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Technological innovations in shifting agricultural practices by three tribal farming communities of Meghalaya, northeast India

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Abstract: Shifting agricultural practices of three tribes of Meghalaya viz., Khasi, Garo and Karbi were studied to analyze and understand the technological innovations adopted by these communities in this age old practice. The methods used for this study involved participatory data collection on the socio-economics, agricultural practices and bio-physical resources through Participatory Rural Appraisal (PRA), household survey and participatory resource mapping of the villages. The study was carried out in six villages viz., Khrang, War-War, Kuswai, Khulia, Chekwatgre and Sasatgre, two each inhabited by Khasi, Karbi and Garo tribes, respectively. It was observed that a variety of indigenous technological innovations have been introduced by these communities for making the system more productive, less degradative and able to generate cash income for modern living. The innovations include: use of cover crops, retention of trees, prudent management of weeds, use of poles and logs for soil conservation, introduction of cash crops and fallow management. Evolved and adopted by these communities through experiential learning, these innovations have ample potential of replication elsewhere.

Resumen: Se estudiaron las prácticas de agricultura itinerante de tres tribus de Meghalaya, —Khasi, Garo y Karbi—, para analizar y entender las innovaciones tecnológicas adoptadas por estas comunidades en esta antigua práctica. Los métodos usados para este estudio involucraron la obtención participativa de datos sobre aspectos socioeconómicos, prácticas agrícolas y recursos biofísicos por medio de una Evaluación Rural Participativa (PRA, siglas en inglés), inspección de núcleos familiares y mapeo participativo de los recursos de las aldeas. El estudio se llevó a cabo en seis aldeas, Khrang, War-War, Kuswai, Khulia, Chekwatgre y Sasatgre, de las cuales dos están habitadas por las tribus Khasi, Karbi y Garo, respectivamente. Estas comunidades han introducido una variedad de innovaciones tecnológicas nativas con el fin de hacer el sistema más productivo, menos degradador y capaz de generar ingresos en efectivo para la vida moderna. Las innovaciones incluyen el uso de cultivos de cobertura, el mantenimiento de árboles, el manejo prudente de malezas, el uso de postes y troncos para la conservación del suelo, la introducción de cultivos comerciales y el manejo de la sucesión. Desarrolladas y adoptadas por estas comunidades por medio del aprendizaje experiencial, estas innovaciones tienen un gran potencial para ser replicadas en otros lugares.

Resumo: Estudaram-se as práticas agrícolas itinerantes de três tribos de Meghalaya i.e, Khasi, Garo e Karbi para analisar e compreender as inovações tecnológicas adotadas por estas comunidades nesta prática ancestral. Os métodos utilizados para este estudo envolveram a coleta participativa de dados sobre a sócio-economia das práticas agrícolas e sobre os recursos

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biofísicos por meio de inquéritos de Avaliação Rural Participativa (PRA), inquérito às famílias e mapeamento de recursos participados das aldeias. O estudo foi realizado em seis aldeias: Khrang, Guerra-Guerra, Kuswai, Khulia, Chekwatgre e Sasatgre, duas das quais habitadas pelas tribos Khasi, Karbi e Garo, respectivamente. Observou-se que um conjunto de inovações tecnológicas indígenas foram introduzidas por essas comunidades para tornar o sistema mais produtivo, menor degradação e também capaz de gerar rendimentos monetários para a vida moderna. As inovações incluem: uso de culturas de cobertura, a retenção de árvores, a gestão prudente das ervas daninhas, o uso de postes e toros para a conservação do solo, introdução de culturas de rendimento e gestão de pousio. Evoluídas e adotadas por essas comunidades através da aprendizagem experiencial, essas inovações têm amplo potencial de replicação noutros lugares.

Key words: Cash crops, fallow management, Garo tribes, jhum, Karbi community, Khasi community, shifting cultivation.

Introduction

Shifting cultivation is prevalent mostly in the tropical countries. Conservative estimates suggest that 300 to 500 million people were engaged in shifting cultivation during 1980s (IFAD, IDRC, CIIFAD, ICRAF & IIRR 2001). Others have argued that more than 400 million people in Asia alone are forest dependent and that many of them are engaged in shifting cultivation. It is observed that about one billion people (22 % of the total population of the developing world in tropical and subtropical countries) rely directly or indirectly on some form of shifting cultivation (IFAD, IDRC, CIIFAD, ICRAF & IIRR 2001). In India the practice is significant in the states of Andhra Pradesh, Nagaland, Meghalaya, Mizoram, Manipur, Tripura, Arunachal Pradesh, Kerala, Karnataka and Orissa. About 5 million tribal families in India are practicing this system on 4.37 million hectare of land (Sahu *et al.* 2005). Many workers have studied the practice from different angles and various organizations at national and international level have attempted to document the shifting cultivation practices (Ramakrishnan 1992; Sachidananda 1989).

In northeast India, explorative studies have been made to determine the extent of area under shifting cultivation and number of families practicing it by various agencies and organizations. Such explorative studies include those of Shifting Cultivation Task Force constituted by the Government of India and Ministry of Agriculture (1983). In addition, the studies on ecological impact of shifting cultivation have also been carried out by Tawnenga (1990), Ramakrishnan (1992), Tawnenga & Tripathi (1996) and Tawnenga *et al.* (1997). Several organizations and workers have made attempt to evolve viable alternative landuse models either to replace the shifting cultivation or to minimize its adverse ecological impact (ICAR 1985; NEPED & IIRR 1999; Okigbo 1984). The total estimated area under the shifting cultivation in the north-eastern states is 1.98 million ha which is 87 % of the total shifting cultivation area in the country (Satpathy *et al*. 2003). At least 100 different indigenous tribes and sub-tribes comprising more than 620,000 families in the region depend on shifting cultivation for their subsistence livelihood (Ramakrishnan 1992).

The state of Meghalaya is located between 25° 47′ N to 26° 0′ N latitude and 89° 45′ E to 92° 47′ E longitude extending over an area of 22,429 sq. km. Bulk of the people belongs to two major tribes- the Khasi and Garo. The term Khasi is applied to the group of matrilineal and Mon-Khmer speaking people who presently inhabit the East Khasi Hills, West Khasi Hills, Ri Bhoi and the Jaintia Hills districts of Meghalaya. Garo is a term used to refer to a particular group of people who belong to Austro-Mongoloid group and are mainly concentrated in the Garo hills. The other important tribe of the state is Karbi of the Mongoloid group and socio-linguistically they belong to the *Mikir* group of the Tibeto-Burman subgroup. The Karbi people mostly inhabit in Jaintia Hills, Ri Bhoi and East Khasi Hills districts.

The total recorded forest area of the state is 8,514 sq. km out of which only 722.36 sq. km is

under the control of the State Forest Department. The remaining forests are managed by the respective Autonomous District Councils of Khasi Hills, Jaintia Hills and Garo Hills as per provisions of the Sixth Schedule of the Constitution of India. The richness of the vegetation of Meghalaya is well known and has been studied by many botanists and foresters (Balakrishnan 1981-1983; Haridasan & Rao 1985-1987). According to Champion & Seth (1968) there are eight types of forest found in Meghalaya and each type harbours a rich diversity of flora and fauna. Baishya *et al.* (2009) mentioned that most tropical forest of the region were affected by one or the other form of cultural disturbances.

Agriculture is the principal occupation of the people of the state. The people practice two distinct types of agriculture: settled and shifting. Except for the reserved forest, protected forests, sacred groves (*Law Kyntang*), restricted forests (*Law Adong*) and private forests, the rest of the forest areas are mostly subjected to shifting agriculture popularly known as jhum. It was estimated that about 5.43 % rural population in Khasi and Jaintia Hills and 26.08 % in Garo Hills practice shifting cultivation (NIC 2001). The estimated population engaged in it is 2,57,140; i.e. 14 % of total rural population of Meghalaya (18,53,457). The current jhum in Meghalaya is estimated to be 442 sq. km i.e. 1.98 % of total geographical area (Jeeva *et al.* 2005). Other than shifting cultivation (Jhum), terrace (bun) agriculture and tree based farming are also prevalent in the state. As per the statistics of the Task Force on Shifting Cultivation, Ministry of Agriculture (1983) 52, 290 families in the state were practicing shifting cultivation on 530 sq. km land area annually. According to FSI 1997, the cumulative shifting cultivation area during the period 1987 to 1997 was 0.18 million ha.

For the tribes of Meghalaya shifting cultivation is not just a means of their livelihood, but in the interiors of the state particularly in Garo Hills it is still considered as a part of life, culture and tradition. Tiwari (2007) analyzed the spatial and temporal variations in shifting cultivation and described four types of shifting agricultural systems viz. traditional, distorted, innovated and modified shifting agriculture. According to Paul & Paul (2009) shifting cultivation helps conservation of soil moisture, enrichment of soil texture and soil structure and development of a good crop canopy due to mixed cropping. Traditionally this method of cultivation provided year round food security to people inhabiting remote and inaccessible areas. Presently due to unavailability of sufficient land people are dependent on market products and farmers are giving more emphasis towards commercially important crops.

The Shillong Declaration in 2004 on shifting cultivation recommended that policy makers re-examine the policies in place, remove explicit policies and policy instruments that discourage shifting cultivation, and strengthen the implementation of existing beneficial policies. It also recommended that policies must address issues of land tenure security, research and extension and their impacts on traditional shifting cultivation practices; market development and commercialization of niche products of shifting cultivation; strengthening and capacity building of customary institutions; credit policies in situations where common property regimes apply; and coordination among the different government agencies that have responsibilities for various aspects of shifting cultivation (Kerkhoff & Sharma 2006). The National Forest Commission (MoEF 2006), recognizing the distinctive nature of problems and the existence of a high proportion of forests and biodiversity in northeast India, has taken over several of the recommendations from the Shillong Declaration, in its advice to the Government of India. Additionally, the Indian Supreme Court had set up an expert committee to advise on the assessment of the net present value (NPV) of forests, which is used when compensation needs to be paid for forestland once it is converted to non-forest uses. In the case of shifting cultivation, there was a fear that temporary land clearing might be considered a non-forest use, while the forest fallows themselves are forests that are often allocated to other purposes by the government and for which compensation would be required. International Centre for Integrated Mountain Development (ICIMOD) and its partners have opined that shifting cultivation is a special agro-forestry land use and not a non-forest use and, therefore, shifting cultivators do not need to pay NPV compensation. At the same time, in case their land is converted to non-forest uses, the compensation that normally accrues to the state forest departments will be allocated for community development in the respective area (Kerkhoff & Sharma 2006). On the other hand, the National Mission on Greening India has proposed different activities for rehabilitation of shifting cultivation areas (MoEF 2010). The mission will support fallow management within the overall framework

of socio-culturally valued, fast-growing species managed by the community. The mission envisages that services of agronomy and silviculture experts along with community indigenous knowledge will be put to maximum use for fallow-management. Also, learnings from existing jhum management models, both community-driven and those supported by the project/agencies will be used under the Mission.

At times shifting cultivation has been viewed as a human activity, practiced by traditional societies which have remained as such over thousands of years. The dynamic character of shifting cultivation and possible evolutionary processes have not yet 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. In this study an attempt has been made to understand the technological innovations made by the farmers practicing shifting cultivation in Meghalaya.

Materials and methods

Two villages inhabited by each of the three tribes (Khasi, Karbi and Garo) were selected for the purpose of this study (Fig. 1). War-War and Khrang comes under Khatarshnong-Laitkroh community development block of East Khasi Hills district and is predominantly inhabited by the Khasi. Kuswai and Khulia fall under Umling community development block of Ri Bhoi district and are inhabited by Karbi while Chekwatgre falls under Gambegre community development block of West Garo Hills and Sasatgre comes under Rongram community development block of West Garo Hills. These two villages are inhabited by the Garo community. The location of study villages is depicted in Fig. 1.

The methods adopted for the present study involved participatory data collection on the socio-economic, bio-physical resources and resource mapping through Participatory Rural Appraisal (PRA). Supporting data were collected from a wide range of secondary sources such as state forest and agriculture departments and related agencies and organizations and from previous studies on shifting cultivation. Household questionnaires were used for collecting household level data. At least 10 % of the household (3-10 HH) from each village were selected for household survey. The data and information on management practices were collected through group discussions and interviews with the village elders. In addition, the historical aspects of shifting cultivation systems were investigated carefully, such as where and how long the farmers cultivated the previous land before moving to the current site, cultivation and management practices and choice of species.

Results and discussion

Socioeconomic profile of study sites

In Khasi Hills, Khrang village (Fig. 2A) has a geographical area of 1508 ha with a total population of 430. There are 102 households in the village and the average family size is 5. The shifting cultivation area is 98 ha and 93 % of the families are involved in shifting cultivation. The shifting cultivation area per household is 1.03 ha. There are only 4 % graduates, whereas 77 % have completed primary education among the educated village people. Basic amenities like health facility, veterinary services, road connectivity, electricity, drinking water, telephone connection and school are all available in the village. In War-War village (Fig. 2B), the total geographical area is 69 ha with a total population of 193. The number of households is 38 and the average family size is 6. The shifting cultivation area is 19 ha and 78 % of the families are involved in shifting cultivation. The shifting cultivation area per household is 0.61 ha. There are only 2 % graduates, 16 % higher secondary passed whereas 79 % have completed primary education among the educated village people. The basic amenities of the village are: road connectivity, electricity, drinking water, telephone connection and school. There is no healthcare facility in the village.

In Ri Bhoi district, Khulia village (Fig. 2C) has a total geographical area of 890 ha. The total population of the village is 300. There are 49 households with an average family size of 7. The shifting cultivation area in the village is 100 ha and 92 % of the families are involved in shifting cultivation. The mean shifting cultivation area per household is 2.2 ha. None of the villagers has the post graduate degree and only 1 % have completed graduation out of the total educated people. Only 3 % and 22 % persons have passed higher secondary and secondary level examinations respectively. 74 % persons have completed primary level education out of the total educated people in the village. The basic amenities of the village are road connectivity, electricity, drinking water, telephone connection and

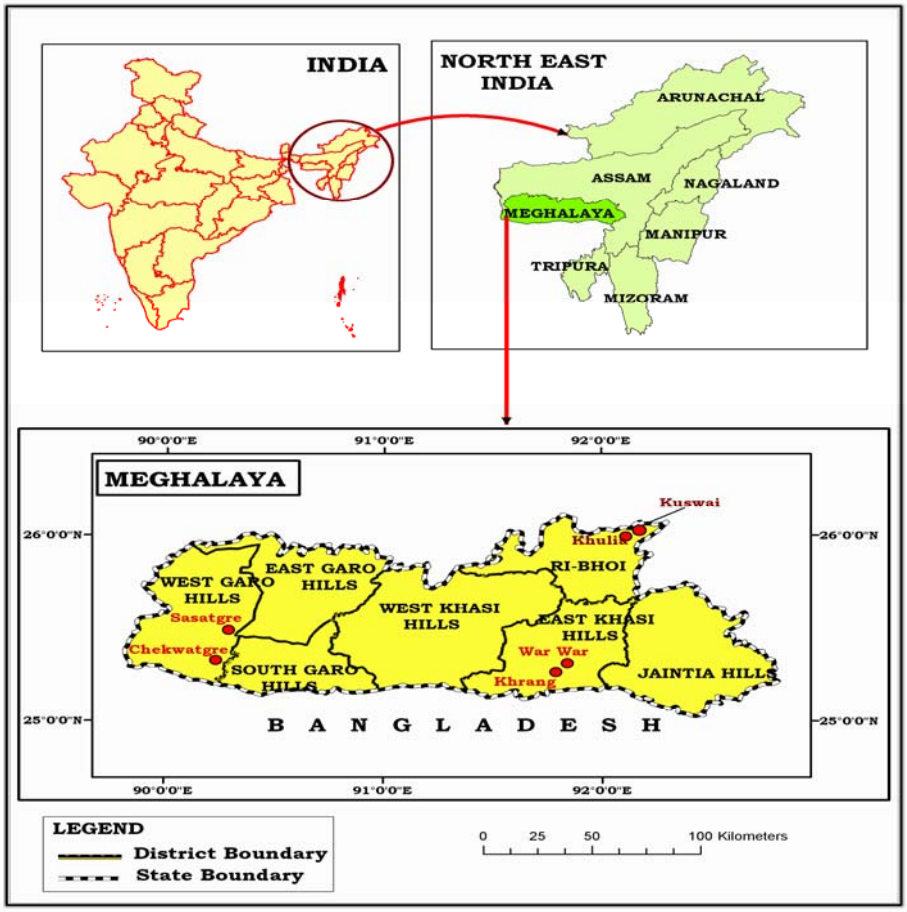
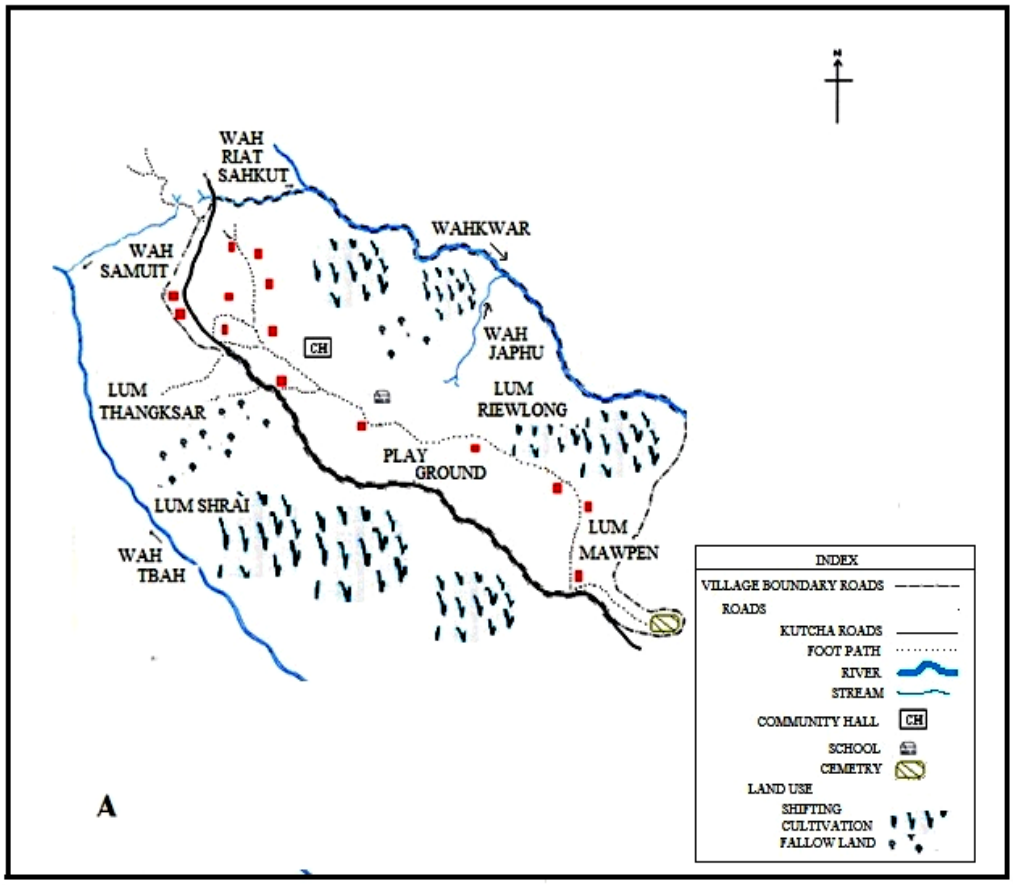


Fig. 1. Study sites in Meghalaya.

school. There is no healthcare facility and no veterinary service in the village. Kuswai village (Fig. 2D) has a total geographical area of 343 ha with a total population of 280. The number of households in the village is 30 and the average family size is 7. The total area under shifting cultivation is 43 ha and 100 % of the families are involved in shifting cultivation. The shifting cultivation area per household is 1.43 ha. There are no post graduates and graduates in the village and only 18 % of the total villagers have completed primary education. The basic amenities like road connectivity, electricity, drinking water, telephone connection and school are present in the village. There is no healthcare facility and veterinary service in the village.

In Garo Hills, Sasatgre village (Fig. 2E) has a total geographical area of 678 ha with a total population of 305. The total number of households in the village is 61 and the average family size is 6. The shifting cultivation area is 41 ha and 97 % of the families are involved in shifting cultivation. The shifting cultivation area per household is 0.69 ha. There is no one in Sasatgre village having graduation and post graduation degree, however, 5 % have passed higher secondary, 71 % secondary examinations and 21 % persons have completed primary education. Basic amenities like road connectivity, electricity, drinking water, telephone connection and school are present in the village. There is no healthcare facility and veterinary service in the village. The Chekwatgre village (Fig. 2F) has a total geographical area of 700 ha with a total population of 278. There are 33 households in the village with an average family size of 6. The shifting cultivation area is 50 ha and 91 % of the families are involved in shifting cultivation. The shifting cultivation area per household is 1.67 ha. There are only 1 % higher secondary, 29 % secondary and 62 % have completed primary level education. Basic amenities like road connectivity, electricity, drinking water, telephone connection and school are present in the village but there is no health care facility and veterinary service in the village.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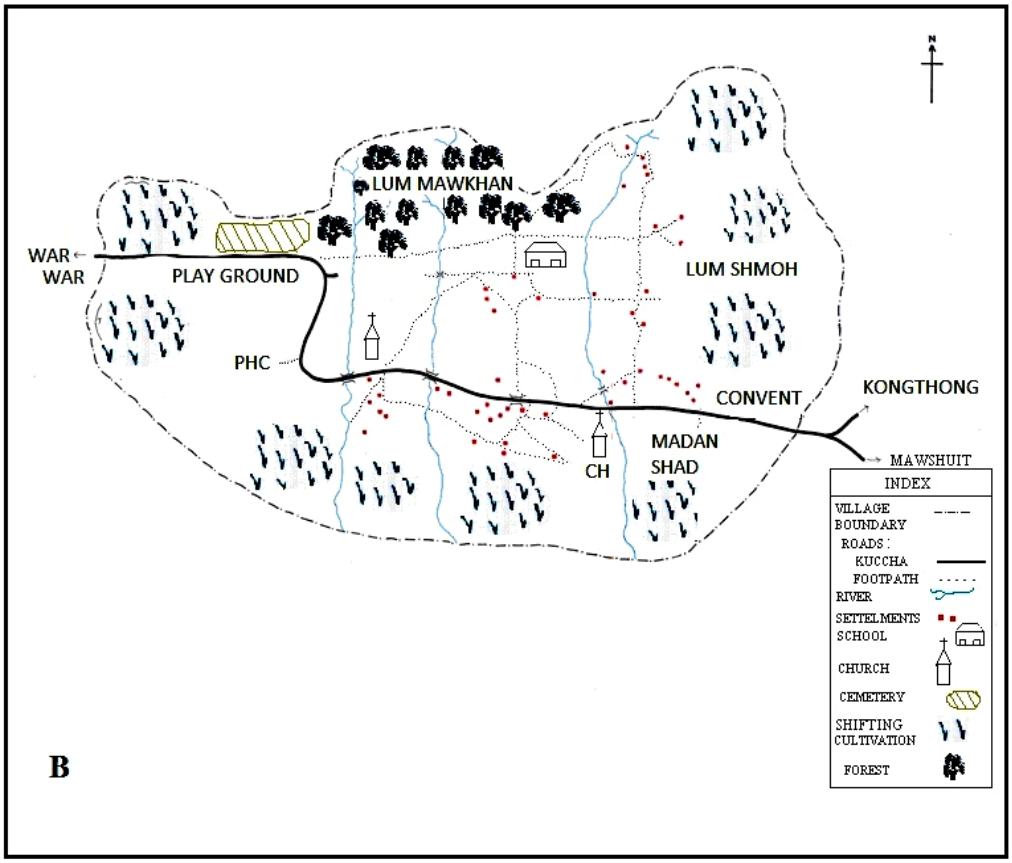
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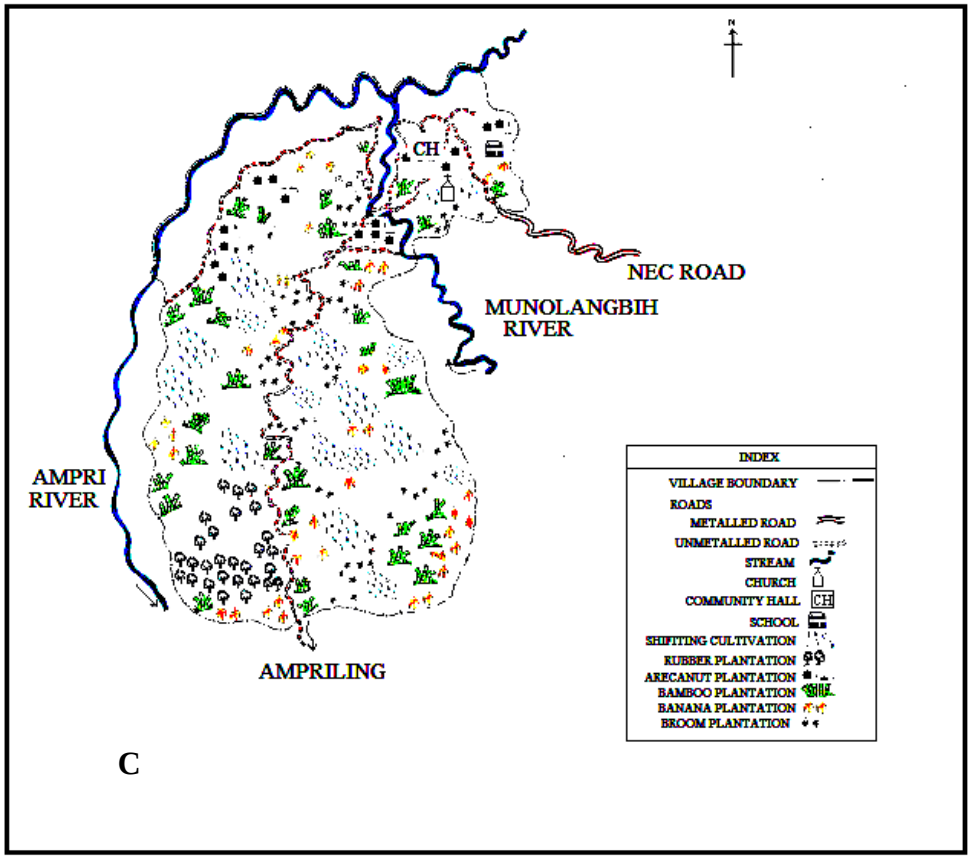
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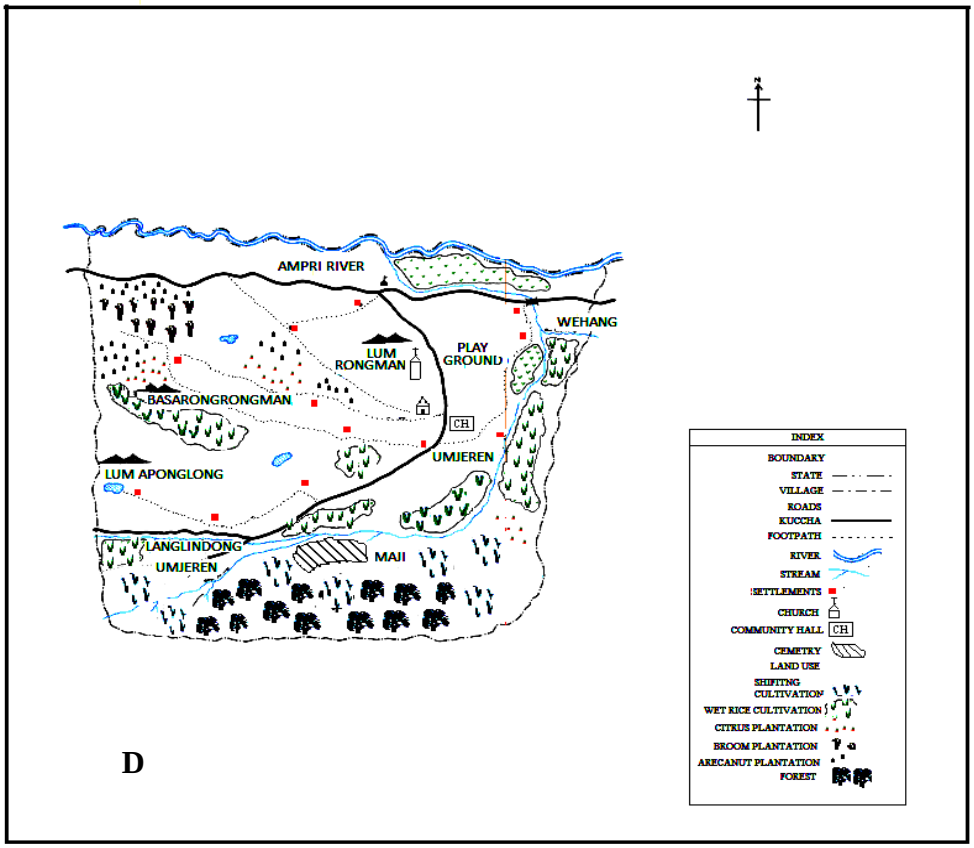
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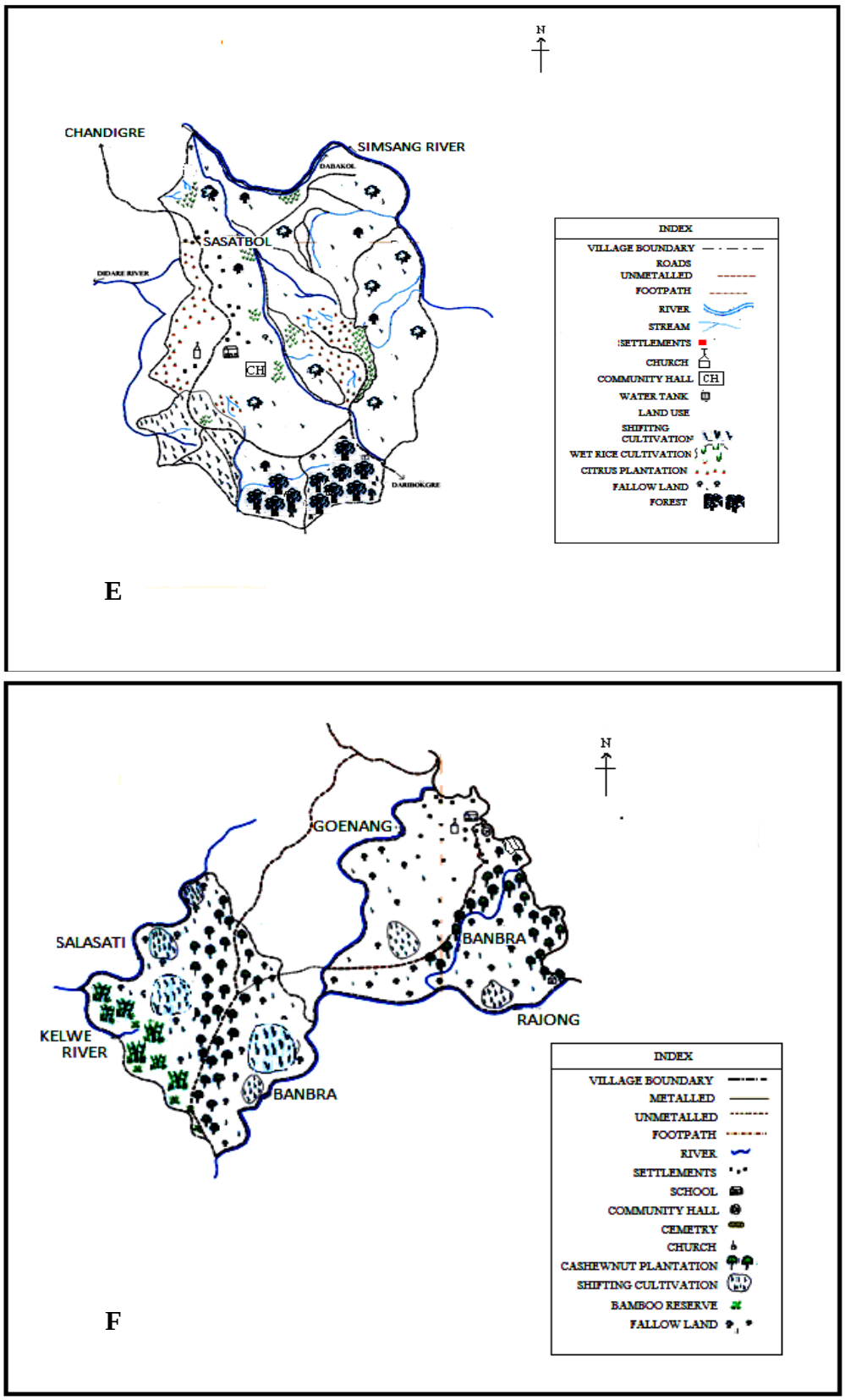

Fig. 2. Landscape elements of study villages.

A. Khrang village B. War-War village C. Khulia village D. Kuswai village E. Sasatgre village F. Chekwatgre village.

Shifting cultivation practices

Shifting cultivation in Meghalaya is known by different names e.g., the Khasi tribe of War-War and Khrang villages call it by the name '*Rep Shyrti*', Karbi tribe of Khulia and Kuswai village call it as *'Ret'* and the Garo tribes of Sasatgre and Chekwatgre villages call shifting cultivation as '*A·ba*'. Shifting cultivation plots at War-War and Khrang villages of Khasi Hills are either privately owned or rented in case of landless people in Khulia and Kuswai villages of Ri Bhoi lands are privately owned where as in Sasatgre and Chekwatgre villages of Garo Hills the shifting cultivation is done on community lands controlled by the *Nokma* (Village Chief). In Garo villages the size of plot allotted to each household varies from 0.2 - 1.25 ha depending on the household size and capacity of family labour, while in Khasi and Karbi villages average size of plots varied between 0.61 - 1.03 ha and 1.4 - 2.2 ha respectively. The plot size was somewhat smaller compared to the range (1.0 - 2.5 ha) reported by Ramakrishnan (1992).

Use of trees and logs

It was observed that clearing of the forest vegetation is partial and short tree stumps in place of large tree boles are left intact to stabilize the slope, reduce soil erosion and to be used as support for the climber crops. It was also noticed that more stumps are left on steeper slopes than on gentle slopes which clearly showed the intent and purpose of the selective felling of trees. Trees belonging to *Schima walichii, Calicarpa arborea, Castanopsis tribuloides, Gmelina arborea* and *Eurya japonica* were left over during clearing the field for their various characteristics like: coppicing, fruit yielding, timber quality and fast growing. Bamboo used as soil binder facilitates soil nutrient recovery and creates microhabitats for regeneration of shade loving species (Rao & Ramakrishnan 1989). The dead stumps are collected and used for fuel wood after harvesting the climbers and twiners. The debris felled after slashing and felling are collected in heaps for drying. Burning is done two to three months after slashing and clearing when the slash has dried. Near haphazard burning was prevalent during earlier days, whereas a fire line of vegetation (2.13 - 2.74 m) is maintained now a days to check the spread of fire. The burning is usually carried out in late afternoon or evening between 3 - 6 p.m. because the wind velocity is the least during this period and fire is more visible.

The Khasi people of the study villages lay wood logs across slopes in a staggered manner to control soil erosion. The slashed branches of pine trees brought from the nearby pine stands are also arranged together with the slash. Stone bunding is made in shifting cultivation fields of Karbi community which are near the streams to check flooding. Water channels are constructed along the stream to divert the flow of water away from the fields and for irrigation especially on steep slopes. Poles are stocked across water courses in steeper areas to slow the flow of water in the stream and arrest soil erosion.

Crop diversity

Shifting cultivation practiced by the three tribes in Meghalaya is a mixed cropping system and it maintains high crop diversity. Although most crops grown by the farmers are for self consumption, the surplus produce is sold in the market for cash income. In War-War and Khrang villages the crops sown for commercial purpose are: potato and turmeric while in Khulia and Kuswai villages, ginger is the main cash crop followed by potato, colocasia, pumpkin and chili to a lesser extent. In modified system, the most common crops sown during the first season is potato (*Solanum tuberosum*) while cabbage (*Brassica oleraceae* var. capitata), cauliflower (*Brassica oleraceae* var. botrytis), pea (*Pisum sativum*) and radish (*Raphanus sativus*) are preferred during the second season. In all, 14 to 16 crops are grown in War-War and Khrang villages while 24 crops each are grown in Kuswai and Khulia villages. In Sasatgre and Chaekwatgre villages of Garo Hills as many as 30 - 35 crops are sown in shifting cultivation plots (Table 1). Ramakrishnan (1984) reported 8 - 35 crops during the cropping phase in northeastern India in a plot of 2 - 2.5 ha, with simultaneous sowing and sequential harvesting. Now-a-days farmers are planting *Bambusa tulda*, *Toona ciliata*, *Duabanga grandiflora* and *Manihot esculenta* along the boundaries of shifting cultivation fields to check soil erosion and to retain soil moisture. Fruit trees like *Artocarpus chaplahsa, Citrus* sp., *Litchi chinensis*, *Mangifera indica, Myrica esculenta*, *Prunus nepalensis* and *Musa* sp. are also grown in some shifting cultivation plots. From the mix of trees and crops the plots resemble an agroforestry system that allows maintenance of higher crop biodiversity. Though mixed cropping is predominant

Table 1. Salient features of Shifting cultivation practiced by Khasi, Karbi and Garo communities of Meghalaya.

Activities	Name of the tribes		
	Khasi	Karbi	Garo
Land ownership	Private/Rented	Private	Community
Allotment of plot by traditional institution	Not necessary	Not necessary	Practiced
Labour for slashing & burning	Family members	Family members	Community activity
Burning Months	February-March	April	March
Sowing Months	March-May	April-June	March-April
No. of crops grown	14-16	24	30-35
Dominant subsistence crops	Bean, Bitter gourd, Coix (Sohriew), Cucumber, Soyabean, Dioscorea, Pea, Raddish, Potato, Sweet Tapioca and etc.	Bean, Bitter gourd, Cucumber, Jhika (fruit), Lady's finger, Lao, Maize, Mesta, Sponge gourd, Banana, Paddy, Sweet Potato, Tapioca and Turmeric	Brinjal, Lai sak (leaf), Local lettuce, Millet, mustard, Sesame, Bean, Bilik (legume), Cotton, Cucumber, Gourd, Kharek (fruit), Jingka (fruit), Lady's finger, Lau, Lentil, Melon, Mesta, Paddy, Cauliflower Pumpkin.
Cash crops	Turmeric, Potato, Maize, Colocassia	Potato, Colocassia, Pumpkin, Chilly, Ginger	Ginger, Maize, Chilly, Pumpkin
Fruit trees	*Artocarpus chaplasha, Citrus* sp., *Litchi chinensis*, *Mangifera indica, Myrica esculenta*, *Prunus nepalensis, Musa* sp.	*Artocarpus* sp.	*Musa* sp., *Citrus* sp.
Fuel wood trees	*Artocarpus* sp., *Betula alnoides, Castanopsis tribuloides, Ficus bengalensis*, *Litchi chinensis*, *Mallotus nepalensis, Mangifera indica*, *Myrica esculenta*, *Prunus nepalensis, Quercus* sp. and *Schima wallichi*	*Albizia procera*, *Artocarpus* sp., *Cassia fistula, Duabanga grandiflora, Gmelina arborea, Michelia champaca, Shorea robusta*, *Tectona grandis* and *Toona ciliata*	*Actinodaphne obovata, Albizia chinensis, Albizia odoratissima, Callicarpa arborea, Careya arborea, Duabanga grandiflora, Eurya japonica, Gmelina arborea, Macaranga* sp. and *Trema orientalis*
Weeding	Twice	Once	Twice
Harvesting period	June-July, Nov-Jan	June-Feb	June-Feb
Cropping period (years)	1	1	1-3
Fallow period (years)	8-15	3-5	7-9
Production (kg ha^{-1})	4653	1991	11293

in most of the systems, people are becoming increasingly interested to grow cash crops in their plots. Another innovation seen in Garo Hills was conversion of lower hill slopes into flat land for cultivation of paddy, whereas the rest of the hill is used for mixed cropping or cash crop production under jhum.

Sowing

The farmers have evolved indigenous method of seed production, especially for crops such as cabbage, cauliflower and raddish. In such cases the farmers select the best individuals from among their crops and transplant them to a new plot. The seeds for sowing next year are collected from these plants. In few cases (e.g. cash crops) seeds are also borrowed/brought from the community members or from outside agencies. Seeds of certain crops like millets, chilies, brinjal and local lettuce are mixed with dry soil from the site to ensure uniform distribution and broadcasted preferably on the next day of slash/burning. Dibbling of seeds of other crops like paddy, maize and vegetables such

as beans, gourd, lady's finger and pumpkin follow thereafter. This is a technique where farmers dig a small hole with a long knife or pointed stick and sow seeds inside with a minimum tillage which is important for erosion prevention on sloping land. Hoeing method is adopted for sowing of tuber crops like ginger, colocassia, tapioca, potato and sweet potato. Sowing of all the crops are over by the end of April, May and June in Garo, Khasi and Karbi community, respectively. The soil is never ploughed and no irrigation is done. Fencing of the individual jhum plots are not practiced by Garo community, however, in Sasatgre village farmers grow Tapioca along the boundary of their plots which acts as a demarcation between the plots as well as helps in control of soil erosion. Soon after the sowing of the crops is over, the Garo people build a miniature house called *'Jamatal'* in their jhum fields which is used to store the harvested grains. It was also observed in few fields that 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 and potash.

Zero tillage helps to minimize soil loss from the fields. Instead of crop mixture, tuber crops like potato are planted early in the fields as cover crops which help in binding the soil and provide a cover in very short period of time. It is reported that the velvet bean (*Mucuna* spp.) is the most popular of all the green manures/cover crops used today by the shifting cultivators and was initially used and spread by farmers along the southern border of the Himalaya in Nagaland partly because it was such a valued source of food (Bunch 2005). The Khasi and Karbi people sow crop immediately after field preparation, whereas the Garo people make sacrifices to *Misi Saljong* (The Great Giver) for good crop and prosperity of the family before sowing.

Weed management

It is the most time consuming and tedious activity. The plants removed during weeding are spread in the field itself to improve the nutrient and retain moisture content of the soil. The Khasi do weeding (locally called as *thiew kynbat* or *thiew niut)* twice in a year during June - July and September - October. This is usually done by hand or by using simple tools such as hand knives or a long knife attached to a wooden handle locally known as *Wait*. The *Karbi* tribe also do weeding (locally known as *bap kephu)* twice in July and August. The Garo people do first weeding in the month of May and second weeding in the month of July. Garos do weeding mainly by hand hoeing. It was found that the second weeding is usually carried out after the rainy season thus the weeds act as mulch during rainy season and control soil erosion. During earlier days uprooted weeds were used as mulch irrespective of species or burnt in the field itself, whereas in modified system easily decomposing plant parts are left to decompose naturally, thereby forming rich source of compost manure. In cases where the land is cultivated for the second successive year, the crop residue is utilized as compost. It can be said without doubt that the management of weeds is aimed at a more efficient recycling of nutrients within the system and it helps in conservation of soil and moisture. It is reported by Ramakrishnan (1994) that the farmers in northeast India leave about 20 % of the weed biomass *in situ*. Under such husbandry, the crop yield is unaffected and indeed the weed ground cover helps to conserve soil nutrients.

In earlier days, 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. In changed scenario harvesting of crops is done in different periods for different crops as they are sown at different times. It is carried out almost continuously for a period of nine months from June to February by the *Karbi* tribe while the *Khasi* farmers harvest the crops during June - July and from November to January. The *Garo* people harvest their crops from June till February. This provides food for nearly six to nine months in the year. Harvesting method varies depending on the type of crop. Some crops are plucked with hands viz., maize, pumpkin, cucumber while others are harvested by using simple tools such as *mohkhiew* (local spade) and spatulas for root crops while leafy vegetables are harvested using knives and sickles. Sequential harvest ensures food security throughout the year. While jhum is subsistence based farming system and fulfills the day-to-day requirements of the farmers, in modified jhum the farmers introduce some cash crops in their fields which are sold in the market to meet the requirement of cash.

Fallow management

The Khasi of War-War and Khrang villages fallow their lands for a period of 8 - 15 years, Garo fallow their lands for a period 7 - 9 years, whereas Karbi fallow their lands only for 3 - 5 years. During

this period the land is set aside to allow regeneration of the vegetation. In earlier days the fallow was totally neglected without any form of management practice. The major reasons for the negligence of the fallow could be attributed to the land tenure system and the ignorance of the farmers about the importance and benefits of management of such lands. The farmers were not only handicapped in terms of resources, but were also generally less endowed with education, training, outside contacts and mass media exposure. Nowadays on some fallow lands of Khasi community (Khrang village) the farmers plant bay leaf, jackfruit and black pepper, whereas *Karbi* farmers (Kuswai village) plant banana and broom grass. The Garo people (Sasatgree village) prefer Arecanut and Citrus plant in their fallow land. All the three communities plant one or the other cash crop in their jhum fallows and consider it a fundamental requisite for modern living. Thus the fallow lands continue to yield some benefit to the people. In addition plants of medicinal value, leafy vegetables, mushrooms and fruits and nuts are also collected from the fallow land. Some common trees retained during cultivation and fallow period by Khasi community are: *Albizia procera, Artocarpus champaca, Castanopsis tribuloides, Duabanga grandiflora, Gmelina arborea, Michelia champaca*, *Schima wallichi*, *Shorea robusta, Prunus nepalensis, Quercus* sp. and *Toona ciliate.* The trees retained by Garo communities are: *Actinodaphne obovata, Albizia chinensis, Albizia odoratissima, Bauhinia* sp., *Bombax ceiba, Callicarpa arborea, Careya arborea, Duabanga grandiflora, Eurya japonica, Gmelina arborea, Macaranga* sp. and *Trema orientalis.* These trees are used for timber, firewood and for honey bee rearing. Thus the notion that the fallow lands do not provide any benefit to farmers is wrong and most fallows are managed and several goods are extracted from such land. N'dja *et al.* (2008) have emphasized that the sustainability of shifting cultivation is enhanced if few trees are retained during cultivation and fallow cycles are relatively long.

Introduction of cash crops

The jhum farmers have realized importance of cash for modern living. Therefore, several traditional crops have been identified for commercial production viz., turmeric, ginger and potato. These crops provide them cash needed for schooling of children and buying goods from the market. Garo people have introduced tree cash crops like Arecanut, Citrus and Coffee to reduce dependence on traditional jhum and for monetary income. It is reported that horticultural cash crops, such as rubber, oil palm, cocoa and coffee are extensively planted by smallholders as an outgrowth of shifting cultivation in many parts of the world (Raintree 1987). In Sabah, Malaysia also the farmers have introduced tree cash crops like Rubber and Coffee in their shifting cultivation plots (Miyakuni 1999). It was noted that many cash crop growing families have completely given up shifting cultivation, over a period of time. Thus introduction of cash crops is seen as beginning of the end of jhum on the land.

While documenting the technological innovations in shifting cultivation practices, it was found that many productivity and conservation enhancing measures have been judiciously incorporated in the shifting cultivation practiced by Khasi, Karbi and Garo communities of Meghalaya (Table 2). Some remarkable measures are: retention of good number of trees, zero tillage, use of trees and horizontally placed poles for soil conservation, fallow management by introducing cash crops, use of extracted weeds as mulch and maintenance of weeds as cover crops during rainy season. These measures help in soil, water and biodiversity conservation. Analyzing the practices on the lines of four types of shifting cultivation described by Tiwari (2007), it can be said that in Garo villages people practice traditional shifting cultivation while in Khasi and Karbi villages people practice innovative shifting cultivation. The study revealed that people are constantly incorporating new measures into shifting cultivation to make it less degradative. Even local/traditional institutions in Garo hills have also taken some innovative measures like fine systems against destruction of natural forests, fire control measures, equity, conflict management, allocation of plots for shifting cultivation practices.

Several land development models are being implemented by different agencies/organizations for enhancing sustainability of shifting cultivation areas in northeast India. The Department of Agriculture, Government of Meghalaya has established watersheds, range-and pasture lands which encourages sustainable initiative on a regional scale to arrest degradation caused by shifting cultivation (Meghalaya Agriculture Profile 2006). The North Eastern Regional Community Resource Management Project (NERCORMP) is promoting 'livelihood' of shifting cultivation families through

Table 2. Technological innovations in different steps of shifting cultivation practices.

Land use/ management component	Khasi		Karbi		Garo	
	Traditional practice	Innovation	Traditional practice	Innovation	Traditional practice	Innovation
Slashing	Large tree boles retained	Selective tree stump also retained	Clear felling of forests	Short tree stump retained	Clear felling of forests	Short tree stump and large tree boles retained
Burning	Uncontrolled spot burning	Controlled burning	Complete burning	Partial burning	Fire line maintained	Fire line well maintained
Field preparation	Plants sown in rows for controlling soil erosion	Rows of bamboo raised on boundaries for soil conservation	Little or no water conservation measures	Stone bunding used for water conservation	No water conservation measures	Water channels constructed
Sowing	Predominantly broadcasting & dibbling	Crop specific method is adopted	Seeds collected from any individuals is used for sowing	Seeds are collected from healthy individuals for sowing	Predominantly broadcasting & dibbling	Crop specific method is adopted
Weed management	Weeds are used as mulch irrespective of species	Easily decomposing plant parts are used	Weeding done throughout the year	Weeding done during specific seasons and used as mulch	Clear cutting and burning of weeds	Uprooted and spread in the field
Cultivation	Mixed crops of cereals, legumes and tubers	Introduction of cash crops viz., turmeric, potato	Mixed crops of cereals, legumes and tubers	Introduction of Ginger and other cash crops	Mixed cropping predominantly tuber crops	Mixed cropping predominantly cereals and other commercially important plants
Harvesting	Selective harvesting of crops for self use	Harvesting for self use as well as for sale	Harvesting for self use	Selective harvesting for self use	Selective harvesting for self use	Selective harvesting for self use and also for sale
Fallow period	Long Fallow period (20-25 years)	Shorter Fallow period (8-15 years)	Long Fallow period (20-25 years)	Short Fallow period (3-5 years)	Long Fallow period (20-25 years)	Shorter (7-9 years)
Fallow management	Set aside for natural regeneration and no fallow management	Plantation of bay leaf, jackfruit and black pepper	Left as such no fallow management	Plantation of broom grass	Left as such no fallow management	Plantation of cash crops like Arecanut, Coffee and Citrus species

natural resource management, institution building at grassroot level and capacity enhancement. (NERCORMP 2010). Nagaland Environmental Protection and Economic Development (NEPED) promoted tree planting activity in shifting cultivation plots. It involved planting indigenous trees along with agricultural crops in the jhum fields during the first 1 - 3 years of cropping (NEPED 2002) thus enhancing the productivity and reducing soil erosion. Indian Council for Agricultural Research (ICAR) for North-Eastern Hill Region at Barapani in Meghalaya has evolved agri-horti-pastoral landuse system as an alternative to shifting cultivation (ICAR 1985). The modifications suggested by these research and development organizations in the shifting cultivation generally suggest to incorporate such measures that can revert the distorted jhum (short cycle jhum) to a system more akin to traditional shifting cultivation that is based on the time tested ecological knowledge of these tribal societies (Tiwari 2007). Present study shows that in areas where fruits of development programmes have not reached, the farmers by themselves through trial and error and experiential learning innovated their cultivation practices and are moving towards more productive and relatively sustainable agriculture. The findings of study to some extent corroborate the central idea of Shillong Declaration (2004) that jhum has several inherent and inbuilt mechanisms that make it sustainable and relatively productive system of farming in hill slopes of humid tropics. Thus blaming shifting cultivators for deforestation is unhelpful rather it is more important to assist in developing best-bet alternatives with economic incentives for producers such as giving a price premium for goods produced without damaging the forest (Norgrove *et al.* 2009) or inclusion of best innovative measures in existing systems.

Conclusions

While exploring the innovative measures of shifting cultivation practices, it was observed that a variety of indigenous techniques have been introduced by the tribal farming communities of Meghalaya for making the system more productive, less degradative and able to generate cash income for modern living. The farmers have adopted several management practices that help in soil, water and biodiversity conservation which in turn bring about sustainability to the system. Some of the measures noted in this study and also reported elsewhere viz., high crop diversity, weed management, retention of trees, use of poles and live hedges for soil conservation have potential of being adopted in modern agriculture on hill slopes of northeast India. It is these farmers led technological innovations that have helped in perpetuation of jhum in this part of India and elsewhere even after exposure to modern agriculture. The study also brings to fore that people across the communities are following the practice and are independently modifying it through their own experience and knowledge.

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