet to generate the process of cultural acceptability. Trans-formation of jhuming cultivation into sedentary farming, therefore, should be gradual and evolutionary. The radical and revolutionary approach for the

transformation of jhum system may not be acceptable to the people of the tradition bound society of the tribals.

Shifting cultivation is one of the greatest threats to the biodiversity of our planet, destroying about 10 million hectares of tropical forests annually. Nevertheless, it supplies farming families with food, firewood, medicines and other domestic needs, though it produces low yields of crops and has almost no potential beyond subsistence farming.

Moreover, where population densities are low and forest areas vast, slash and burn practices are sustainable and harmonious with the environment. The long term objective should be to develop alternatives to shifting cultivation that are ecologically sound, economically feasible, and culturally acceptable.

The environmental degradation as a result of shifting cultivation may be checked substantially by:

(i) Developing practical and relevant guidelines for policies that encourage farmers to adopt technologies that are eco-friendly and environmentally sound;

(ii) Improve conditions for people living near the forests by diversifying land use and thereby increasing food production;

(iii) Protect biodiversity and ensure better use of genetic resources;

(iv) Increase soil productivity and reduce emission of greenhouse gases by capturing carbon in the soil. Intensification and modification of traditional systems—prolonged cropping cycles and decreased fallow periods—will lead to increased soil organic matter and plant biomass;

(v) Involve local people at all stages of decision making as well as in all research processes;

(vi) Amalgamate the most indigenous knowledge, and national and international experience and expertise;

(vii) Develop suitable strategies for agricultural marketing and subsidies;

(viii) Design biological barriers to prevent soil erosion and water runoff;

(ix) Develop tree, crop and pasture systems that cycle nutrients and enhance soil fertility, reducing the need for expensive inorganic fertilizers; and

(x) Evaluate policy option for reclamation of degraded lands.

All these steps, if taken together, may go a long way in improving the socioeconomic conditions of the shifting cultivators as well as enhance the sustainability of the ecology and environment.