Chapter 6

INNOVATIONS IN SHIFTING CULTIVATION, LAND USE AND LAND COVER CHANGE IN HIGHER ELEVATIONS OF MEGHALAYA, INDIA

B.K. Tiwari
Centre for Environmental Studies, North-Eastern Hill University,
Shillong-793 014, India

Introduction

Shifting cultivation is an age-old practice of subsistence agriculture, mostly practised in humid tropics. Though some basic features like fallowing of land, clearing of vegetation, use of human labour and primitive implements are found in all variants of shifting cultivation, in finer details the practice varies a great deal from one community to other. Often, within a small geographical area one can notice variations in pattern of slashing, intensity of burning, method of sowing, crop diversity, methods of soil and moisture conservation and fallow management. These variations are often described in "typology" of shifting agriculture. No attempt has so far been made to analyze these minor differences in shifting cultivation systems in the light of edapho-climatic conditions of the place and overall environment of the area. At times shifting cultivation has been viewed as a human activity, practised by traditional societies which have remained as such over thousands of years. The dynamic character of shifting cultivation and possible evolutionary processes have not received due attention. Present study was taken up to investigate the adaptations of shifting cultivators in response to increasing population, socio-economic development, exposure to market economy and increasing communications. It is an attempt to document the innovations that shifting cultivators make in order to maximize the ecological and economic returns from the limited land and other resources. The paper also analyses the long- and short-term ecological and socio-economic impacts of the innovations on the farmers and tries to identify the possible drivers that triggered the innovations.

Study Area

To find answers to the questions, the most crucial requirement was identification of a study area, which has experienced increasing population, socio-economic development and has been exposed to market economy during recent past and also about which some baseline data was available. The study area, Pomlakrai-Mawbynna village, is situated about 13 km South-West of Shillong, the capital city of Meghalaya (Fig. 6.1). The village is located at an altitude of approximately 1,880 metres above sea level and is spread over a geographical area of approximately 12 sq km. The village also has the distinction of having Lum *Shillong*, in its jurisdiction, the highest point in the state of Meghalaya. Topography is mostly hilly with slopes ranging between 20-40°. Soil is slightly acidic with a pH value range of 4.5-6. The natural vegetation of the area consists of sparsely distributed *Pinus kesiya* trees with rich undergrowth of shrubs and herbs. Average annual rainfall is 3,070 mm. The total population of the village is 873 distributed among 187 households. The cultivated lands are either owned by the farmers or hired from individual owners. The prevalent rate of land rental was Rs 700/acre/yr (December, 2002). In certain cases, the farmers possessing their own lands also cultivate on hired lands if their lands are still in the fallowing period. The traditional laws determine ownership of land, whereupon the youngest daughter inherits all ancestral property including land. However, if the land is not an ancestral property then the choice of the heir depends on the owners.

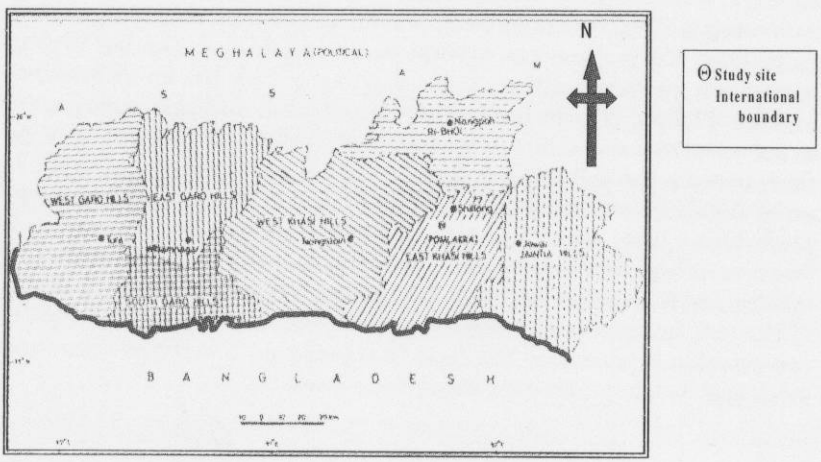

Fig. 6.1. District map of Meghalaya showing study site.

Methods

The data on the socio-economics, land use and land cover change, and innovations were collected through household survey and key informant interview. Interviews and group discussions were held using a questionnaire. Household data were collected from all 185 households of the village using a semi-structured questionnaire designed for the purpose. The village has an active self-help group (SHG). In order to facilitate the process of data collection three young members of the village SHG were trained and involved in collection of village and household data. The data and information were crosschecked through group discussion and informal consultations with the key informants and farmers. For studying the vegetation structure and plant species composition in the forests and fallows, quadrats were randomly laid and data on frequency, density, gbh, dominance and species composition were collected using standard vegetation analysis methods (Mishra, 1968). Marketing channels were investigated using methods described by Karki et al. (2001).

The traditional method of cultivation is popularly known as 'rep bun', where the lower branches of pine trees, growing outside cultivated lands, are lopped in the month of December and the slash is arranged in parallel rows running down the slope and allowed to dry. In the month of February, soil is placed on top of the slash, so as to form ridges and furrows running down the slope. This slash covered with soil is burnt. Consequently the burning of the slash is slow and controlled. Seeds/tubers are then directly planted into the burnt debris, i.e. on the ridges.

The ridges are about 1 m wide and 6 m long with the intervening furrows having a width of about 0.5 m. Thus, of the total land area available for cultivation is about two-third while one-third is uncultivated. This method of shifting cultivation has several features which make the system ecologically prudent such as, 1) the slashing of only the lower branches instead of felling of trees is an efficient method of resource management as it ensures the availability of the source of 'slash'. 2) Slow burning of the slash beneath the soil reduces loss of volatile nutrients and blowing of ashes (Mishra and Ramakrishnan, 1981). Such burning process releases phosphorus from rocks and kills soil-borne pests more efficiently. 3) Furrows having relatively compact soil serve as channels for run-off water (Mishra and Ramakrishnan,1981). 4) Making of ridges improve the porosity of the soil, an agronomic requirement for tuber crops. It also helps in conservation of moisture. The land thus prepared is cultivated for three years and then left fallow for about three years.

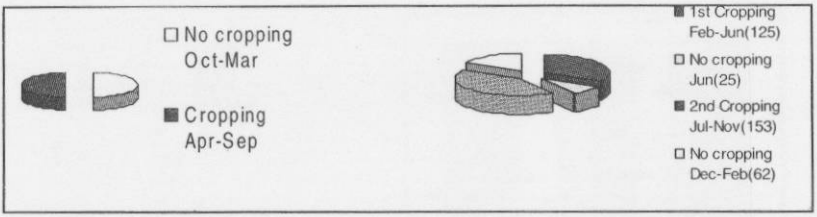

Fig. 6.2. Comparison of the past and present cropping patterns (figures in parantheses indicate number of days).

Innovations

Until five years ago, cropping was done for a year, with the season beginning from the month of April to September (Mishra, 1981). However, nowadays the farmers cultivate their crops in two seasons (Fig. 6.2). The first cropping is done between February till the early part of June while the second cropping is done between July and November. The land is not cultivated upon during the months of June and from December to early February. This enables the crops to escape the wettest month of the year (June) and also the coldest and driest period (December to early February) when the days receive the least sunlight. Thus, this innovation has led to more efficient utilization of solar energy by the crops.

Upturning of soil, composting and partial shifting

The farmers practising '*rep burn*' have over the years resorted to a method of cultivation slightly different from the traditional method. This innovative method is referred to as '*rep pull*' by the locals. However, this method is employed only on land, which has been previously cultivated and left fallow. In this modified version of shifting cultivation the vegetation of the fallow is slashed and arranged such that the slash (predominantly grass turf) lies along the ridges as well as along the furrows (Fig. 6.3). The soil from the previous ridges is upturned and placed on top of slash lying in the ridges as well as the furrows. The slash is not burnt but is left instead to decompose naturally, thereby forming rich source of compost manure. In cases where the land is cultivated upon for the second successive year, then the crop residue is also utilized as compost. Thus in this method, there is an interconversion of ridges into furrows and vice versa. The farmers are of the opinion that land prepared in such a way remained fertile for a longer period as compared to land prepared according to the traditional system of slash and burn. Hence, in this case there occurs the event of partial shifting within the land itself. The partial shifting within the cultivated land allows for efficient utilization of the land and soil nutrients. Also biomass, which is the most precious resource, is utilized most efficiently.

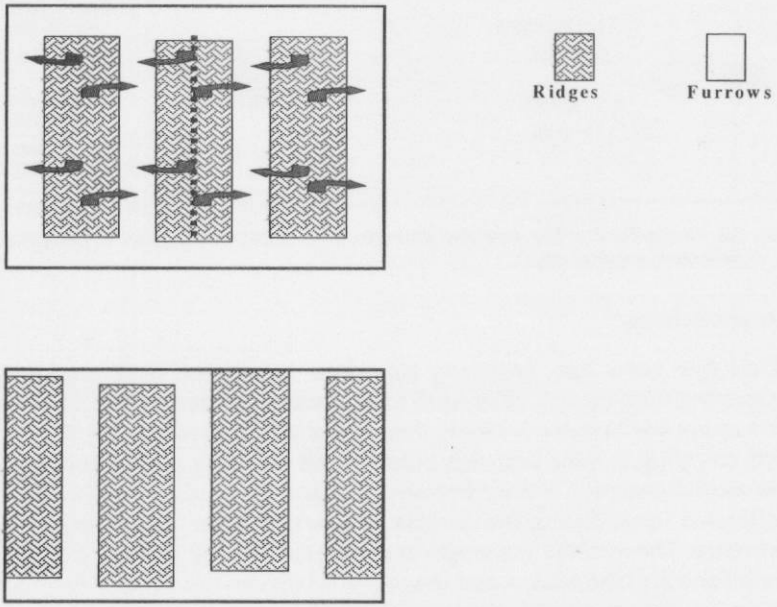

Fig. 6.3. Position of ridges and furrows on land during previous cultivation

Schedule of activities

The preparatory works for the first season of cropping usually begins during later part of December in the lands to be cultivated again after the fallow period. The vegetation growing in the fallow is slashed and arranged in parallel rows running down the slope for drying. The slashed branches of pine trees brought from the nearby pine stands, are also arranged together with the slash. In the later part of January, soil is placed on top of the slash and a controlled burning of the slash is carried out. Sowing is done in the first week of February and the crop is harvested by the last week of May. The field is then prepared for the second season of sowing. This includes manual turning of soil, manuring and weeding. In this case, there is no burning of slash, instead the fields are provided with manure such as cow dung, ash or chemical fertilizers such as urea, potash and super phosphate. Sowing is done by mid-July and harvesting takes place by the end of October.

Composting

In cases where burning is not performed, preparation of land for the first season begins by the latter part of October. The vegetation is slashed and arranged in parallel rows along the ridges and furrows. Soil from the ridges is then turned outward into the furrows, completely covering the slash. This is carried out in October and the slash is then left to decompose until

February (approximately 120 days). However, sowing and harvesting is similar to the previous method.

Farming duration and rotation cycles

In the modified 'bun' system of cultivation, the land is cultivated upon for a period of approximately three to four years after which the land is left for fallowing. The most common crop sown during the first season is potato (*Solanum tuberosum*) while cabbage (*Brassica oleraceae* var. *capitata*), cauliflower (*Brassica oleraceae* var. *botrytis*), pea (*Pisum* sp.) and radish (*Raphanus sativus*) are preferred during the second season.

The farmers seldom cultivate radish on the land except during the last year of cropping. The farmers' explanation is that radish crops tend to reduce the fertility of the land or is more exploitative of the nutrient available and hence is cultivated towards the later period of the cropping cycle.

Fallow Management

In the higher elevations of Meghalaya, at present, the land is left fallow for a period of three to four years. Over the last two decades the length of the fallow period has been on the decline. The change in the length of the fallow period over the last twenty years is shown below.

Time period	Length of fallow period (in years)
At present	3-4
5 years ago	5-6
10 years ago	7-8
15 yeas ago	9-10
20 years ago	10-12
25 years ago	13-15

During this period the fallow is totally neglected without any form of management practice (indigenous or otherwise). The major reasons for the negligence of the fallow can be attributed to the land tenure system and the ignorance of the farmers about the importance and benefits of management of such lands. The farmer is not only handicapped in terms of resources, but is also generally less endowed with education, training, outside contacts and mass media exposure. To the farmer the main concern is to get maximum output from as minimal an input as possible. The other constraints of farming are financial, land tenure systems, seasonality of

the rains, availability of better yielding crop varieties, etc.; the farmer becomes too preoccupied with trying to achieve maximum benefits from very limited resources. Hence giving attention to the land which, in the first place has been left fallow, seems like a waste.

The fallow lands have several important functions. For example, the vegetation on the fallow land is utilized as fodder, compost and in 'bun' preparation. They are also utilized for grazing of cattle, which provide the farmers with meat, and also dung which is used as manure. In addition plants of medicinal value are also collected from the fallow lands. These include *Potentila nepalensis* (locally called lyniang), *Eupatorium adenophurum, Lantana camara, Centella asiatica* etc.

Regenerative processes

Soil fertility and nutrient recuperation

In the '*rep puli*' system of farming the use of the fallow vegetation and unused agricultural products as source of manure is an efficient method of resource management. Thus in this case it can be seen that the farmers have unintentionally resorted to the 'Nutrient Access concept' of manuring rather the 'Nutrient Banks concept' (Bunch, 2001), which is frequently associated with the traditional systems of shifting agriculture. There is no evidence of the use of green manures and cover crops by the farmers practising shifting cultivation. During cultivation, the nutrients lost from the soil are replenished either by adding organic manure such as animal dung, or by application of inorganic fertilizers such as urea, potash, etc.

Soil management

Soil management in terms of reduction of extensive soil loss due to erosion effected by rainwater is almost negligible, since the nature of rainfall encountered in this region does not usually cause erosion. The rainfall unlike in tropical regions is sharp with small drops as a result of which splash erosion is more or less absent. However, in very rare cases, the farmers employ the use of patches of soil containing grass (*stong*) to cover the exposed soil surface, thereby reducing soil loss due to run-off water.

Weed control

The control of weeds is done by simple weeding involving human labour. Weeding is generally carried out during the initial stages of cultivation. The use of biological control agents is not known to the farmers.

Pest management

Pesticides such as *Tatafen, Diosis, Indofil, Dithane 45* and *Thaidan* are used for pest management.

Seed selection processes and management

Seeds are obtained in two ways: i) bought from among the community

members or from outside agencies and ii) produced by the farmers themselves. The farmers have evolved indigenous methods of seed production, especially for crops such as cabbage, cauliflower and radish. In such cases, the farmer selects the best individuals from his crops and transplants them to a new plot. In case of cabbage, the vegetative bud is incompletely divided into four halves before it is planted in the new plot while for cauliflower, the plant is decapitated and then planted. The plants are protected from excess moisture by plastic bags/sheets. In the case of radish, the plant is uprooted along with the modified root. The apex of the root is removed to stop further growth and extension and then planted in the new plot such that the leaves and a portion of the root are exposed above the soil surface. The plants are then allowed to grow and seeds are formed in about three to four months. This process of seed production, locally known as '*kalom symbai*', takes place during the later part of the year, i.e. from the month of October to January.

Seed exchange networks

The seed exchange network is largely localized, with the farmers obtaining the seeds amongst themselves within the community. Sometimes the farmer also obtains seeds from outside agencies such as nurseries and farms.

Income generation

Due to several factors, especially the increased demand for agricultural produce, the farmer is tempted to increase his production in order to achieve a higher income. Thus over the years certain innovations have crept into the age-old methods of cultivation; innovations, which the farmer considers, will benefit him more. However, the chief factor in determining the type of innovation(s) still seems to be from a monetary standpoint. This pattern of thinking prevalent can be well summarized from the caption below:-

Therefore, any innovation which the farmers have adopted and are still are practised must be beneficial monetarily. As will be seen from the Table 6.1 given the present system of cultivation is economically more efficient as compared to the previous system. **For every Rupee invested** in production **in the present system of cultivation the farmer receives a return of Rs.3.02** while the previous system yielded a return of only Rs.1.91 for every Rupee invested in production. This can also be seen from Table 6.1.

However, the information given above may not truly reflect the difference economic returns achieved by the farmers since the information pertaining to the previous pattern of shifting cultivation is based on research conducted in the year 1981. Another aspect to be considered is the devaluation of rupees (Rupee) since the period the aforesaid research. At

a glance, it looks as though there has been a tremendous increase in the net return in the present system as compared to the previous system of cultivation.

Table 6.1. Cost-benefit analysis (Rupees/ha/yr) of previous and present pattern jhum system at the higher elevations in Meghalaya

Production measures	Previous pattern (1981)	Present pattern (2002)
Inputs		
Labour	1,608	1,968
Organic manure	412	11,055
Fertilizer and pesticide	29	1,983
Seeds	1,243	949
Land rental (if hired)	not available	1,750
Outputs		
Root and tuber crops	5,188	15,364
Cereal grains	53	nil
Legumes	nil	4,750
Leafy vegetables	1,065	27,534
Cost of production (a)	3,292	15,737
Gross return (b)	6,306	47,648
Net return (b–a)	3,014	31,911
Return per Rupee spent	1.91	3.02

Ecological effects of the system

The effect of the system of cultivation practised can be broadly categorized:

Ecological

Any system of shifting cultivation in which the land is not left fallow for a long period of time will definitely have a negative influence on the land especially the soil system. In the traditional system of cultivation the use of fire further aggravates this problem since fire releases cations in a single pulse, as a result of which their availability may exceed the retention capacity of the jhum agro-ecosystem and are invariably lost from the system. The large amount of cations released after the burn also increases the soil pH (Ahlgren and Ahlgren, 1965; Wells, 1971). The increase in the soil temperature between 35 and 58°C also leads to destruction of the thin-walled nitrifying bacterial colonies. Thus the low residual viable nitrifier population could, perhaps, be responsible for a steep decline in nitrification soon after the burn (Raison, 1979). Under the modified version of '*rep burn*

i.e. '*rep puli*' fire is not used as a result of which the damages to the soil system are greatly minimized. Also the use of the fallow vegetation and crop residue as compost is an efficient method of managing the limited resources available. This has led to lesser slashing of pine branches leading to lesser wanton destruction of the surrounding forests (Box 6.1).

Box 6.1 Comparison of the ecological efficiency between the systems of shifting cultivation in the higher elevations of Meghalaya and the slash and burn type of shifting cultivation in the lower elevations of the region.

Shifting cultivation systems in the higher elevations of Meghalaya	**Slash and burn type of shifting cultivation in the lower elevations of Meghalaya**
Cutting of lower branches instead of whole trees is an efficient way of resource management. Further the use of fallow vegetation as well as the crop residue further increases resource management efficiency.	Cutting of whole trees instead of only branches reduces the availability of biomass for the next round of cropping.
Controlled burning of the soil covered crop residue (*rep bun*) releases phosphorous from rocks and to some extent reduces the loss of nutrients.	Burning of the slash in an uncontrolled manner leads to release of a large amount of nutrients in a single pulse resulting in extensive nutrient losses.
Cultivation on the ridges with the furrows serving as channels for run-off water is an efficient method of reducing soil loss due to erosion.	No formation of ridges and furrows leads to excessive loss of soil and nutrients due to erosion and leaching.
The presence of fallows mingled with the agricultural fields in a mosaic fashion enables the soil and nutrients lost from the agricultural fields to be retained by the fallow lands and vice versa.	The soil and nutrient washed away are usually lost from the shifting cultivation system.
Partial shifting within the cultivated land (as in *rep puh*) enables efficient utilization of land.	There is no record of any form of partial shifting within the cultivated land.

In *rep puh* allowing the slash to decompose naturally enables better utilization of the nutrients locked up in the plant biomass as they are not released in a single pulse.	Nutrients are released extensively in a single pulse, after burning of the slash. The amount released far exceeds the amount utilized by the crops and hence most of them are washed away from the system, along with the runoff water.
Use of *stong* (patches of soil containing grass cover) is also an efficient and indigenous method of reducing the loss of soil from the exposed surface, due to run-off.	Such soil management practices are not commonly found.
Cultivation of nitrogen fixing crops such as *Pisum* sp enriches soil nitrogen content while non-cultivation of *Raphanus sativus* until the later stages of cultivation enables better utilization of the land.	Crop rotation is not common with the view of conserving the fertility of the soil.

Economy

Under the new cropping pattern, the farmers have the opportunity to raise two crops in a year resulting in a higher output as compared to the previous method where only a single crop was grown in a year. This has enabled the farmers to support themselves even if by any chance one of the crops happened to fail. Therefore the increase in the number of cropping seasons has resulted in a certain degree of security for the shifting cultivator. It has also led to higher economic returns for the farmers if none of his crops failed and on the other hand has made them less susceptible to the vagaries of nature even though their dependence on nature has by no means decreased. However, the economic returns achieved are still far from ideal. At household level, on an average the farmer receives a return of approximately 1264.4 Rs/acre/yr, as a result of which a considerable portion of the population have resorted to different means of income generation such as daily labour, carpentry, working in private or public sectors, etc.

Conclusions

The system of cultivation practised in the higher elevations of Meghalaya have undergone several changes. These change have not only increased

its economic efficiency but have also led to better land use and management, which can be summarized as below:

i. Partial shifting within the cultivated land (as in '*rep puli*') enable efficient utilisation of land as a result of which the period of cultivation on the land can be increased resulting in longer fallow periods.

ii. The non-usage of fire ('*rep puli*') results in lesser destruction of the soil system.

iii. Allowing the slash to decompose naturally allows for better utilisation of nutrients locked up in the plant biomass as they are not released in a single pulse.

iv. Use of 'stong' reduces soil loss from the exposed surface due to run-off.

v. Cultivation of nitrogen-fixing crops such as *Pisum* sp. enriches soil nitrogen content while the non-cultivation of *Raphanus sativus* until the later stages of the cropping cycle allows better utilisation of land.

Apart from these changes, the Khasis have still retained the beneficial practices of '*rep buri*' such as cutting of only the lower branches of trees and controlled burning of the soil covered crop residue (where '*rep puli*' is not practised). Cultivated lands are still modified into ridges and furrows and also mingled with the fallows in a mosaic fashion.

Therefore the present method of cultivation employed by the Khasis of the higher elevations of Meghalaya, is a mixture of the traditional cultivation practice and the innovations adopted resulting in better utilisation of the resources available, viz. land and plant biomass. The farmers by their innovations have also succeeded to a certain extent to make the system of agriculture practised more sustainable since sustainable agriculture involves not only efficient use of resources based on recycling but also regulated cropping, done in a manner that would contribute towards sustaining soil fertility.

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